Managing Innovative Suppliers:

Exploring Company, Procurement

& Performance Variables

in New Zealand Construction Supply Chains.

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Abstract

The research concerned semi-dyadic relations in SMEs and large companies that managed innovative suppliers in New Zealand construction supply chains. This industry faced productivity and sustainability issues. In part, these issues could be solved with construction innovations from innovative suppliers. Construction innovations are complex and have low success rates. Extant research did not coherently reveal how companies managed such suppliers with the objective of procuring or (co-) developing and further introducing such innovations into construction supply chains. This research consequently wanted to increase the understanding on this phenomenon.

It investigated effects of (independent) company variables on (mediating) procurement management variables, and also the effects of these two types of variables on (dependent) procurement performance variables when managing innovative suppliers. Literature revealed a range of potentially-relevant variables and practices that could affect procurement management and performance. However, it regularly provided incomplete and partly-conflicting interpretations. These could be explained from the contingency theory and the early lifecycle of the research domain. Hence, the research was mainly exploratory and descriptive.

Exploratory interviews (N=5) revealed that innovation procurement in the case companies was professional and logical within their contexts. Findings reflected the inconclusive results from extant literature.

Survey I (N=112) revealed a fine-grained and varied picture. Most case companies followed a product leadership strategy, and were equally entrepreneurial toward innovative customers and innovative suppliers. They were innovative and gave innovative suppliers a dominant role in supplier innovations. They seemed to prefer radical innovations less than incremental innovations, but still somewhat more than New Zealand averages. Companies had slight preferences for new, small, or foreign suppliers for radical innovations. Innovations with supplier interactions were more beneficial to the company and the natural environment, than innovations without supplier interactions. Higher company innovation-benefits could equal higher environmental innovation-benefits. This profile differed from the profile of average companies in the construction supply chain.

Survey I only found weak correlations among output performance variables and process or proxy performance variables.

Dependent (procurement and performance) variables were affected differently. Conversely, independent (company and procurement) variables had different effects.

Different from extant literature, Survey I found limited statistically-significant effects of company variables on procurement management variables & practices, and of these two variable types on performance. A good minority (41%) of company variables affected procurement variables; only two company variables (13%) affected performance; a good minority (40%) of procurement variables affected performance.

The following two company variables affected performance: product leadership and NPD/innovation experience. Moreover, the three company variables: trust, lifestyle strategies and survival strategies affected procurement variables. Conversely, 27% of performance variables (satisfaction on marketing & sales, and benefits for the natural environment) and 30% of procurement variables (entrepreneurial orientation with innovative suppliers, intensity of relations with manufacturers, and small vs large suppliers for radical innovations) responded stronger on some company variables. Company size (<99 versus >250 staff) had little effects.

The following procurement variables: innovating, opportunity-seeking and trust towards innovative suppliers, and intense relations with innovative service providers had highest effects on performance variables. Conversely, 46% of the performance variables (satisfaction with innovative suppliers, benefits for natural environment and company) responded stronger on innovating, opportunities-seeking and trust variables.

Survey II (N=33) identified 12 procurement best-practices that respondents used for specific supplier or innovation types.

The research provided a nuanced and varied understanding on management of innovative suppliers, on the effects of entrepreneurial orientation to innovative suppliers, on the limited effects of company size, on the complex relation between various performance measures, and on entrepreneurship as a theoretical lens in innovation procurement. Companies had several options on how they managed their innovative suppliers. Additionally, the company characteristics and context of in this nascent research domain could be more important than commonly assumed from extant research.

Sample sizes were acceptable,   and validity was strengthened via triangulation. Due to the nascent research domain and the exploratory nature of the research, causation or correlation in the research was treated cautiously. Findings are relevant to industry and academia, but generalisation should be done with care. The thesis suggests several avenues for further research. Journal articles will follow.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person except for the co-authored articles as mentioned in the List of Publications and as explicitly referred to in this submission. This submission does not contain material, which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Anne Staal

> If you want to build a ship, do not drum up people to collect wood
> and do not assign them tasks and work,
> *but rather make them desire for the immensity of the sea.*
> Attributed to Antoine de Saint Exupéry (1900-1944).

Acknowledgements

Life can be a journey with desire and purpose, and not merely travelling from A to B. This PhD journey started in 2013. Meanwhile I learned, failed and explored and tried again, discussed with many others and with myself.

I experienced lonely nights at my desktop, when the sheer amount of work looked like an angry sea. But then the following weeks it looked like a good sailing day.

My family and I started our journey from Groningen to Auckland in 2013. We arrived with 6 m^3 of personal belongings, including four boxes with books and articles on procurement, SMEs, management and innovations. I very much feel indebted to people and friends at Auckland University of Technology and at Hanze University of Applied Sciences for their mental and financial support.

We lived in Auckland for three happy years. It gave me insights beyond obvious statistics, textbook examples, or newspaper success stories. With the fieldwork almost finished we returned to Groningen in 2016. After a break for family and monetary reasons, the work resumed in putting it all together. Again I enjoyed the financial and mental support from the two universities.

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List of Publications

Peer-reviewed conference papers

Staal, A., Hagelaar, G., Walhof, G., Holman, R. (2016). Developing Risk-Based Procurement Management Tools for SMEs. Presented at ACERE 2016, QUT, Brisbane, Australia.

Staal, A. Tookey, J., Seadon, J., Mobach, M., Walhof, G. (2015). How entrepreneurial New Zealand firms Procure Technical Innovations for the Construction Industry: A Literature Review. Presented at USE 2015, Hanze University of Applied Sciences, The Netherlands.

Crutzen, J., Losekoot, E., Staal, A. (2015). FM KIWI Style – The developments of Facilities Management professionals in New Zealand. Paper for European FM Conference 2015.

Staal, A., Tookey, J. (2015). Entrepreneurial or SME New Zealand construction firms procuring non-incremental sustainable technology innovations. Presented at ACERE 2015, Australia.

Hagelaar, G., Staal, A., Walhof, G., Holman, R. (2015). The Nature of Embedded Purchasing Activities in SMEs – Results from a Dutch multiple case study. Working paper for IPSERA Conference Amsterdam, the Netherlands. *Professor Van Weele tweet: promising research!*

Hagelaar, G., Staal, A., Walhof, G., Holman, R. (2015). Tool for identifying Critical Control Points in SME purchasing. Working paper for IPSERA Conference Amsterdam, the Netherlands.

Hagelaar, G., Staal, A., Walhof, G., Holman, R. (2014). A Conceptual Model and Analytical Framework for studying Purchasing & Supply Management in SMEs. *Rated as a TOP 10 competitive paper and presented at IPSERA Conference, South Africa*.

Staal, A. (2014). NZ construction SMEs procuring radical innovations. Paper presented at doctoral workshop IPSERA Conference, South Africa. *Winner of a 2014 IPSERA Bursary*.

Other publications

Staal, A., Walhof, G., Dries, J.R. (2018). Research Pilot on ISO 20400 Sustainable Procurement. (Work-in-Progress).

Staal, A. & Walhof, G. (2017). Negotiation Practices in Procurement. (In Dutch). Book special with "Shoppen voor Professionals, Inkoop in Strategisch Perspectief" by Van Weele, A., Van Berkel Schoonen, J. & Walhof, G., Vakmedianet BV, The Netherlands.

A Staal (2018). Blogs on my research & business teaching (ISO 20400; Future of Procurement; Sales & Procurement). Public Spend Forum (US).

Staal, A. (2015). Get Green Suppliers on Board. Presentation & article at FMANZ Summit.

Staal, A. & Walhof, G. (2015). At first sight - students' case study research on the purchasing function within four Dutch SMEs. (Work-in-progress).

Staal, A. Tookey, J., Seadon, J., Mobach, M., Walhof, G. (2014). Procurement of non-incremental sustainable technology innovations-the case of small entrepreneurial firms supplying New Zealand construction & building industry. Extended abstract presented at NZBERS, Massey University, Auckland, New Zealand.

Glossary of Terms and Definitions

Term	Definition	Sources or remarks
Acquiring innovations	The ability to locate, identify, evaluate and acquire innovations.	Lane & Lubatkin (1998); Manley *et al.* (2014). OECD (2005: 978). Koen *et al.* (2001).
Activities	Collection of tasks or sub-processes which structured together form a process aimed at a specific result.	Colliers & Evans, (2013: 143) hierarchically defined a task as a specific unit of work to create an output; an activity as a group of tasks to create an intermediate or final output; a process as a group of activities; a value chain as a network of processes. (See also Wynstra, 1998)
Affect (Could affect) (See correlation, and see causal relation)	The research wanted to increase an understanding into possible correlations or causations in relations among variables. For this the research developed conceptual models. (§2.14). However, as the research was exploratory it was not designed to determine causal relations. However from literature and the conceptual models the empirical research could indicate to a certain extent whether relation was a mere correlation or was possibly causal.	See §2.14 and §3.5 Hence this research applied qualifiers such as "seemed affected", "could affect", "could have an effect", "findings seemed", or "findings suggested". Also where such qualifiers were not used, relations had to be interpreted with care. (See also §10.4).
Business model	A company's purposeful alignment between its strategy and operations for creating value for customers and stakeholders. A conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money. A method of doing business by which the company sustains itself through generating revenues.	Wikstrom (2010: 834); Mason (2011: 1038). Ostenwalder & Pigneur (2013) Chesbrough (2003) For green construction business models see Mokhlesian (2012).
Case companies	The *focal companies* were the companies of interest for this research. The *case companies* were the subset of focal companies that actually participated in this research.	
Causal relation	The research design could not be structured to define "causal relations", but the design was exploratory to reveal relations which could be mere correlations or *possibly* be causal. Interpretation of findings could then give an *indication* of whether such relations merely correlated or were indeed causal.	§2.14; §3.5 (Cramer & Howitt, 2004: 20, 75). Hence this research applied qualifiers such as "seemed affected", "could affect", "could have an effect", "findings seemed", or "findings suggested". Also where such qualifiers were not used, relations had to be interpreted with care. (See also §10.4).
Construct	Components or concepts in the research objective that organise and guide the research. (Verhoeven, 2016: 317). This research defined a "construct" as a cluster of several related variables.	§1.4
Companies supplying the construction industry	The focus of this research were New Zealand 1st tier or 2nd tier companies supplying (directly or indirectly) to main contractors, (sub)-contractors, building companies the construction industry, or to asset and facilities owners or managers of built assets. The research was interested	Page (2013)

Term	Definition	Sources or remarks
(See also unit of analysis) (See also innovative suppliers)	in how such companies managed innovative suppliers. This is a broad definition: see §2.1.2 Examples of focal companies are (sub-) contractors (traders; subbies), material or component suppliers, or specialist service suppliers. In the New Zealand context such companies are often small (§2.6)	
Company performance measures	The result of procuremeny management practices; the combined procurement and innovation performance.	See §2.12.
Company variables	Company size, entrepreneurial orientation, company turnover type and company strategy, experience levels and roles of respondents, company age, customer strategy	§1.4 See Chapter 2, see §5.1
Construction and Building Industry (In short: construction industry)	Building is often seen as building for residential purposes (houses); Construction is often seen as building large scale civil engineering infrastructural projects (roads, bridges) or facilities for non-residential (e.g. hospitals, schools) or commercial purposes (shops, offices, factories). This research defined the constructoin industry as a part of the construction supply chain.	Source: Fairweather *et al.* (2009: 3) This is the vertical infrastructure of the built environment This current research excluded civil engineering i.e. horizontal infrastructure such as bridges or roads. Bates *et al.* (2001). (See also PWC, 2016) §2.1.2; §2.2
Construction company	Providing services for the construction of buildings and other structures, additions, alterations, reconstruction, installation, maintenance and repairs including companies engaged in demolition or wrecking of buildings and other structures, and clearing of building sites are included. It also includes companies engaged in blasting, test drilling, landfill, levelling, earthmoving, excavating, land drainage and other land preparation	(ANZSIC, 2015). These companies are primarily offering services, as opposed to supplier companies. The system integrator is often called contractor, main contractor, general or principal contractor. The contractor (or the clients) hires subcontractors for specialised services as mentioned.
Construction supply chain	This research distinguished between 1st or 2nd tier focal companies and their respective 2nd or 3rd tier suppliers. In this research "construction industry" was defined as a part of a "construction supply chain".	§1.4 See §2.1; §2.3; §2.4
Correlation	The research design could not be structured to define "causal relations", but the design was exploratory to reveal relations which could be mere correlations or possibly be causal. Interpretation of findings could then give an indication of whether such relations were indeed causal or merely correlated.	(Cramer & Howitt, 2004: 20, 75). §2.14; §3.5 Hence this research applied qualifiers such as "seemed affected", "could affect", "could have an effect", "findings seemed", or "findings suggested". Also where such qualifiers were not used, relations had to be interpreted with care. (See also §10.4).
could affect	The research wanted to increase an understanding into possible correlations or causations in relations among variables. For this the research developed conceptual models. (§2.14). However, as the research was exploratory it was not designed to determine causal relations.	For a discussion, see §3.5

Term	Definition	Sources or remarks
	However from literature and the conceptual models the empirical research could indicate to a certain extent whether a relation was a mere correlation or was possibly causal. Hence this thesis used phrases such as "seemed causal" or "seemed significant".	
Dyadic relationships	One-to-one buyer-seller relationships, the building block of supply chains. (See also semi-dyadic relations)	Johnsen *et al.* (2014: 30). Chick & Handfield (2014: 197) added the aspect that "both parties have the ability to influence each other".
Entrepreneurial company (See also innovative company)	Ambitious company that could have a potential of high growth through their innovating activities. Such company pursues long-term growth over short-term profitability. It is: pro-active to innovation and risk, show competitive aggressiveness, autonomy, opportunity recognition, growth ambitions, and organisational learning. It can be a game-changer and create new markets & products.	Zortea (2012). Manley (2008) Lumpkin & Dess (1996). Mazzarol (2013 44/69: 262). (Covin & Slevin, 1989) Davidsson: (2005: 4) distinguished between growth of entrepreneurial and growth of non-entrepreneurial companies. The latter being via steady (existing) business or via acquisition(s).
Entrepreneurial orientation (EO) variables	The research distinguished innovativeness, opportunity driven, aggressiveness, risk-taking. This research added trust, which often is not included as an EO variable	See §2.7.1 (Table 13); See §2.9.5 Based on: Lumpkin & Dess (1996) Wiklund & Shepherd (2008)
Environment	The surroundings or conditions in which a person, animal, or plant lives or operates. The natural world, as a whole or in a particular geographical area, especially as affected by human activity.	English Oxford Dictionary (2015) Related terms: zero-waste; cradle-to-cradle; industrial ecology; circular economy; closed loop (economy); reverse logistics; waste-reduction; waste-minimisation; clean production; energy-efficient; low-energy; energy-neutral; green; sustainable.
Environmental technologies	Environmental technologies include all those whose use is less environmentally harmful than relevant alternatives. (Colloquially also called green-tech).	European Commission (2006).
Focal companies	The *focal companies* were the companies of interest for this research. The *case companies* were the subset of focal companies that actually participated in this research.	See §1.1.1; §3.2.1
Green	Often as a synonym for environmental or sustainable.	Literature suggested (e.g. Miemczyk *et al.* (2012: 481, 484) that the term "green" is more commonly used than "environmental". As used e.g. in "green public procurement".
Green buildings	1. Integration with local ecosystems; 2. Closed-loop material systems; 3. Passive designs & renewable energy; 4. Optimized hydrologics; and 5. Full indoor environmental quality measures.	Kibert & Grosskopf (2005). They considered that current green building standards (LEED) based on existing materials and methods, tools and fee structures did not stimulate step-change innovations. Certification methods such as Green star, BREEAM, LEED. See Van Dijk (2014) for a comparison of several systems theories related to construction industry. Related terms: Green construction, sustainable green construction, low energy housing, passive energy housing. Sustainability.

Term	Definition	Sources or remarks
Incremental innovation See also radical innovation	The opposite of radical innovation. A small improvement of products, services, technological and organisational processes, leading to a successful commercialisation.	§2.10.1 See §2.2.3 for typologies of construction innovations, notably Table 5.
Innovation (to innovate; innovating; innovative)	In this research: The focal company procures (obtains or co-develops) product, process, or business innovation(s) from innovative suppliers, and possibly through interaction with its own innovation activities produces (manufactures) and commercialises (implements) a product, process, or business innovation with significantly improved or new benefits (functional performance) in economic and other terms.	See also §2.2.2. Based on Drucker, 1985, Dodgson & Bessant, 1996, OECD (2005), Hardie (2011). This research combines the procured input (product or process innovation), the innovation process and the output (product or process innovation). Sexton & Barret (2004: 344) stated that the *newness* aspect differentiated innovations from [other types of] change.
Innovative	In this research: establishing any non-obvious improvement leading to increased performance. (Slaughter, 1998; The use of "innovative" in this research was inter-subjective	See §2.2 See §3.2.3
Innovative company	A company that has implemented or is implementing an innovation. (In this research an innovative supplier, or a focal company)	OECD (2005: 47)
Innovative supplier (See also managing innovative suppliers)	A supplier that a focal company uses in a construction supply chain to procure (obtain or co-develop) supplier innovations.	§1.4 See Figure 9 on the construction supply chain in §2.1.2. (See also §2.2, §3.1.2 and §3.2.3).
Interaction (of activities)	Collaborative activities and inter-dependencies for ultimate company performance. This includes: joint prioritising, mobilising, co-ordinating, timing and decision-making.	Based on Wynstra (1998, 2004) Related terms: involvement, role, integration, contribution
Large companies	In the empirical part of this research (mainly Chapter 5, 6,7): large companies have >250 staff	See §2.6 See §5.1.1 and §6.1
Managing innovative suppliers (See also innovative supplier).	A part of procurement management processes in focal companies. A company that manages innovative suppliers procures product, process, or business innovation(s) from innovative suppliers, and possibly through interaction with its own innovation activities produces (manufactures) and commercialises (implements) a product, process, or business innovation with significantly improved or new benefits (functional performance) in economic and other terms. This included strategic or tactical practices or activities to specify innovation needs, find-select innovative suppliers, negotiate-contract, and manage-relations with innovative suppliers.	See definition in §2.2.2 See also §2.11 and §2.4
Market orientation	Market-driven management: A corporate culture focused on the market and on developing new knowledge; Distinctive capabilities to efficiently connect companies with the key market actors;	Arrigo (2015: 10).

Term	Definition	Sources or remarks
	and A flexible configuration that optimizes the acquisition of information and coordinates all activities within the organization.	
New Zealand companies	This research distinguished seven size classes, and notably distinguished between small focal New Zealand companies (1-99 staff) and large focal New Zealand companies (>99 or >249 staff) that managed innovative suppliers.	See §2.1 and §2.6
Open innovation	The use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively.	Chesbrough (2003) See §2.3.5
Open innovation strategy	A process in which organizations collaborate extensively with their environment, maximising the efficiency of external knowledge exploration and exploitation.	Lasagni (2012: 330); Chesbrough (2003)
Performance variables	Also called procurement performance variables. Innovation numbers, innovation turnover percentage, innovation-satisfaction measures (on procurement, innovation, and sales results), and innovation-benefits (for company & environment).	See §2.12; see §5.3
Procurement	Managing the company's external resources in such a way that the supply of goods, services, capabilities and knowledge (including acquiring or getting access to innovations) in exchange for financial means, is secured at the most favourable conditions.	Based on Van Weele (1988, 2010: 8), who used the word purchasing and did not include the financial means (cf. Telgen, 1998). Procurement is often the strategic term in the US; purchasing is the strategic term in Europe (EIPM, 2005). In construction the term procurement has a preference. (See Miller *et al.*, 2009: 10 for a discussion of definitions). Construction procurement is the project-based activities of clients and 1st tier main contractors to the 2nd tier level suppliers (Morledge, 2006). There is a relation with supply chain management, but procurement does not incorporate logistical aspects.
Procurement management (process) steps	This process includes four mains steps. Specify-needs; find-select suppliers; negotiate-contract; manage-relations with suppliers	Based on Van Weele (2010) See also EIPM (2005)
Procurement management practices (Practices)	Variables related to one of the four procurement process steps: specify-needs; find-select innovative suppliers; negotiate-contract; and manage-relations with innovative suppliers.	§1.4 See §3.5
Procurement management variables	Variables related to procurement decisions, e.g. entrepreneurial orientation towards suppliers, supplier types, supplier innovation types,	§1.4 See §2.9, §2.10; see §5.2
Procurement performance variables	The research distinguished related innovation numbers, innovation turnover percentage, innovation-satisfaction measures (on procurement, innovation, and sales results), and innovation-benefits (for company & environment)	§1.4 §2.12
Procurement strategy	Set of structured activities that affect the procurement function […] and the	Ad (1): NEVI glossary (2008: 221).

Term	Definition	Sources or remarks
(Synonym: Purchasing strategy)	procurement results. This strategy is derived from the company strategy. Synonym for sourcing strategy. The pattern of procurement (purchasing) decisions of materials and services to support operations activities in alignment with higher level strategy.	Ad (2): see sourcing Ad (3): Carr & Schmelzer, 1997). (on a commodity level)
Radical innovation (Synonym: Step-change innovation)	The drastic (non-trivial, non-incremental) renewals or improvements of products, services, technological and organisational processes, leading to a successful commercialisation. Many definitions available (discontinuous, system, systemic, disruptive, integral; see §2.2.3).	Linton (2009) Slaughter 2000) OECD (2005) Drastic is related to level of newness for the company and/or its customers and competition and to impact and linkages.
Relation between variables	The conceptual models posited from literature whether relations between variables were merely correlation or possibly causal. This logic was applied in the empirical research. However due to the exploratory nature of the research, statistical analysis would only assume, and not establishe such relations.	See §2.14 and §3.5 (Cramer & Howitt, 2004: 20, 75). Hence this research applied qualifiers such as "seemed affected", "could affect", "could have an effect", "findings seemed", or "findings suggested". Also where such qualifiers were not used, relations had to be interpreted with care. (See also §10.4).
Reliability (qualitative)	In this research: How well can exploratory interviews and focus-group discussions be reproduced?	Based on Yin (1994: 33) See §3.7.1
Internal validity (qualitative)	In this research: How well can the interviews and the focus-group discussion establish causal relationships?	Based on Yin (1994: 33) See §3.7.1
External validity (qualitative/ quantitative)	In this research: How well were the research results (i.e. new theoretical insights) generalisable to another theoretical domain?	Based on Yin (1994: 33) See §3.7.1
Internal validity quantitative	In this research: Content validity: How well was the phenomenon from the conceptual model represented in the Survey? How did the data collection methods (scale or measurement instrument) measure what it was designed to measure? Instrument validity: How well can the standard, criterion or instrument used make accurate predictions?	Based on Yin (1994: 33) See §3.7.2
Construct validity qualitative	In this research: Having the right measures for the constructs being studied	Based on Yin (1994: 33) See §3.7.1
Reliability (quantitative)	In this research: To what extent can Survey I and II be reproduced by future researchers?	Based on Yin (1994: 33) See §3.7.2
Construct validity quantitative	In this research: How well do the measurement questions actually measure (represent) the presence of the constructs they were intended to measure?	Based on Yin (1994: 33) See §3.7.2
Shadow company	In this research related to company size: Employees from suppliers with long-term relationships were not counted as employees of a focal company but could still be considered part of the extended company.	NZIER (2014: 11) See §2.6.1.1
Small company (also small	NZ: SMEs with <20 staff USA: SMEs with < 500 staff EU: SMEs with < 50 staff	MBIE (2013b) See §2.6.1.1. Definitions vary over countries.

Term	Definition	Sources or remarks
entreprise or small business)		
Small companies	In the empirical part of this research (mainly Chapter 5, 6,7) small companies (SMEs) have <100 staff.	See §2.6.1 See §5.1.1, §6.1
Semi-dyadic relations	See dyadic. A relation analysed or managed from either the perspective of the supplier or from the perspective of procurement.	Johnsen *et al.* (2014: 30).
Small and Medium-sized Enterprises (SMEs)	New Zealand SME companies are smaller than US or European SME companies. This research defined SMEs <100 staff.	SMEs in USA: 10-500 staff SMEs in Europe: 9–250 staff SMEs New Zealand: 1-19 staff See §2.6.1.1 for more details and a classification.
Sourcing	Process to identify, qualify and select new suppliers. (Often inadequately used as a synonym for procurement or purchasing)	EIPM (2005)
Sourcing strategy	Identifies for a specific category from how many suppliers to buy, what type of relationship to pursue, contract form and duration, sourcing locally or globally.	Van Weele (2010: 410). See also procurement strategy.
Strategic procurement (strategic purchasing)	The process of planning, implementing, evaluating, and controlling strategic and operating purchasing decisions for managing all activities of the purchasing function toward opportunities consistent with the company's capabilities to meet its long-term objectives.	Carr & Schmelzer (1997). Hence on a functional level. Make/buy Type of relationship Decide how procurement should support company strategy.
Strategy (See also procurement strategy)	As a plan, ploy (tactic), pattern, position, perspective In an SME context this could either be deliberate or emerging patterns of actions.	Cf. Mintzberg (1990): Schools of Strategies. Cf. Ates (2008: 227); Verreynne (2006)
Supplier (See also innovative supplier)	A company providing goods, services or information to a buying company Synonyms: Vendor, seller, manufacturer or small contractor.	Benton & McHendry, 2010: 228) In some contexts 'supplier' denotes a company that supplies materials, while 'contractor' is used for providers of services. (CIPS glossary).
Supplier innovation	An innovation procured from or co-developed with an innovative supplier	See §2.1.2, §2.2, §2.3
Supplier-innovation variable	The research contrasted radical versus incremental innovations, product versus process innovations, and procurement priorities in the idea phase versus develop phase in innovation processes with innovative suppliers.	§2.10
Sustainable Related terms: Green, clean, social, environ-mental	Meet the need of the present generations without having an impact on the needs of future generations.	Brundtland (1987) This implies considering the triple bottom line (Elkington, 1998) of economy, society and environment for multiple stakeholders. Bos (2010) distinguished between a regulation approach (must-comply) or a voluntary approach (want to comply / improve).
Sustainable procurement	Sustainable procurement is the consideration of environmental, social, ethical and economic issues in the management of the organisation's external resources in such a way that the supply of all goods, services, capabilities and knowledge which are necessary for	Based on Miemczyk *et al.* (2012). This definition is broader than the definition of environmental procurement that is being used in this current research.

Term	Definition	Sources or remarks
	running, maintaining and managing the organisations primary and support activities provide value not only to the organisation but also to the society and the economy.	
Technical innovation	Practical application of technology which leads to significantly improved functional performance.	Based on Hardie (2011b). She used the term 'technical innovation' referring to Slaughter. But then Slaughter only defined 'innovation' (with a reference to Freeman, 1989). Hardie (ibid: 33) saw the technical aspect in improved functionality hence "significantly improved functional performance".
Technology	Includes know-how, intellectual property (e.g. patents), copyright, prototypes, devices & technical services.	Dahlman & Westphal (1981). OECD (2005). Sexton & Barrett (2004) saw technology innovation transfer in SMEs as "the know-how about the transformation of operational technologies and processes; material technologies; and knowledge technologies"
Unit-of-analysis	In this research: Procurement processes within focal companies with one innovative supplier on one innovation.	See §3.1
Variables	Individual element or attribute upon which data have been collected. (Saunders, et al. 2009: 603) Factors, drivers, attributes, determinants, characteristics etc. that can relate to or affect other variables or practices	This research further distinguished *practices* (within procurement steps), and *activities* (used in a general sense as a collection of tasks (Collier & Evans, 2013: 143).
Variable type	In this research: several related variables, i.e. company variables, procurement management variables, procurement performance variables.	See §1.4

See also "cluster" |

Appendices to the Research

This is a separate document.
It includes the overview of references.
Appendices are listed in order of first occurrence in the thesis text.

List of Literary Citations used throughout the Thesis

Since the late Middle Ages it has been customary at Dutch universities that doctoral students also defend a number of propositions during their oral examination. Some of these would relate to the thesis matter; others would relate to social, political or even humorous aspects.

Some theses would mention quotes from poets, writers or philosophers, which would be inserted in the thesis on a loose sheet of paper. This thesis used such quotes at the beginning of each Chapter.

ACKNOWLEDGEMENTS
If you want to build a ship,
don't drum up people to collect wood and don't assign them tasks and work, *but rather make them desire for the immensity of the sea.*
Attributed to Antoine de Saint Exupéry (1900-1944).

PART 1
Die Schärfe eines Messers trennt alles vom nichts – in der Mitte ist man allein.
(A sharp knife dissects all from nothing – one is left alone in the middle.)
H. Arkstede (1910 – 1988).

CHAPTER 1
Apart from the known and the unknown, what else is there?
H. Pinter (1965).

CHAPTER 2
Mit dem Wissen wächst der Zweifel.
(Doubt increases with knowledge).
W. von Goethe (1749 – 1832; Reflections).

CHAPTER 3
I keep six honest serving-men
(They taught me all I knew);
Their names are What and Why and When
And How and Where and Who.
R. Kipling (1865 – 1936).

PART II

No man is an island.
J. Donne (1572-1631).

CHAPTER 4
Nothing ventured, nothing gained.
English proverb.

CHAPTER 5
The art of data analysis usually lies in finding the most useful and appropriate comparisons to make.
J. MacInnes (2016: 254).

CHAPTER 6
Where is all the knowledge we lost with the information.
T.S. Elliot (1888-1965; The Rock).

CHAPTER 7
Life is what happens to you, while you are busy doing a PhD project.
Based on J. Lennon (1940 – 1980).

CHAPTER 8
If at first you do not succeed – try again!
W.C. Fields (1880 – 1946).

PART III
I have not failed. I have just found 10,000 ways that won't work.
Th. A. Edison (1847-1937).

CHAPTER 9
[...] leaving the rest unsaid,
Rising in air as on a gander's wing
At a careless comma,
R. Graves (1895 – 1985).

CHAPTER 10
The beginning is the most important part of the work.
 Plato (approx. 427 BC - 347 BC).

***

PART I

Die Schärfe eines Messers trennt alles vom nichts – in der Mitte ist man allein.
(A sharp knife dissects all from nothing – one is left alone in the middle.)
H. Arkstede (1910 – 1988).

Introduction to Part I

Part I introduces the research on how companies manage innovative suppliers in New Zealand construction supply chains. This is a relevant topic from a business, an environmental and a societal perspective. Indeed, we all live and work in buildings that were constructed and are maintained by companies in construction supply chains. Construction innovations can for example improve affordability of buildings, can make them more beautiful, can make them safer to build or maintain, or can reduce the related carbon footprint or waste. However, success rates for construction innovations are low. Moreover, we know little how we manage innovative suppliers who often contribute to construction innovations.

Chapter 1 introduces the research topic. It gives a justification of the research, presents the research objectives and gives a summary of the research methodology. Chapter 2 presents a review of the current literature related to the topic. Chapter 3 discusses the methodology needed for the research.

Part II presents and discusses empirical results.

Part III synthesises findings, gives conclusions, implications and limitations on the research.

Chapter 1

Points of Departure

Apart from the known and the unknown,
what else is there?
H. Pinter (1965).

Chapter 1

Points of Departure

There is a common opinion (supported by research, e.g. Fairweather, 2010; BRANZ, 2014; PWC, 2016; Curtis & Norman, 2014: 11) that the construction industry in New Zealand and in other countries is not innovative compared to other industries. However, the construction industry regularly adopts new technologies and implements improved processes. Such changes are driven by sustainability ratings, more stringent regulator demands, informed clients, costs, or customer trends (Lim & Ofori, 2007; Hardie, 2011b; Miller *et al.*, 2009: 61). Alternatively, innovative suppliers can drive such changes[1]. (For example: Winch, 1998, Bossink & Vrijhoef, 2004; Pries & Janzen, 1995). This Chapter discusses the context, scope, relevance, and objectives of the research topic.

Opinions on innovativeness in construction are fuelled by different innovation definitions, objectives, and measures. Whether innovative or not, the construction industry has a large impact on national economies, the natural environment, and personal wellbeing (e.g. Anting *et al.*, 2014). Studies and government initiatives often expressed the need for more construction innovations (e.g. Latham, 1994; Egan, 1998).

Academic research tends to discuss construction innovations on a micro, meso or macro level and from different perspectives such as business development, competitive position, innovation management, or governmental support policies. Using construction innovations can be inherently risky as they need to interface with other building systems, are installed by low-to-medium-skilled construction workers, and have a technical life that exceeds many innovations in other industries. It tends to be forgotten that such innovations need to be *procured* as well. As an example, academic textbooks on construction procurement (Benton

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[1] For an extensive review of sources for this Chapter, please see Chapter 2.

et al., 2010; Morledge *et al.*, 2006) did not discuss procurement of construction innovations[2].

Academic research on construction procurement frequently focuses on procurement systems, i.e. the procurement methods between principals (clients) and main contractors or architects, or on procurement strategies between main contractors and their subcontractors (Bemelmans, 2012; Hinton, 2013; Vrijhoef, 2011). Principals, architects, engineers and main contractors often depend on upstream companies in supply chains for construction innovations (Mlecknik, 2013). (§2.1.1; §2.3.4). However, such research does not coherently discuss procurement processes related to such supplier construction innovations. (§2.13).

As is described in more detail in Section §2.2, chances of success in construction innovations are low. This current research posits that the ultimate success of construction innovations also depends on procurement management processes with innovative suppliers.

The locus of this study was New Zealand and the research focused on *how New Zealand companies managed innovative suppliers in construction supply chains*. Most New Zealand companies in the construction industry were small or very small by nature (Page, 2013; PWC, 2016)[3]. In New Zealand 96% of construction companies (PWC 2016: 12) have <10 staff. In fact, the only multinational (integrated) New Zealand construction company enjoys a de-facto monopoly position.

Developing or procuring innovations and successfully bringing such innovations to the market requires a management and business process (Davidson, 2013: 344; McCoy *et al.*, 2010). Extant procurement research is often positioned in the domain of operations management, and (open) innovation research is often positioned in the domain of innovation management. This research posited that when companies managed innovative suppliers, they could exhibit entrepreneurial traits, i.e. be innovative and opportunity-driven (Lumpkin & Dess, 1996; Davidson, 2016). Hence the research also assessed entrepreneurial research. Finally, as many New Zealand companies are small by nature, this research included a growing body of small business (SME) research. The research combined

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[2] This research used the word "procurement" but acknowledged a large body of (mainly European-based) research that would use the word "purchasing" with the same connotation. (See §2.3.2).
[3] This research distinguished between small (or smaller) companies with ≤99 staff, and large (or larger) companies with >99 staff. Related words in this research: SMEs, small business, firms. (See §2.6.1).

these five research domains in a specific construction supply chain context. (§3.4). It put extra focus on SME procurement and SME inbound open innovation. (§2.3.3; §2.3.6).

Table 1 below provides quotes taken from academic literature. These quotes suggested a knowledge gap in research *on how companies in the construction industry procured innovations.* This research took a narrower approach as it focussed on how such companies *managed innovative suppliers.* It explored this gap in detail with the objective to increase the understanding of the research topic. (See §1.6; §2.13).

Table 1: Quotes suggesting gaps in academic literature on the research topic

There is a dearth of research investigating innovation from the perspective of the small construction company.	Sexton & Barrett (2003: 623)
We need case-study research on the trajectory of particular [construction] innovation to identify who generates new ideas and how they are managed into good currency.	Winch (1998: 277)
It is likely that supply chains could be critical during the develop phase of a [construction] innovation, but become less so when things are progressing well.	Hardie (2011: 260)
International procurement of SMEs remains an under-researched phenomeon.	Agndal (2006: 182)
[Participants] did not reveal a great deal about their supply chain relationships [...] which could simply represent a reluctance to be open about commercially sensitive [supplier] relationships.	Hardie (2011: 260)
Mainstream purchasing models and techniques, grounded from the perspective of dominant and highly resourced companies, and are being used to measure the efficiency and effectiveness of SMEs. It is questionable how appropriate these techniques are when applied to much SMEs with fewer resources.	Morrissey & Pittaway (2006: 279-280)
SMEs could be following the development of large companies in terms of their approach to purchasing but are currently lagging behind.	James *et al.* (2012: 9)
Future [SME] purchasing research should investigate the relationship between motives, purchasing practices and purchasing performance. SME types should be differentiated by context [importance of input costs, commodities, or high-tech market, motives [entrepreneurial, lifestyle, survivors], sector [industry, profitability] and size [micro, small, and medium]. Research needs contrast small versus large companies [and needs to avoid] large company concepts and vocabulary [to get a better understanding].	Morrissey & Knight (2011: 1152)
[We see] an excessive and exclusive interest in high growth / technology businesses in entrepreneurship, [...] rather than [...] a desire to understand the diversity inherent in entrepreneurship.	Welter *et al.* (2017: 2)
Studying innovations in large companies is easier than in SMEs	Urbina *et al.* (2012: 174)
Despite the rapid growth of academic papers about open innovation in innovation management field, few studies have [yet] investigated the existing theoretical linkage between [market-orientation (market-driven management)] and open innovation.	Arrigo (2015: 2)

This Chapter continues with discussing productivity and sustainability (§1.1), the justification of this research (§1.2), and stakeholders and beneficiaries of this research (§1.3). It then discusses research aims and objectives (§1.4), and research questions (§1.5). Section §1.6 presents a summary of the methodology; Section §1.7 presents main assumptions and limitations. Finally, Section §1.8 gives a chapter summary and conclusions, and shows the main structure of this thesis.

1.1 Productivity and Sustainability in the Construction Industry

The building & construction industry designs, builds, and maintains residential and non-residential buildings. (Fairweather *et al.* (2009). The industry accounts for approx. 8% of the New Zealand GDP, and its 178,000 employees form approximately 10% of the nation's workforce (PWC, 2016). The economic activity related to this GDP was comparable to other developed countries. Major cities such as Auckland, Wellington and Christchurch have an increasing demand for new buildings. Related investments make an important contribution to the New Zealand economy (PWC, 2016).

In New Zealand and other countries this industry faces *productivity issues* (Anderson, 2012; Benton, 2010; Bossink & Vrijhoef, 2009; Fairweather *et al.*, 2009) which affected product quality, private affordability, and public government spending. Moreover, the industry was *environmentally unsustainable* (DOE, 2009; EIPRO, 2006; EU 2009; IMPRO 2008; Van Dijk *et al.*, 2014: 21; for New Zealand: Curtis & Norman, 2014) as construction activities, occupancy, and demolition activities were energy-inefficient, caused physical waste and high CO_2 emissions. (See §2.1.1).

The past decades have seen government and industry initiatives to understand and to improve the *construction industry productivity*. The New Zealand construction industry piloted advanced process improvement techniques such as alliancing (see Vilasini, 2014) and lean methodologies such as the last planner system (Zaeri *et al.*, 2017). The industry experimented with supply chain integration (Masood *et al.*, 2016: 18)[4]. As a legislator and as a dominant client, the New Zealand government aimed to increase productivity and reduce its own construction procurement costs by 15-20% (MBIE, 2013a).

The past decades have also seen government and industry initiatives to understand and improve *sustainability in the construction industry*[5]. The New Zealand Waste Minimisation Act 2008 (WasteMINZ) currently (2017) does *not* require sustainability targets. Nevertheless, New Zealand has seen sustainability initiatives in the construction industry, notably in the Productivity Partnership initiative (Buildingvalue.nz, 2012), and with several industry associations (e.g. PrefabNZ and NZGBC). New Zealand has witnessed a modest rise in new buildings with sustainability rankings (Cutler, 2015). New Zealand capital costs for sustainable buildings seemed to be high, although e.g. Cutler (ibid: 6-16), Bush (2014), and

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[4] For productivity examples in New Zealand see BRANZ (2010), New Zealand Green Building Council and Buildingvalue.NZ (2012); in AU see BRITE; in the UK see GCS (2012); in NL see Chain Integration AFNL (2010).
[5] For sustainable examples in New Zealand see BRANZ/REBRI; in Netherlands see Bossink (2004), Bos (2010); in Australia see BRITE & SBENRC programmes, e.g. by Manley (2007-2013); in the United States see Kibert (2005), McCoy (2012), (Sheffer (2010, 2013).

Bint & Pollard (2014: 74) argued otherwise. The discussion on costs versus sustainability also depends on the exact functionality and the heterogeneity of new buildings (Rehm & Ade, 2013: 207). However, considering that the life of the average New Zealand building is 50–80 years, upgrading (renovating and retrofitting) existing buildings will have a priority (Wilkinson, 2012).

1.1.1 Improvements and Innovations in the Construction Industry

Improvements in construction is not a new theme. Agren & Wing (2013) discussed a history of improvements and innovations over the last 250 years. De Valence (2010) discussed early research by Rosefielde and Mills (1979) on construction innovation. The UK Latham report (1994) and Egan report (1998) both discussed the need to stimulate construction innovations. The latter report explicitly called for "step changes" (Sexton & Barrett, 2004: 342). Similar studies from the US (Benton & McHenry, 2010), stressed the need for construction innovation. As referred to in the previous Section, the New Zealand government published a target for increasing the multi-productivity in 2020 by 15%-20%. (MBIE, 2013a).

In his seminal work on creative destruction in the construction industry, Winch (1998) saw this industry as a complex system where the *innovation infrastructure* (trade contractors, consultants, suppliers) proposed innovations (see Figure 1 below). He saw critical roles for the two *system integrators* (architects & engineers, and principal (main) contractors) and for the *innovation superstructure* (clients, regulators, and professional institutes) in the adoption of such innovations.

Winch (1998) concluded that resistance and defending self-interest (notably from regulators and professional institutions) hindered the adoption of construction innovations. In this context, he perceived two problems. Firstly, the system integrator is split over two roles. Second, whereas (2) architects / engineers have technical skills, they cannot integrate subsystems. In addition, whereas main contractors possess skills on a management level they have fewer skills on a technical level. As the (fragmented) professional institutions cannot play a brokering role this leads to "system sub-optimisation" (Winch, 1998: 10). This causes issues in the normal operations of the chain, but certainly in the diffusion of innovations (Bossink & Vrijhoef, 2009: 7).
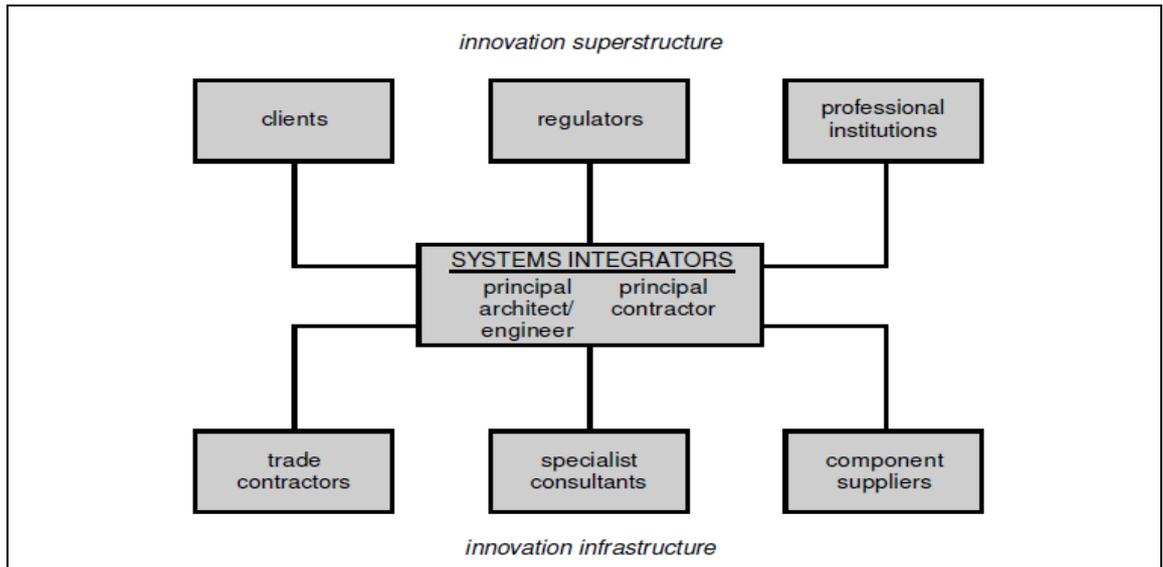
Figure 1: The construction industry as a complex system (from Winch, 1998: 271)

This research visualized the construction supply chain for innovations as shown in Figure 2 on the following page. (For an explanation, see §2.1.2). The *focal companies*[6] of this research were 2nd tier companies but could also be 1st tier asset managers or owners.

This research posited that if the New Zealand construction industry wanted to meet *productivity* and *sustainability* targets, it needed more innovation initiatives. It would need (relatively frequent) *incremental* and (relatively in-frequent) *radical* construction innovations. (For definitions see §2.2).

The focal companies (i.e. tier 1 or 2 companies) of this research would (co)-develop or procure such innovations from upstream 3rd or 2nd tier innovative suppliers (e.g. Pries & Janszen, 1995; Koebel, 2008; Slaughter, 1999). The research was interested to know how such focal companies managed such innovative suppliers. In this research "innovate" was defined *as establishing any non-obvious improvement leading to increased performance*. (Slaughter, 1998; see §2.2). This concept of "innovative" was used inter-subjectively in this research depending on the perception of the research-participant. (See §3.2.3).

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[6] Focal: relating to the centre or most important part. (Oxford Dictionaries, accessed 21 June 2018).
The *focal companies* were the companies of interest for this research.
The *case companies* were the subset of focal companies that actually participated in this research.
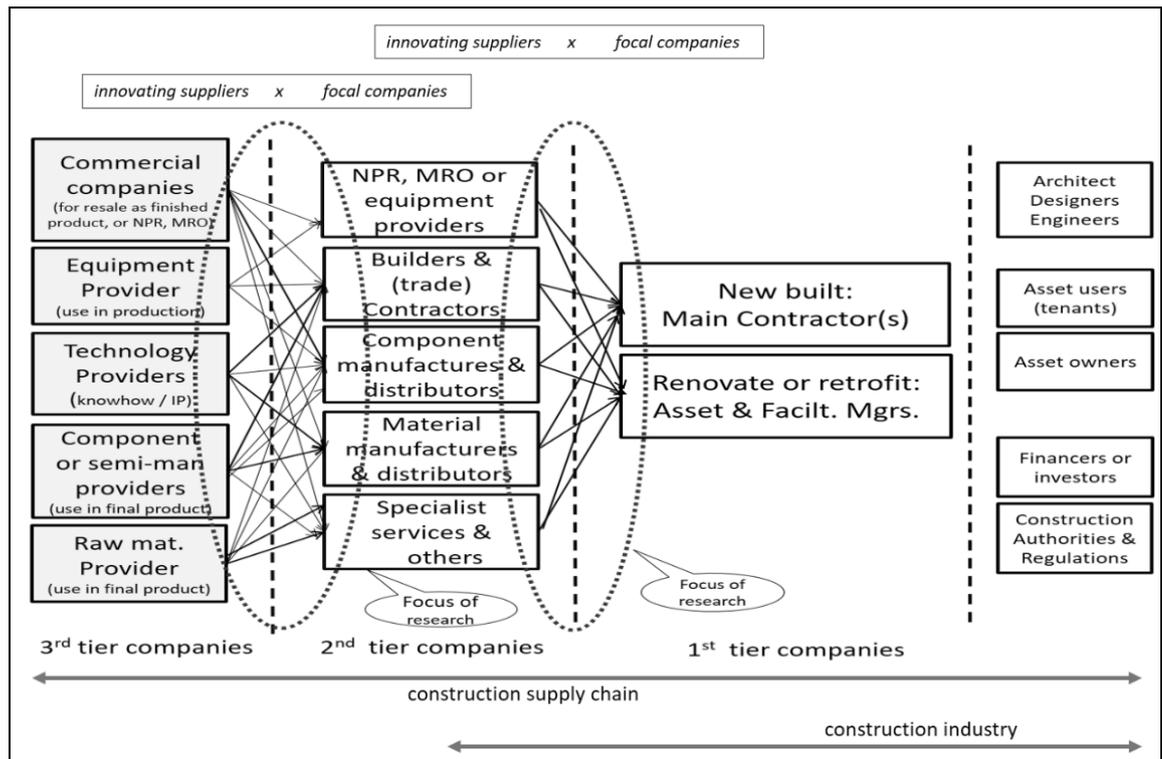
Figure 2: Construction supply chain with 2nd and 1st tier companies as focal companies

Section summary-conclusion:
1. *The New Zealand construction industry faced productivity and sustainability issues. In part these issues could be solved with construction innovations from upstream 3rd and 2nd tier innovative suppliers. This research focused on how companies managed such innovative suppliers.*

1.2 Justification of this Research

The research explored how focal New Zealand companies managed innovative suppliers in construction supply chains. Focal companies that managed or owned commercial or industrial property assets would be large. However, especially within the context of New Zealand, most focal companies of this research were small (Page, 2013; PWC, 2016; see §2.1, §2.6). Figure 2 in §1.1 shows several types of focal companies. This research posited that these companies could exhibit different innovation procurement behaviour, depending on internal or external factors. (§2.6.1).

Small companies (SMEs) in construction are "dominant" (Koebel, 1999) in numbers and in economic output (OECD, 2010ab). There is a common perception that SMEs behave uniformly, which is also suggested by the common practice of segmenting such companies only on industry, turnover, or size. However, SMEs vary on organization, specialization,

ambitions and strategies, management practices and possibly also on other aspects. (Meijaard *et al.*, 2005; Keijzers *et al.*, 2007; Julien, 1995, Torres & Julien, 2005. See §2.6.1).

Procurement research often focuses on operations management; less so on supplier innovations; and then often from perspective of public bodies or large corporates. (Johnsen *et al.* 2017, Benton, 2010, Pryke, 2009). Procurement can play an important role within SMEs (Paik, 2009abc, 2011; Pressey *et al.*, 2009; Quayle, 2002). Research only slowly appeared on small-company procurement (e.g. Hagelaar *et al.*, 2014, 2015; James *et al.*, 2011, 2012; Morrissey & Pittaway, 2004, 2006; Morrissey & Knight, 2011). Procurement activities and innovation activities are conducted by the owners or senior staff (e.g. Ellegaard, 2006: 273), depending on company structure, the owners' characteristics and ambitions, and the importance, complexity, or uncertainty (risk) of the purchase (Hagelaar *et al.*, 2015b). Research also suggested (Morrissey & Knight, 2011; Paik, 2009, 2011; Ramsay, 2007) that procurement processes among SMEs could vary.

Similarly, research suggested (Lee *et al.*, 2010; Urbina-Criado, 2012; Van der Vrande *et al.*, 2009; Wynarczyk *et al.*, 2013; Zabala, 2012) varying approaches on open innovation processes within SMEs. Finally, small business construction research on innovation (e.g. Hardie, 2006; Miller, 2009) suggested various innovation approaches depending on company and innovation variables. (See Sections §2.3.2 and §2.3.6 for a discussion on procurement and for inbound open innovation in SMEs). Diffusion of innovations in construction is difficult (Fairweather, 2009; Bossink & Vrijhoef, 2009). Companies often procure such innovations upstream (Slaughter, 1999; Pries & Janszen, 1995; Koebel, 2008).

The management relevance of the current PhD research project was clear: main contractors, asset owners, or asset users depend on construction supply chains for construction innovations. As discussed, the innovativeness in construction supply chains is lagging. Sections §2.1 to §2.4 discuss bodies of literature from the domains of innovation, open innovation, procurement, construction management, small business, or entrepreneurship. They describe aspects of the diffusion and adoption of innovations in construction supply chains. However, this research found *no comprehensive literature on how companies managed innovative suppliers to (co-) develop or introduce supplier innovations further into construction supply chains.*

Section summary-conclusion:
2. *Extant research suggested a paradox. Successful supplier innovations in construction supply chains could stimulate construction productivity, sustainability, decrease costs, or increase quality.*

3. *However, extant research does not coherently discuss how companies managed innovative suppliers with the objective of procuring or (co-)developing and introducing such innovations into construction supply chains.*

1.3 Who were involved & Who would benefit

Schumpeter (1942) was one of the first to posit that successful innovations increase company profits and are beneficial for the prosperity of national economies. This was confirmed in numerous later studies (for innovation-benefits see e.g. Tidd & Bessant, 2009: 11-12; for construction innovation-benefits see e.g. Manley *et al.*, 2005). Literature distinguished several drivers for construction innovations as is discussed §2.2.3.3. Such innovations benefit direct stakeholders in the construction industry (companies, employees, principals or end users).

Following a stakeholder perspective (e.g. Bossink, 2006, Kibbeling, 2010) allowed for incorporating more (indirect) stakeholders as successful innovations could also have economic, environmental, and social benefits (for philosophical perspectives on this research, see §3.4).

Consequently, the outcome of this research could be beneficial to companies that managed innovative suppliers, and to their direct suppliers and customers. It was hoped that this research could also (ultimately & indirectly) benefit owners, tenants and users of buildings, employees and neighbours, the wider industry, institutions, and the natural environment. Finally, the research aimed to bridge academic knowledge gaps.

Section summary-conclusion:
4. *The research aimed to have a scientific, management and societal relevance.*

1.4 Research Aim and Research Objectives

There was a lack of theoretical & empirical understanding on *how companies managed innovative suppliers in construction supply chains*. The overall research aim was to learn how companies procured innovations from such suppliers. The research posited that specific internal and external variables could affect (§3.5) how such innovative suppliers were managed.

In more specific and manageable terms the *overarching research objective aimed to:*

Explore to what extent company variables could affect procurement management variables and practices, and furthermore how these two variable types could affect procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains.

The sensitising constructs[7] in this research objective were defined as follows:

- "variables" factors, drivers, attributes, determinants, characteristics etc. that could affect other variables or practices[8]. (For a discussion on causal or correlation effects, see §3.5).
- "company variables". The research used variables related to company size, company or customer strategy, experience and roles, entrepreneurial orientation. (§2.6, §2.8).
- "procurement management variables". The research distinguished several procurement management variables related to procurement decisions:
  - "entrepreneurial orientation variables". The research distinguished innovativeness, opportunity driven, aggressiveness, risk-taking (trust) towards innovative suppliers. (§2.7)
  - "supplier type variables". The research contrasted foreign versus domestic, new versus current, and small versus large suppliers, and identified the intensity of supplier relations (and trust levels)[9]. (§2.9)
  - "supplier-innovation type variables". The research contrasted radical versus incremental innovations, product versus process innovations, and procurement priorities in the idea phase versus develop phase in innovation processes with innovative suppliers (§2.10)
- "procurement management practices" or simply "practices". The research separately distinguished procurement management practices in four procurement process steps[10] (specify-needs, find-select innovative supplier, negotiate-contract, relations with innovative suppliers). In part, the research classified such practices as belonging to the procurement management variables. (§2.4; §2.11).
- "procurement performance variables". The research distinguished related innovation numbers, innovation turnover percentage, innovation-satisfaction measures (on procurement, innovation, and sales results), and innovation-benefits (for company & environment). Note that these variables could also be labelled "innovation performance", however this research considers this performance as a result from procurement activities. (§2.12).
- "could affect". The research wanted to increase an understanding into possible correlations or causations in relations among variables. For this, the research developed conceptual

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[7] Components or concepts in the research objective that organise and guide the research. (Verhoeven, 2016: 317). This research defined a "construct" as a cluster of several related *variables*. (See footnote below).

[8] *Variable*: individual element or attribute upon which data have been collected. (Saunders, *et al.* 2009: 603). Depending on the context, extant research also used phrases as characteristics, drivers, attributes, determinants, factors, or also tools, strategies, instruments, or activities.

In this research *variable types* are company, procurement management, or performance variables. This research further distinguished *practices* (within procurement steps), and *activities* (used in a general sense as a collection of tasks (Collier & Evans, 2013: 143).

[9] In Chapter 8 (conceptual model **III**) the innovation and the supplier variables were jointly referred to as "supplier-innovation variables"

[10] In this research each of the four "procurement process steps", "procurement steps", or "process steps" contained "procurement management practices". A "procurement management practice", a "procurement practice" or just a "practice" was a specific variable within a procurement process step. Extant research also tended to call such "practices", variables, tools, strategies, instruments, or activities. (See §2.11).

models. (§2.14). However, as the research was exploratory it was not designed to determine causal relations. However, from literature and the conceptual models the empirical research could indicate to a certain extent whether a relation was a mere correlation or was possibly causal. Hence this thesis used phrases such as "seemed causal" or "seemed significant". (For a discussion, see §3.5).

- ▪ "New Zealand companies". This research distinguished several size classes, and notably distinguished between small companies (1-99 staff) and large companies (>99 or >249 staff) that managed innovative suppliers. (§2.1; 2.6).
- ▪ "innovative" in this research was establishing any non-obvious improvement leading to increased performance. (Slaughter, 1998; see §2.2). The use of "innovative" in this research was inter-subjective (see §3.2.3).
- ▪ "innovative supplier" in this research was a supplier in a construction supply chain that a focal company used to procure (obtain or co-develop) supplier innovations. (§2.1.2, §3.1.2)
- ▪ "managed innovative suppliers" was considered a part of procurement management processes in focal companies. It included strategic or tactical practices or activities to specify innovation needs, find-select innovative suppliers, negotiate-contract, and manage-relations with innovative suppliers. (§2.1.2; §2.2; §2.11).
- ▪ "in construction supply chains". This research distinguished between 1st or 2nd tier focal companies and their respective 2nd or 3rd tier suppliers. In this research "construction industry" was defined as a part of a "construction supply chain". (§2.1.2; §2.3; §2.4).

In several steps, the research identified and explored variables and practices. For this, the research applied *three conceptual models*. (Table 2 below, for a discussion see §3.5).

Table 2: Classification of constructs in the three conceptual models[11]

	Independent	Moderating / mediating	Dependent
Initial broad model I	Organisation (size, experience & role) Entrepreneurial orientation Company & customer strategy, incl. source of turnover Supplier variables Innovation variables	Procurement practices in each of the procurement steps: Specify-needs Find-select Negotiate-contract Manage-relations.	Procurement performance variables for company & environment
Modified broad model II	Company variables Company size Entrepreneurial orientation Respondents role & expertise Customer & company strategy	Procurement management variable Procurement step priorities idea & develop phase Supplier types Intensity of relations Innovation types Entrepreneurial orientation with suppliers Procurement practices	Procurement Performance variables Number of innovations Turnover from innovations Innovation-benefits Innovation-satisfaction
Focused model III	Supplier-innovation variables Radical innovations Incremental innovations Green aspects important Quality aspects importants Cost aspects important Three supplier types	Company variables Company size Company type / profession Main source of turnover Main customer strategy	Selected procurement best-practices For Specify-needs Find-select Negotiate-contract Manage-relations

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[11] Note that the constructs and the classification of variables within the three models differ slightly. (§2.14; §3.5).

Based on an initial literature review (Staal *et al.*, 2015), the research developed an initial broad conceptual model I. This initial model I consequently served as a guide for the extensive literature review (Chapter 2) and was then amended into the modified broad conceptual model II (see §2.13).
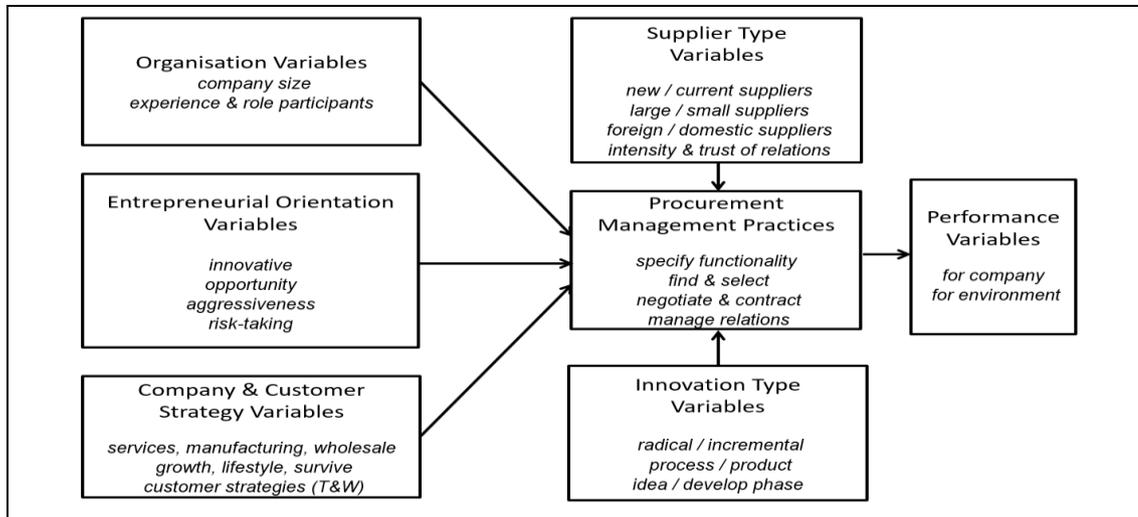
Figure 3: The initial broad conceptual model I used during the extensive literature review

Conceptual model II was partially validated in exploratory interviews (§4.7) and then used as a conceptual basis for Survey I. Based on findings from Survey I and partially validated in one roundtable discussion, conceptual model III was then developed for Survey II that focused on a selection of key-variables and best-practices. (See §8.1).

Sections §2.14 and §3.5 discuss the models in more detail.

1.5 Research Questions and high-level Hypotheses

As mentioned in §1.4, the *overarching research aim* was explore how focal companies procured innovations from suppliers. In more detail, the research consequently aimed to:

Explore to what extent company variables could affect procurement management variables and practices, and furthermore how these two variable types could affect procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains.

This overarching research objective was sub-divided into three parts, each supported by several research questions or high-level hypotheses.

The first objective (Part I) was (1) to introduce the research topic, (2) to increase a detailed understanding from extant literature on the research topic, and (3) to design an appropriate research methodology to achieve the overarching objective of this research.

This first objective hence helped to structure the empirical research.

The structuring research questions for Part I were:

RQ1: What were context, scope, relevance & objectives of the research topic? (Chapter 1)

RQ2: To what extent did extant literature provide guidance on how New Zealand companies in construction supply chains managed innovative suppliers? (Chapter 2)

RQ3: What was an appropriate research methodology to explore the research domain in order to achieve the overarching research objective? (Chapter 3)

The second objective (Part II) was (1) to identify and explore company variables and procurement management variables & practices, (2) to identify and explore company variables that could affect such procurement management variables & practices, (3) to identify and explore company variables and procurement management variables & practices that could affect procurement performance, and (4) to identify and explore procurement practices that companies would use with specific basic supplier-innovation variables.

Consequently, this second objective aimed to increase an understanding in relations between company variables, procurement management variables & practices, and ultimate procurement performance. Note that considering the nascent or immature phase of the research domain (see §3.2.4 for a discussion), the research could only suggest whether such relations were correlations or causal (§3.5).

The empirical research questions for Part II consequently were:

RQ4: To what extent did exploratory interviews in five New Zealand companies on how they managed innovative suppliers in construction supply chains increase the understanding of the research domain and confirm the variables &practices and conceptual model II from Chapter 2? (Interviews, Chapter 4)

RQ5: What variables & practices did respondents report, what was the profile of the case companies, and to what extent did these companies represent the target-population? (Survey I, Chapter 5).

a. What were company variables of New Zealand companies that managed innovative suppliers in construction supply chains?

b. What were procurement management variables & practices of New Zealand companies that managed innovative suppliers in construction supply chains?

c. What were procurement performance variables of New Zealand companies that managed innovative suppliers in construction supply chains?

d. What was the profile of the survey respondents and case companies?

e. To what extent did respondents and the case companies represent the target-population? (This sub-research question was supported by three high-level hypotheses).

RQ6: What relations existed between company variables and procurement management variables & practices in New Zealand companies that managed innovative suppliers in construction supply chains? (Survey I, Chapter 6). This research question was supported by several high-level hypotheses.

RQ7: What relations existed between company variables, procurement management variables, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains? (Survey I, Chapter 7). This research question was supported by several high-level hypotheses.

RQ8: What relations existed between (independent) supplier-innovation variables and (dependent) procurement management best-practises in New Zealand companies that managed innovative suppliers in construction supply chains? (Survey II, Chapter 8). This research question was supported by one high-level hypothesis.

> *The third objective (Part III) was (1) to synthesise research findings and extant literature, (2) to define contributions & implications for specific stakeholders and for the wider industry, (3) to define contributions & implications for research, (4) to define suggestions for future studies, and (5) to define limitations of the research.*

The concluding research questions for Part III consequently were:

RQ9: To what extent did the research answer empirical research questions RQ4-RQ8, also in view of the extant literature from Chapter 2? (Chapter 9)

RQ10: To what extent did the research achieve the three objectives? (Chapter 10)

RQ11: What are the contributions and implications of the research study for management practice and for theory? (Chapter 10)

RQ12: What are the limitations of the research? (Chapter 10)

To achieve the overarching research objective, the research analysed data obtained through interviews, one focus-group discussion, two online surveys, and literature. It formulated the research questions to guide the study. The empirical part of the research additionally applied high-level hypotheses (Cramer & Howitt, 2004: 75) on a Section level. The following Table 3 provides an overview.

Table 3: Overview of research questions, high-level hypotheses, and summarised results

RQ	Research Questions	Results and Hypotheses from the research
1	What were the objectives, context, scope, and relevance of the research topic?	Discussed in Chapter 1
2	To what extent did extant literature provide guidance on how New Zealand companies in construction supply chains managed innovative suppliers?	Discussed in Chapter 2 This led to modified conceptual model II and related overviews of potentially-relevant variables and procurement practices.
3	What was an appropriate research methodology to explore the research domain in order to achieve the research objectives	Discussed in Chapter 3 The philosophical perspective and methodology provided guidance to the research.
4	To what extent did exploratory interviews in five New Zealand companies on how they managed innovative suppliers in construction supply chains increase the understanding of the research domain and confirm the variables and conceptual model II from Chapter 2?	Discussed in Chapter 4 The combined interviews confirmed the relevance of the variables for the research and confirmed conceptual model II as a basis for the quantitative part of the research.
5	What variables & practices did respondents report, what was the profile of the case companies, and to what extent did this profile represent the target-population?	Discussed in Chapter 5
5a	What were company variables of New Zealand companies that managed innovative suppliers in construction supply chain?	Discussed in Chapter 5.1 Descriptive statistics provided more details on the case companies. H1: The company data were representative for the estimated $N=3,000$ to $N=6,000$ companies that managed innovative suppliers in New Zealand construction supply chains. (H1 was confirmed)
5b	What were procurement management variables & practices in New Zealand companies that managed innovative suppliers in construction supply chains?	Discussed in Chapter 5.2 Descriptive statistics provided more details on the targetted population of case companies. H2: The procurement management data were representative for the estimated $N=3,000$ to $N=6,000$ companies that managed innovative suppliers in New Zealand construction supply chains. (H2 was largely confirmed)

5c	What were procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains?	Discussed in Chapter 5.3 Descriptive statistics provided more details on the targetted population of case companies. H3: The procurement performance data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains construction supply chains. (H3 was confirmed).
5d	What was the profile of the survey respondents and case companies? 5e: To what extent did respondents represent the target-population?	Summarised in Chapter 5.4 Sections §5.1-§5.3 defined the profile of the survey respondents. H1 and H3 were confirmed; H2 was largely confirmed. Hence the respondents were representative for the target-population.
6	What relations existed between company variables and procurement management practices in New Zealand companies that managed innovative suppliers in construction supply chains? (RQ6 was supported by several high-level hypotheses).	Discussed in Chapter 6 Inferential statistics showed relations between variables and procurement practices of the case companies. H4: Differences in company variables had significant effects on procurement management variables. H4a: Differences in company size had significant effects on procurement management practices. (§6.1) (H4a was largely rejected). H4b: Differences in entrepreneurial orientation towards innovative suppliers had significant effects on procurement management practices. (§6.2) (H4b was largely rejected) H4c: Differences in experience levels had significant effects on procurement management practices. (§6.3) (H4c was largely rejected) H4d: Differences in strategy types had significant effects on procurement management practices. (§6.4) (H4d was largely rejected). Overall, H4 was largely rejected, which seemed an important finding when contrasted with the literature review.
7	What relations existed between company variables, procurement management variables, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains? (RQ7 was supported by several high-level hypotheses).	Discussed in Chapter 7 H5: Differences in company variables had significant effects on procurement performance variables. (§7.2). Largely rejected, only for the innovation experience variable H6: Differences in procurement management variables have several significant effects on procurement performance variables. H6a: Differences in procurement step priorities variables had significant effects on performance variables. (§7.3). Rejected. H6b: Differences in supplier type variables had significant effects on performance variables. (§7.4). Largely rejected. Only for foreign versus domestic suppliers for (somewhat) incremental innovations. H6c: Differences in supplier relation intensity variables had significant effects on performance variables. (§7.5). Partly confirmed. Especially with suppliers providing services and wholesale-distribution providers. H6d: Differences in innovation type variables had significant effects on performance variables. (§7.6). Confirmed, but then only for developing radical versus incremental supplier innovations. H6e: Differences in entrepreneurial orientation variables with suppliers had significant effects on performance variables. (§7.7). Confirmed for the four variables innovating, risk-taking, opportunity-seeking and trust with innovative suppliers. Largely rejected for aggressiveness in supplier markets. Therefore, hypothesis H5 was largely rejected, hypothesis H6 was only partially confirmed.

8	What relations existed between a selection of supplier-innovation variables and a selection of procurement management practises in New Zealand companies that managed innovative suppliers in construction supply chains? (RQ8 was supported by a high-level hypothesis).	Discussed in Chapter 8 Based on conceptual model III, one roundtable discussion explored priorization of key moderating, independent, and procurement management practices. H7: Differences in supplier-innovation key-variables had significant effects on procurement practices. Hypothesis H7 was largely confirmed. The small sample size, the variety of respondents, and the basic survey structure limited generalisation of Survey II findings to the target-population.
9	To what extent did the research answer empirical research questions RQ4-RQ8, also in view of the literature from Chapter 2?	Discussed in Chapter 9. The research was able to answer empirical research questions RQ4-RQ8.
10	To what extent did the research achieve the three objectives?	Discussed in Chapter 10.1. The research achieved the three research objectives.
11	What are the contributions and implications of the research study for management practice and theory?	Discussed in Chapter 10.2, 10.3. The research identified seven contributions, and suggested further research.
12	What are limitations of the research?	Discussed in Chapter 10.4. Limitations were based on the low survey sample sizes. However triangulation from other research methods helped increase validity and generalisation.

Section summary-conclusion:

5. *The overarching research objective aimed to identify and explore how focal companies managed innovative suppliers.*

6. *In more detail, the research aimed to identify and explore relations between procurement management variables & practices, and related organisation, innovation, entrepreneurial orientation, supplier, strategy variables, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains.*

7. *The research was exploratory (§3.4). Supported by conceptual models and extant literature the research would indicate whether such relations were mere correlations or possibly causal. (§3.5).*

8. *The research developed 12 research questions and several high-level hypotheses for the empirical research. These should act as a guidance for this research to achieve the overarching research objective.*

1.6 Summary of the Methodology

From an ontological and epistemological perspective (see §3.4), the research took a pragmatic philosophical position to support the three research objectives and methodology. The initial literature review was inductively with a grounded approach (Yin, 2003; Saunders *et al.*, 2009: 490, 501) until a relatively stable conceptual model I (derived from Staal *et al.*,

2015) enabled a deductive review approach on a higher level, and an inductive review approach on a more detailed level. This more extensive review led to conceptual model II.

The empirical research was mostly deductive, exploratory, and mixed-mode: it alternated qualitative and quantitative methods. Research methods were designed in a flexible manner (Saunders *et al.*, 2009: 488), and where necessary were amended during the project. (See §3.6). The research used the following methods:

1. *Literature review.* The study used an iterative and structured literature review.
2. *Industry consultation.* The study used semi-structured interviews in an exploratory manner with classic case-study methodology.
3. *Survey I.* The study used a quantitative survey for limited theory building & testing.
4. *Focus-research.* The study used one roundtable discussion where academics and practitioners generated, refined, and validated knowledge.
5. *Survey II*. The study used a quantitative survey for limited theory building & testing.

The research methods are summarised in the following Table.

Table 4: Summary of research methods (copy from §3.6)

	Lit. review	Interviews	Survey I	Focus-group	Survey II
Inductive / deductive	First inductive, then high level deductive, detailed level inductive	High level deductive, detailed level inductive	deductive	On high level deductive, detailed level inductive	Deductive
Structure	Structured	Semi-structured	Structured	Semi-structured	Structured
Objective	Exploratory	Confirmative / validation	Exploratory Descriptive Explanatory	Exploratory Confirmative / validation (in part)	Exploratory Discriptive Explanatory
Theory	Theory building	Limited theory testing	Limited theory building and limited testing	Limited theory building	Limited theory testing
Qual/Quant	Qualitative	Qualitative	Quantitative	Quantitative in qualitative setting	Quantitative

With this design, the research aimed to obtain sufficiently-rich qualitative data and sufficiently-significant quantitative data to achieve the overarching research objective. (See §3.6 and §3.7 for a discussion). The research planning is shown below.
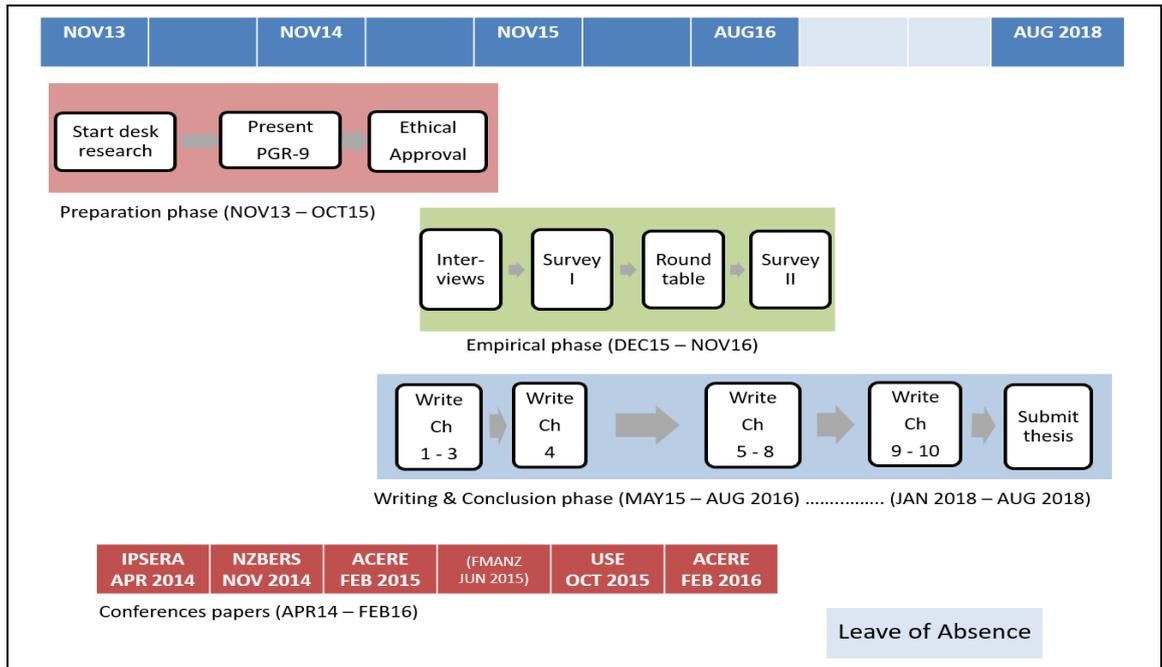
Figure 4: Main structure of this research project

Section summary-conclusion:
7. The research took a pragmatic philosophical position. It used qualitative and quantitative research methods to find answers to the research questions and to achieve the research objectives.

1.7 Main Assumptions and Limitations of this Research

The research did not try to build a theory that captured everything. The field was wide and immature (see §3.2.4). Research results would have limited explanatory and predictive power and would certainly not be "all things for all people" (Tidd, 2014: vii).

This research decided to focus on a micro (semi-dyadic[12]) level as it explored how focal companies managed innovative suppliers within their industry and micro setting. The overall nature of this research was exploratory (§3.2.4; §3.3). This best addressed the gap in literature (§2.13) as this enabled the research to identify and explore company variables, procurement (key) variables and (best) practices for companies when they managed innovative suppliers.

The main assumptions were as follows.

1. Procurement of innovations was conducted in a company context, and probably was not always perceived as procurement processes per se (based on Fisher, 1970, as cited in Van

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[12] Dyadic relationships are one-to-one buyer-seller (buyer-supplier) relationships. Semi-dyadic is only seen from the perspective of the seller, or the perspective of the buyer. (Johnsen *et al.,* 2014: 30).

Weele *et al.*, 2017: 53). Instead research participants could perceive such processes as business development, or as innovation activities with suppliers.

2. The research explored how both large and small company managed innovative suppliers. In this research, the notion of such "small companies" implied companies <100 staff. Note that this is still large in the New Zealand context, where the average company is much smaller (§2.1, §2.6.1).

3. There was extensive large-company research into innovation procurement, construction innovations, and supplier innovations. (See §2.2, §2.3). However, the relevant bodies of research on small-company procurement and small-company open inbound innovations were limited. (See §2.3.3, §2.3.6). The research posited that large and small companies would show different procurement behaviour.

4. The industry and academic experience of the PhD researcher helped him to increase the understanding of the research topic. At the same time, it could be argued that the desk and empirical research methodologies, and the researcher's own subjectivity could impede the objectivity and validity of this research. Hence an adequate selection and execution of research methods was imperative.

The main limitations were as follows.

1. The research aimed to increase the understanding of managing innovative suppliers. Participants in this mixed-mode research communicated their intersubjective understandings (§3.2.3) on current or historic management of innovative suppliers within their companies. This brought inherent limitations to the research as it could not define neutral constructs. Instead interpretation of constructs could vary with company context and individuals. (§3.2.3).

2. It was not feasible to study all possible variables that could be potentially-relevant to manage innovative suppliers in construction supply chains. This would exceed the available resources of a PhD researcher. This research selected those variables that appeared most common based on the literature review. Additionally, selections were based on findings from empirical parts in this research, from feedback from academic peers, and from the researcher's industry experience and knowledge. (See §3.2.4).

3. Considering the exploratory nature, this research was designed comprehensively. The selection of variables in this research still gave a multitude of possible relations based on the contextual variety. As the research was exploratory, some amount of subjectivity had to be accepted in variable selection and research outcomes. There could be an argument

for selecting other, fewer or more variables. Nevertheless, the selected variables enabled a feasible analysis (cf. Hardie, 2011: 103).

Small-company procurement seemed a hard research topic (Ramsay, 2007). Hardie (2011b) stated that construction companies were not eager to share strategic commercial aspects. Urbina *et al.* (2012: 174) suggested that innovations in large companies was more easily studied. Nevertheless, the researcher was confident he could create new insights on the research topic.

Section summary-conclusion:

8. *The locus of this research was New Zealand and the context was the construction industry and its supply chain. The knowledge contribution focused on semi-dyadic relations when companies managed innovative suppliers.*

9. *As such innovation procurement behaviour was largely uncharted territory, the research was mainly exploratory. The scope, assumptions and limitations helped to achieve the objectives of this PhD research.*

1.8 Chapter Summary and Structure of this Thesis

As with all Chapters in this thesis, this Chapter discussed a research question.

(RQ1) What were the context, scope, relevance, and objectives of the research topic?

The Section summaries-conclusions are summarised below.

1. The overall objective of the research was to learn how focal companies managed innovative suppliers.
2. The locus of this research was New Zealand and the context was the construction industry and its supply chain. The focus of the research was on semi-dyadic relations when companies managed innovative suppliers. The knowledge contribution was to a limited extent generic as the thesis aimed to increase knowledge on procurement of construction innovations of mainly SMEs.
3. The New Zealand construction industry faced productivity and sustainability issues. In part these could be solved with innovations from upstream 3rd and 2nd tier suppliers.
4. The research took a pragmatic philosophical position. It used qualitative and quantitative research to find answers to the overarching research objective.
5. Extant research suggested a paradox. Successful innovations could help the direct stakeholders in the construction industry (companies, employees and customers, users), and indirect stakeholders in the environment and in society. However, it was unclear how companies managed innovative suppliers with the objective of introducing such innovations into the construction industry. Extant research was especially lacking on small companies (SMEs).

Figure 5 below gives the thesis structure. Chapters started with an introduction and research questions. Chapters with quantitative research additionally used high-level hypotheses. Each Section ended with summary-conclusions. Each Chapter ended with a Chapter summary and where appropriate answered hypotheses. Research questions were answered in Chapter 9.

Chapter 1	• Points of Departure
Chapter 2	• Review of Literature
Chapter 3	• Methodology of this Research
Chapters 4 – 8	• Empirical research • Interviews | Survey 1 | Focus-Group | Survey 2
Chapter 9	• Discussion on Findings and Literature
Chapter 10	• Conclusions, Limitations and Contributions

Figure 5: Main structure of this thesis

Chapter 2

Review of Literature

Mit dem Wissen wächst der Zweifel.
(Doubt increases with knowledge).
W. von Goethe (1749 – 1832; Reflections).

Chapter 2

Review of Literature

This chapter presents the results from a systematic and iterative review of the literature. (See §3.6.1 for the review methodology). This review aimed to answer the following structuring research question:

(RQ2) To what extent did extant literature provide guidance on how New Zealand companies in construction supply chains managed innovative suppliers?

The review served four objectives: (1) to obtain a deeper understanding in the research topic (§2.1 to 2.4); (2) to obtain an understanding what company variables (§2.6), entrepreneurship variables (§2.7), strategy variables (§2.8), supplier variables (§2.9), and innovation variables (§2.10) could potentially affect procurement management and consequently performance variables; (3) to obtain an insight into potentially-relevant procurement management practices (§2.11) and procurement performance variables (§2.12); and finally (4) to develop and validate conceptual model I on the research. As an intermezzo, §2.5 discusses organisational theory and related contingency variables.

Section §2.13 summarises gaps and presents the modified conceptual model II that was validated in interviews and used in Survey I. Section §2.14 summarises and concludes this review Chapter.

The research focused on large and small companies (SMEs). It expected to have a few large companies and many SMEs in the target-population. It selected variables & practices that could be observed in both types of companies. It posited that large companies were complex but also more homogeneous. Large company innovation procurement activities are fairly-well known from literature. (E.g. Van Echtelt (2004); Johnsen *et al.* (2011), Pulles *et al.* (2014); see §2.2 and §2.3). This was not the case with SMEs. The research further posited that large-company variables could not always be relevant or measured in SMEs. (§2.3.3). It

therefore focused on those variables that could be observed in SMEs, as those would also be visible in large companies[13].

Consequently, the following Sections in this Chapter mainly discuss research from the context of SMEs, and present variables for SMEs or contrast variables for small versus large companies. Figure 6 below shows the initial broad conceptual model I. This model resulted from the literature review for the PhD research proposal (Staal *et al.*, 2015) and was used as a basis for this review. (In the Figure, each variable type
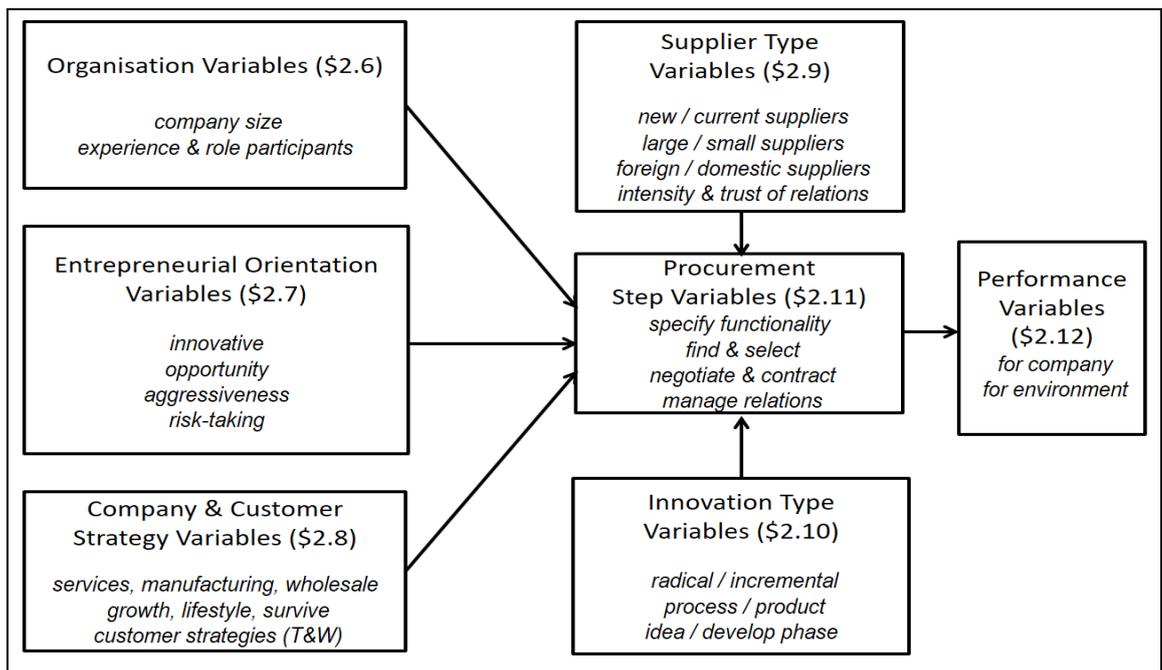
Figure 6: Initial broad conceptual model I with constructs & variables to guide the review (copy Fig 3)

Each of the Sections introduces the wider topic, then discusses the literature in the context of this research and ends with a Section summary-conclusion. The Sections describe the context and variety of variables that in varying degrees could affect procurement and ultimate performance of this research.

2.1 Context: The New Zealand Construction Industry

The construction and building industry (*in short:* the construction industry) builds, maintains, and demolishes e.g. houses, high-rise office buildings, hotels, town halls, or

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[13] Note that this was a reversed approach of a fairly common strategy to apply large-company thinking upon small companies (Morrissey & Pittaway, 2006: 273). (See also §2.6.1).

shopping malls. More specifically, the construction industry consists of the 2006 ANZIC classifications as shown in the Figure in the corresponding Appendix §2.1.

The ANZIC (Australian and New Zealand Standard Industrial Classifications. PWC, 2016) distinguished between *construction companies*[14] and *companies supplying*[15] services or materials to such construction companies (MBIE, 2013). The focus of this research was on both categories.

ANZSIC classified c*onstruction companies* in ANZSIC class E and statistical data were available. *Supplying companies* were dispersed over several ANZSIC sub classes (in C, F, B, N, I) and therefore only less-aggregated statistical data were available.

2.1.1 The Construction Industry

The consultancy firm PWC forecasted that from 2016 to 2030, the global construction industry would grow by 85% to approx. 22.5 trillion NZD (PWC, 2016) with most of the growth situated in China, India, and the US. The European Commission forecasted that the total European spending in construction was estimated to be over 20 trillion NZD in Europe, and contributed to 9% of European GDP. (European Commission, 2014).

The New Zealand construction industry had a turnover of NZD 30+ billion (PWC, 2016). This implied numerous business-to-business buyer-seller transactions in a fragmented supply chain (Vrijhoef, 2011). The industry directly employed about 178,100 employees and indirectly another 56,600 employees in related service industries (See Figure 7). Approximately 15% of New Zealand manufacturing and wholesale service companies (PWC, 2016: 23) also supplied to the New Zealand construction industry.

In the UK (Greenhalgh & Squires: 2011: 1) about 50% of construction turnover came from central or local governments; the other 50% from private asset owners or users (industry, property investors, retail companies etc.). The public procurement construction market in New Zealand was assumed to be somewhat smaller (30%).

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[14] Engaged in the construction of buildings and other structures, additions, alterations, reconstruction, installation, maintenance, and repairs including companies engaged in demolition or wrecking of buildings and other structures, and clearing of building sites are included. It also includes companies engaged in blasting, test drilling, landfill, levelling, earthmoving, excavating, land drainage and other land preparation (ANZSIC, 2015).

[15] ANZSIC defined the supplier companies as "providing services (engineers and architects)" or "conducting manufacture, wholesaling, and retailing of construction materials". Such materials (NZBE, 2010) could be on the level of discrete raw materials (e.g. concrete, wood, timber, wall lining, aluminium, bricks or tiles, or roofing material). It could also be on a component or system level (e.g. concrete, paint systems, windows, or HVAC systems).
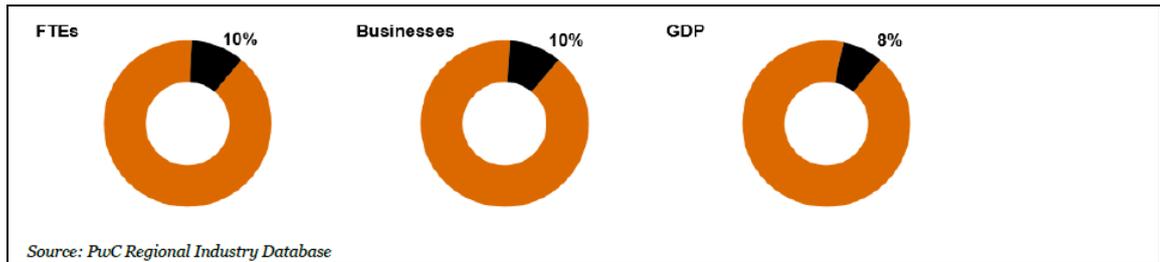
Figure 7: Contribution of construction sector to the New Zealand economy (from PWC, 2016: 35)

As introduced in §1.1, the construction industry in New Zealand and abroad had a poor productivity record and a low track-record for successful innovations (Fairweather, 2010; BRANZ, 2014, PWC, 2016: 35). The industry also lagged in sustainability performance (NZGBC, 2014; BRANZ 2014: 20) when seen from a lifecycle perspective. Chancellor *et al.* (2015: 64) found that the construction productivity level in New Zealand had not changed for decades.

A European Commission study revealed that the construction phase and the occupancy (use) phase of buildings caused between 25% and 35% of the environmental impact[16] (EIPRO, 2006: 16). Anting *et al.* (2014: 16) found that the construction sector had an "oversized environmental footprint". They (ibid) noted that a large part of this footprint related to the use of the buildings, but:

> "a significant [and] less-understood proportion come from the broader design, [from] construction process[es] and the choice of materials used".

The occupancy phase (heating, cooling ventilation, and hot water) constituted up to 25% of New Zealand's energy consumption, and the construction and demolition phase combined constituted approximately 45% of the total landfill waste in New Zealand (Burghout *et al.*, 2013). Van Tran (2017) concluded from New Zealand government data that despite industry efforts, physical construction waste did not decrease between 1997 and 2014.

Nevertheless, as introduced in §1.1, the industry is an important contributor to the New Zealand economy (Page, 2013), and "*can be an even bigger part of the solution… with proven and commercially available [technology innovations] … without significantly increasing investment costs*" (Arnel, 2009: 2). Construction innovations could benefit focal companies,

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[16] Impact categories: energy, waste, land use, smog, use of raw materials. (IMPRO: 21; EIPRO: 13). Sustainability certifications in construction see similar categories. The LEED certification distinguishes sustainable sites, water efficiency, energy & atmosphere, material & resources, indoor environmental quality, innovation & design process. (Glavinich: 19-22). BREEAM uses energy efficiency, environmental impact, health, operation & management (ibid: 24). See also: Antink *et al.* (2014: 25).

and could increase productivity in the construction industry (PWC, 2016: 36). It could also have a positive impact on the environment and the wellbeing of people (e.g. dwellers of building or construction workers).

The Productivity Partnership (2012: 4) in New Zealand identified that a construction productivity increase of 10% would increase the GDP by 1% "*to everyone's benefit*". Their Research Action Plan wanted an increased understanding of innovation processes and drivers, and an increased understanding of effective ways to spread new technologies and innovations (ibid: 13, 30).

For several decades, the New Zealand construction industry had conducted productivity improvement activities, but progress was slow (Building a Better New Zealand, 2013: 2-3; Fairweather *et al.,* 2009; PWC, 2016: viii). Christie (2010) also indicated a slow adoption of sustainability innovations by New Zealand home-owners.

One example of a successful sustainability initiative in New Zealand is shown in Fig 9. It shows ratings of a Greenstar sustainability audit for an Auckland office building.
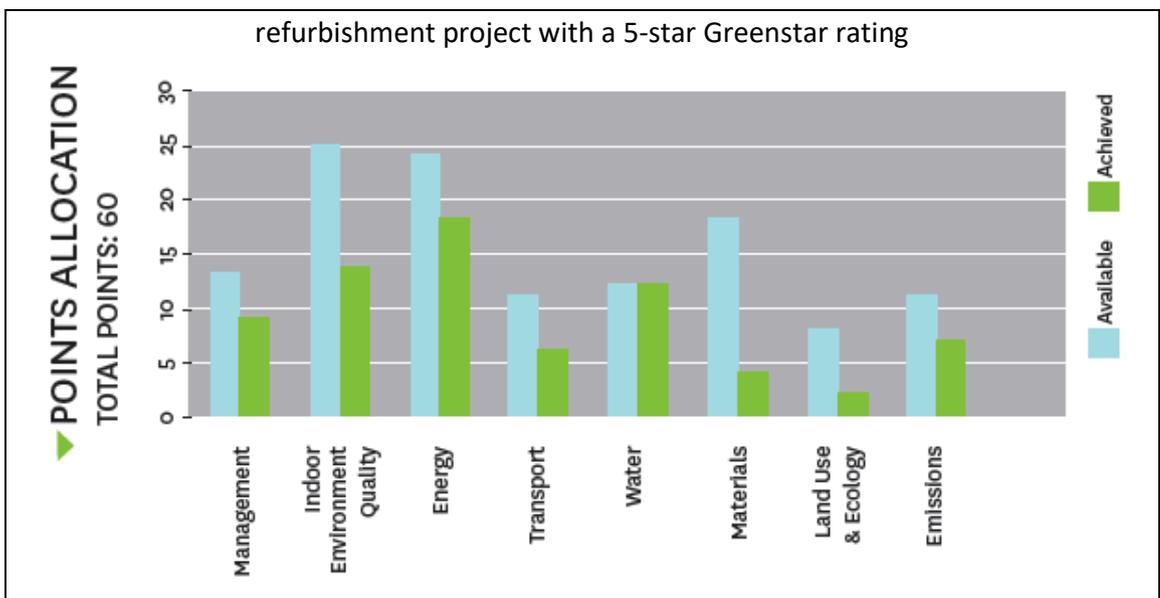
Figure 8: Refurbishment results of an Auckland office building (from NZGBC website, 2015)

During a major refurbishment project both conventional (e.g. waterless urinals) and state-of-the art (e.g. new solar-reflecting glass types) were installed. Moreover, 70% of construction waste was diverted. The Greenstar-rating measured several outcomes as indicated on the X-axis of the graph. The objectives of the owner included decreasing operational cost, minimising environmental impact during refurbishment, and improving

the work environment of office staff. This example shows that newness, outcomes, and objectives of construction innovations could vary within one construction project.

2.1.2 The Construction Supply Chain

Supply chains in construction start from extracting raw materials, manufacturing and distribution of products, the design, engineering, *construction of buildings*, and maintenance, refurbishing, and ultimately demolition and recycling (Pryke, 2009; italics added). Hence the construction industry should be seen as a part of a longer construction supply chain. This industry is project-based, labour-intensive, and fragmented with many SMEs. It has many actors in complex and short-term supply chains where competitive bidding is dominant (Benton & McHenry, 2010: IX).

Construction innovations are developed and implemented via industry networks. Such innovations could emerge from clients' needs (pull) to realize innovations from the focal company. Innovations could also come from (push) entrepreneurial or innovative suppliers upstream or from outside the industry. (Baumol, 2002; Farschi & Brown, 2011; Gambatese & Hallowell, 2011; OECD, 2005, 2010; Pries & Janszen 1995; Pries & Doree, 2005; Mlecnik, 2013: 88; Philips, 2004; Johnsen *et al.*, 2011). (See §2.2).

This Subsection defines (see Figure 10 below) a construction supply chain[17] based on Pryke (2009: 2), Van Weele *et al.* (2017), Benton & McHenry (2010: 228), and Winch (1998: 227; see §1.1.2). The supply chain model is in line with Gann & Salter (2000: 960) who distinguished between construction innovation suppliers (the supply network), construction innovation intermediaries (project-based companies), and construction innovation users (that issued projects).

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[17] In reality this construction supply chain related to a dynamic network with potential partners and suppliers (Dubois & Gadde, 2002). For any individual innovation, the network of any focal company from distant (loose) end-customers to distant (loose) 4th or 5th tier suppliers could easily include dozens or hundreds existing or potential network partners (De Jong, 2005). This research simplified such an innovation-related network into a supply construction chain (Johnsen *et al.*, 2014: 30).
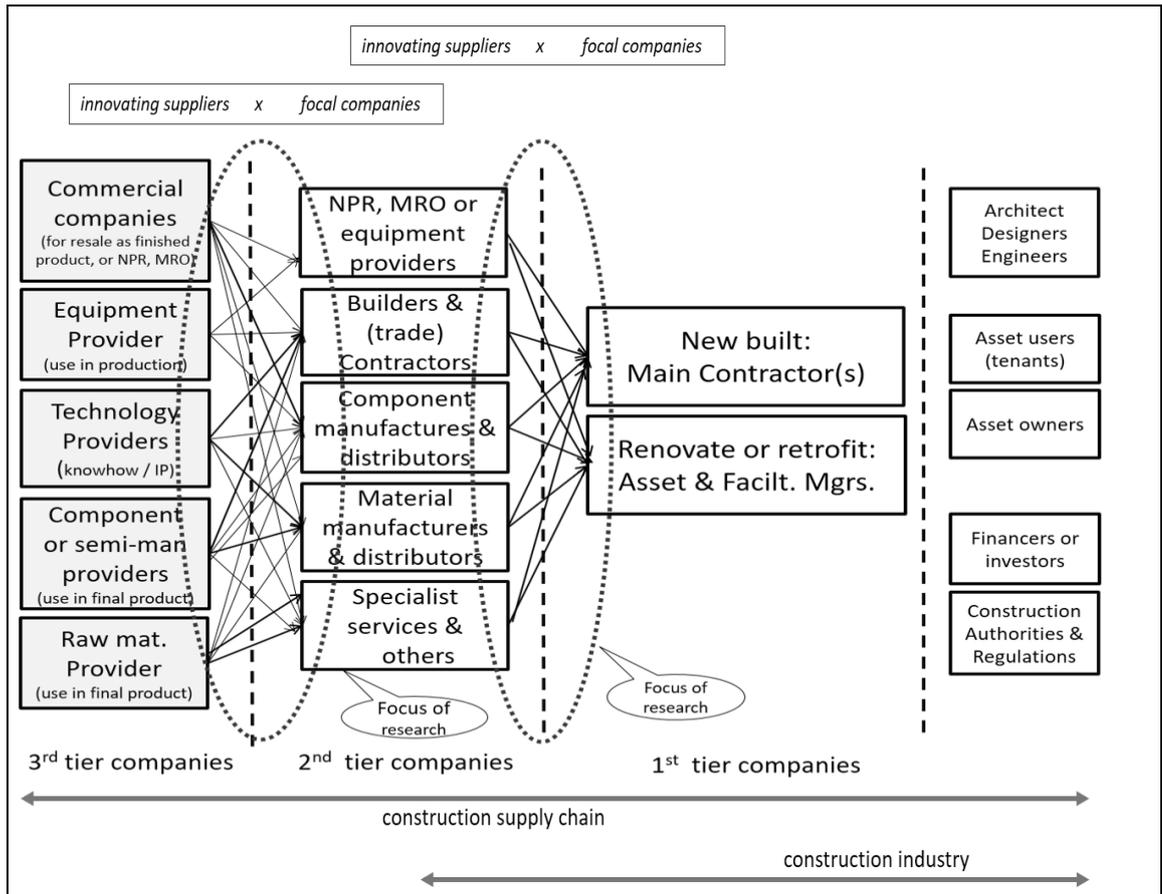
Figure 9: Construction supply chain with the focal 1st and 2nd tier companies (copy Fig 2)

From right to centre, this Figure 10 shows several levels of companies. The 1st tier companies have direct contact with their customers, the asset or project owners. These 1st tier companies (Winch, 1998: *system integrators*) either have a role of main contractors (*for new-build*) or a role of asset or facilities managers (*for renovations, refurbishments, or retrofits*). The far-right side of this Figure includes what Winch (1998) called the "*innovation superstructure*" that is asset managers and owners, financers, architects, engineering & quality, construction authorities & regulations.

The two dashed ovals indicate the research domain of the focal 1st and 2nd tier buying companies[18] with their respective 2nd or 3rd tier supplying companies (i.e. innovative suppliers). The focal companies help to provide innovations to their downstream clients. The 2nd and 3rd tier companies could be classified in several ways. Winch (1998: 271) called them the "*innovation infrastructure*" and distinguished *trade contractors*, *component suppliers, and specialist consultants.* Benton & McHenry (2010: 228) distinguished: *vendor, seller, manufacturer, contractor,* or *subcontractor*. Lasagni (2012: 323) used a similar

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[18]From the perspective of the main contractor, Fagerström & Jackson (2002: 26) called these main suppliers and sub-suppliers.

typology for supplier involvement with inbound open innovations. He distinguished *innovative machinery suppliers, innovative material suppliers,* and *innovative knowledge suppliers.*

However, these typologies were limited as they did not recognise company differences, the multi-tiered supplier structure, and several commodity types. The (1st or 2nd tier) focal companies in this research could acquire or develop different types of innovative products or services with their (2nd or 3rd tier) innovative suppliers. Consequently, this research distinguished 10 types of 2nd or 3rd tier innovative suppliers. (See the corresponding Appendix).

The literature review found that several company, supplier or product/service characteristics could affect how focal companies managed innovative suppliers. An investigation into these (2x5) supplier, (7) company types (see §2.5), and many product or innovation characteristics (see §2.2, §2.9, §2.10) would require analysing many moderating or mediating variables which was considered out-of-scope for this PhD research.

To overcome this limitation, the research posited that focal companies in the above dyadic relations, could show different *procurement behaviour* towards such innovative suppliers *depending on the individual supplier innovation.* This had four consequences:

1. For reasons of time-constraints, the empirical part of the research did <u>not</u> investigate and validate the identified types of (1st or 2nd tier) focal companies. Instead the research assessed the effect of customer interactions based on a customer or value perspective (Porter, 1995; Hagelaar *et al.*, 2015).

2. Consequently, the research distinguished three main company turnover types (discussed in §2.8.1). The research furthermore investigated the effects of three company and three customer strategies on suppliers (discussed in §2.8.2 & §2.8.3).

3. Similarly, the empirical part of this research did <u>not</u> investigate the identified types of suppliers. Nor did it investigate all characteristics of procured innovative products or services. Instead it selected three generic supplier types and focused on three generic characteristics of the individual innovation (discussed in §2.9 and §2.10).

4. The research acknowledged that other supply chain aspects, i.e. company, supplier, or product characteristics as presented in this Subsection and corresponding Appendix could act as moderating or confounding variables.

NOTES:
1. For Survey II, the research did apply an industry classification (NZGBC, 2016) as this could increase an understanding on the organisational context of the supplier innovations and procurement practices. (§8.3.1).
2. In Chapter 10 the impact of the research was assessed by analysing the impact on the company types in the construction supply chain from Figure 10.

Section summary-conclusion:

1. *The construction industry formed an important part of the New Zealand economy, it was not considered particular innovative and had a high environmental footprint in the build and use phase.*

2. *Construction innovations were driven by regulation, cost benefits, and clients' needs. They could be generated within contractor companies, but often come from suppliers upstream or from outside the industry.*

3. *Innovation procurement behaviour could vary with different external and internal variables.*

4. *The research developed a construction supply chain with 1st and 2nd tier focal companies, and with 2nd and 3rd tier innovative suppliers.*

5. *In this supply chain, the procurement practices of 1st and 2nd tier focal companies could (1) be affected by their company characteristics, (2) by the characteristics of their 2nd and 3rd tier suppliers, and (3) by the product or innovation characteristics.*

6. *Investigating all possible variables in such supply chains would go beyond the scope of this PhD. Consequently, the research investigated the effect of customer offerings, and of customer and company strategies on how companies managed innovative suppliers. It also decided to focus on generic innovation types and generic supplier types.*

7. *The research acknowledged that other supply chain aspects, i.e. company, supplier, or product/service characteristics could act as moderating or confounding variables.*

2.2 Innovations in the Construction Industry

A working definition of an innovation (see also §2.2.2 and §2.2.3) is *any non-obvious improvement leading to increased performance* (Slaughter, 1998). Innovations (see OECD, 2010a) are generally needed for increases in productivity, quality, and profits. Innovations however have failure rates that generally increase with the levels of newness, complexity, stakeholders, and risks involved (OECD, ibid).

2.2.1 Innovation in General and in Construction

Depending on the definition of innovation, a general assumption is that companies in the construction industry did *not* innovate. Data from Australia (Hardie, 2011: 4) and New Zealand (NZstats, 2013) suggested that 6%-15% of construction companies innovate. MBIE

(2013a: 80) used different measures and found that 41% of New Zealand construction companies reported "innovative activities" compared to 46% of all New Zealand companies. This data could be skewed as it excluded the large segment of small construction companies <6 staff, and this segment could be less innovative. Nevertheless, due to BRANZ levies, R&D activities were comparable to national New Zealand levels. The view of *lower-innovations* in construction is widespread. Miller *et al.* (2009: 53) found that construction was the lowest-innovative industries of 16 Australian industries. A longitudinal survey on product innovations in 1,250 Dutch small companies (<100 staff) found that construction scored lowest of seven industries (De Jong & Vermeulen, 2006: 597), with 21% reporting recent product introductions, compared to an average of 31%. Sheffer (2010a) found similar results for the US.

1. *Cement industry.* Diffusion and change of such innovations in the construction industry can take a long time as Tushman & Anderson (1986) showed when they analysed the history of the US cement industry. This industry started with a competency-destroying radical innovation in 1896 with a completely new manufacturing kiln. In the following decades this was followed by a series of major competence-enhancing modular and architectural innovations. Together these innovations greatly increased the quality and output of this industry. Tushman & Anderson argued that such innovations come in cycles.

2. *Energy saving opportunities.* The aspect of diffusion of for example energy-saving innovations was addressed by Sheffer (2010a, 2010b, 2012, and 2013). She found the same aspects of construction supply chains as for example mentioned by Vrijhoef. Sheffer (2013) concluded that *modular* innovations diffuse slow and *integral* innovations (which she called complex products) even slower. This is in line with for example Fairweather *et al.* (2009) that disruptive construction innovations are more difficult to manage than incremental construction innovations.

3. *Gypsum sheet replacing brick walls.* Sheffer (2010, p. 8) mentioned that the diffusion of gypsum sheets with sheet metal frames took 15 years to replace brick walls in the American construction industry. In general the rate of adoption will vary per firms, industry and technology (Sheffer, ibid; p. 10).

Figure 10: Three examples taken from literature on diffusion of construction innovations[19]

The above Figure 11 gives three examples of construction innovations. These show that construction innovation diffusions take time and involve multiple stakeholders.

Slaughter (1998), Winch (2003) and others disputed low-innovation numbers by stating that the used innovation definitions give a false comparison. Littlemore & Chan (2013: 356)

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[19] Sources: Tushman & Anderson, (1986; Sheffer (2010a, 2010b, 2012, 2013); Fairweather *et al.* (2009); Vrijhoef (2011).

additionally found that managers in construction and their construction workers had different perceptions on practices on building sites. Construction workers explained several innovative practices in their daily work, which did match formal innovation definitions but were not recognised by management. Similarly, Slaughter (ibid) found several types of innovation occurring on building-sites and concluded the sector was more innovative than popularly thought.

As in other countries the New Zealand construction industry is risk-averse (e.g. Hinton 2013; Fairweather, 2009). Partly this is cultural (Fairweather, 2009) or related to the industry structure (Vrijhoef, 2011). This is also related to high regulation and consequent risks of delays during the building process (NZBCSD, 2009: 6). Figure 12 (below) compares New Zealand averages on innovation barriers (Y-axis) with the New Zealand construction industry (MBIE, 2013: 81). It shows that particularly costs, a lack of staff and management resources act as innovation barriers.
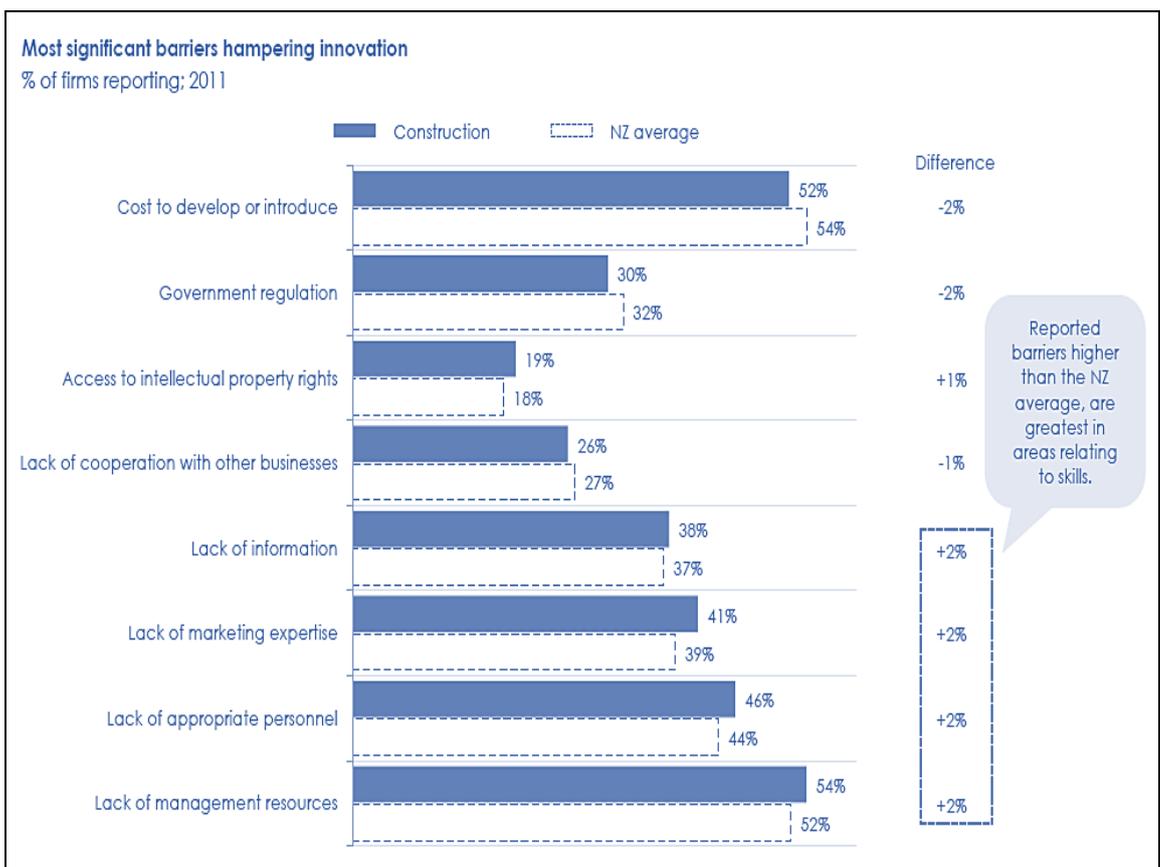
Figure 11: Innovation barriers of New Zealand construction companies (from MBIE, 2013a: 81)

For building companies <19 staff, NZIER (2014) saw the following innovation regulation barriers: testing and consent costs were higher than benefits, little room for own initiatives,

barriers to import of new materials, liability issues. Finally, MBIE (2013a: 11, 86) mentioned as additional barriers to construction innovations the lack of scale, the cost of implementing innovative solutions, (including training and changes in practices), and the limited introduction and diffusions of innovative products. Nevertheless, some (Australian) companies do "succeed against the odds" in introducing innovations into the sector. (Manley, 2008: 10).

2.2.2 Definitions of Innovation as an Object or a Process

Schumpeter is often seen as the "godfather" (Tidd & Bessant, 2009: 15) of innovation studies. In his opinion, innovations should destroy current and build new monopolies (Schumpeter, 1942). In general, the exact wording of an innovation definition would depend on its purpose. This Subsection first discusses the term *innovation* as an object (noun), then as a process (verb).

The company's perception of innovation as an object (based on Van Weele, 2010: 96) could relate to (1) an input (from suppliers), (2) a throughput (internally and with external parties), (3) an output (for the company) and (4) an outcome (for customers and other stakeholders). Considering the intersubjective nature of the research topic (§3.2.3), this research adopted a broad approach on innovation which included the underlined constructs[20] from the definitions below.

1. A product innovation is the implementation and commercialisation of a product with improved characteristics such as to deliver objectively new or improved services to the customer. (OECD, 2005).
2. Innovation is the process through which companies seek to acquire and build upon their distinctive (technological) competence, understood as the set of resources a company possesses and the way in which these are transformed by innovative capabilities. (Dodgson & Bessant, 1996).
3. Innovation is the tool of entrepreneurs, via which they exploit change as an opportunity for a different business or service. (Drucker, 1985).
4. Innovation is an improvement in functionality performance as perceived by the owner of the company (Hardie, 2011: 33).
5. Innovation is the actual use of non-trivial change and improvement in a process, product or system that is novel to the developing organisation[s], […] and can be associated with market growth […] and reductions in the cost of production (Slaughter[21], 1998, 2000: 2).

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[20] This broad application with the underline terms implied that innovations in the context of this research had one or more of the underlined aspects. Note that the research only implicitly referred to these aspects (see §3.2.3), and did not further investigate or classify the supplier innovations with these aspects.
[21] The 1998 definition of Slaughter referred to Freeman (1989) as cited in Xue *et al.* (2014). The 2000 definition of Slaughter referred to Marquis (1988) and Schmookler (1952).

Innovations as objects are created in innovation processes. The focal company of this research procured innovations from suppliers, and additionally could add value through its own innovation activities. This *increase in value* could be seen in output (cf. §2.2.3.2) and outcome (cf. §2.1.2).

The objectives of *innovation processes* are improved results in economic and broader terms (see §2.12). This research combined the above five definitions. The focal company when *managing innovative suppliers in construction supply chains*:

> procures (obtains or co-develops) product, process, or business innovation(s)
> from innovative suppliers, and possibly through interaction with its own
> innovation activities produces (manufactures) and commercialises (implements)
> a product, process, or business innovation with significantly improved or new
> benefits (functional performance) in economic and other terms.

2.2.3 Typologies for Construction Innovations

This research applied a broad definition for innovations. The construction industry is quite stable as the last 250 years only witnessed a few transformational innovations (see §1.4). For an increased understanding of construction innovations, the research now discusses several construction innovation typologies, based on newness and change, output, and industry or drivers.

2.2.3.1 Construction Innovation classified by Newness and Change

Most innovations in construction seem incremental. Nevertheless, over the past decades the industry had witnessed radical innovations as described by e.g. Gambatese & Hallowell (2011a, 2011b), Hardie (2011b) and Mlecknik (2013). Innovations in construction often operate in a system (Vrijhoef, 2011; Winch, 1998) consisting of several interrelated subsystems. Incremental construction innovations are most frequent, but separately have a low impact with low changes. Radical innovations are rare (unique) and separately have a large impact with high changes in linkages and concepts.

Slaughter (1998, 2000) introduced an innovation classification[22] for the construction industry research that went beyond this classical incremental versus radical dichotomy. This model was validated in innovation construction research by Shields (2005), Hardie (2011b),

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[22] Based on Henderson & Clark (1990) and Abernathy & Utterback, 1978). It has similarities with a Boulton & Allen model (2004) as discussed in Tidd & Bessant (2009: 326).

Fairweather *et al.* (2009: 7), and Mlecnik (2012: 87). Figure 13 shows the Slaughter typology[23]
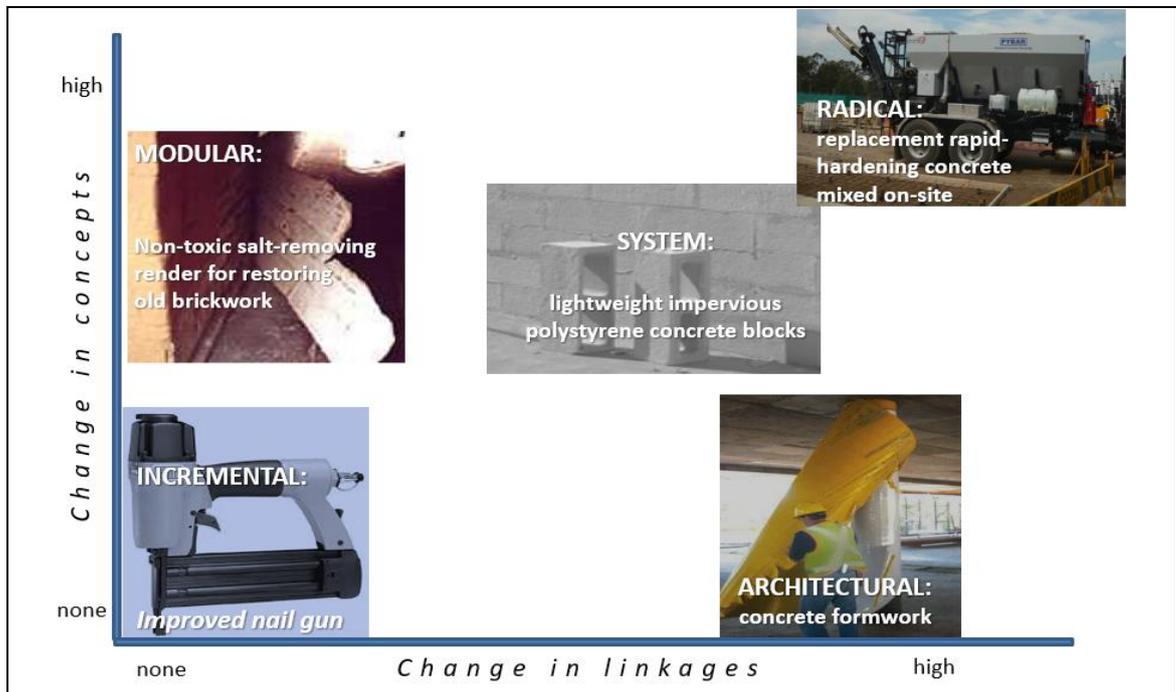
Figure 12: Construction innovations in Slaughter taxonomy (Examples based on Hardie, 2011b: 43)

The Slaughter model shows varying degree of concepts and linkages and distinguished five types of innovations[24]. Bottom-left is an incremental innovation (e.g. an improved nail gun), top-right is a radical innovation (e.g. a rapid-hardening concrete for road repairs). The three other innovation types in the model: modular, architectural and system innovations match within these two extremes. Modular construction innovations have a significant change on a concept (technology) level, whereas architectural construction innovations have a significant change on a linkage level. System innovations then have both moderate changes on a technology and on a linkage level. Slaughter (1998) saw radical innovations as rarely appearing extremes of system innovations, with even higher changes on both aspects. Nevertheless, the term "radical" is commonly used in the construction industry and related research, often denoting the opposite of "incremental" innovations or improvements. Strictly following the Slaughter taxonomy, a more correct term could be "non-incremental innovations". However, this term was not widely adopted[25].

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[23] Except for the improved nail gun bottom left, the examples were taken from Hardie (2011: 43).

[24] This change (newness) in concepts relates to technology/components; the change (newness) in linkages relates to markets or stakeholders involved. Innovations need not be absolutely new, but will be new to the industry or the focal company. (Songip, 2013a, 2013b; Gambatese, 2011: 508; Manley, 2008; Sexton & Barrett, 2003).

[25] Related to construction/building industry, Google Scholar (14 March 2016) gave 9 hits on "non-incremental innovation"; 1870 on "radical innovation"; and 1340 on "incremental innovation".

Table 5: Categories & innovation sources (from Mlecnik, 2013: 87, based on Slaughter, 2000: 4-13)

Categories of construction innovation	Assessment with respect to advancement of the state of knowledge and links to other components or systems	Proposed most frequent source of construction innovation	Usual timing of commitment within construction project phases
Incremental innovation (Marquis, 1988)	Small improvement in current practice (based upon current knowledge and experience), minimal impacts on other components and systems	Within the organization that has the knowledge base on which to develop improvements (can include all parties in the value chain)	Any time
Modular innovation (Henderson & Clark, 1990)	Significant improvement in concept (or new concept), requires no changes in other components or systems	Within organizations that have control over and responsibility for a module; or through new entrants	Design/selection
Architectural innovation (Henderson & Clark, 1990)	Small improvement within a specific area or core concept, major changes in other components or systems in order to function	In the field (for example general and specialty contractors)	Design-to-implementation
System innovation (Cainarca et al., 1989; Slaughter, 1998)	Set of complementary innovations which work together to provide new attributes or functions, together they can significantly advance the state of knowledge or practice	Entities that do not have a vested interest in current configurations and (sub)systems; often coordinators (technically competent and responsible for project performance)	Conceptual design
Radical innovation (Nelson & Winter, 1977)	Completely new concept or approach, including interdependent components or systems (often renders previous solutions obsolete)	From outside an existing industry, often based upon scientific or engineering research (often new companies and organizations)	Technical feasibility

The above Table furthermore suggested a relationship between the type of innovation, the timing of commitment, and the source / type of supplier. She suggested that *contractors* could be good sources for architectural and system innovations, whereas *suppliers* could be good sources for modular innovations. Radical innovations would often originate from outside the industry and were based on R&D or engineering research. (See also §2.9 & §2.10).

Mlecnik (2013) adopted the Slaughter (2000) taxonomy in his research on 2nd tier (SME) suppliers on construction innovation. His research found that innovative suppliers (contrary to main contractors) have a broader vision of innovation processes and use a wide network in the construction chain. Such suppliers could start with what seemed an incremental innovation, but through collaboration with other players this could change into a different type of innovation (Mlecnik, 2013: 109).

Shields (2005) warned against intersubjective consequences of the Slaughter typology. This could hold true for the *time-aspect* (something starts as an incremental innovation, and grows into a system or radical change), and the *experience-aspect* or *size-aspect* (what seems incremental for a large organisation, could be radical for a smaller or less-experienced organisation). (See also §3.2.3).

Nevertheless, the Slaughter typology recognised that adoption of innovation types varies with the change of concepts and with involvement of stakeholders. It suggested different supplier sources with different types of innovations.

2.2.3.2 Construction Innovation classified by Output and Complexity

Innovations are also classified according to the intended output, i.e. the result from an innovation process. The OECD (2005: 47-51) distinguished in product innovations, process innovations, marketing innovations or organisational innovations.

Material suppliers could generally develop product innovations, whereas sub-, or main-contractors could develop process innovations. (Koebel, 2008). Both types of companies could develop marketing or organisational innovations. The first two innovation types were considered most relevant to this research on managing innovative suppliers.

As discussed, construction innovations could be classified by degrees of *newness*, either for the focal organisation and/or for the industry or customers. Related to this, construction innovations could be classified in increasing *complexity* for adoption, which often relates to changes in concepts and linkages involved (§2.2.3.2). Linton (2009: 730) identified several partly overlapping innovation terms related to complexity. For a better understanding of the variety in terms, this research amended a review by Linton (2009) (summarised in Appendix §2.2.3.2).

2.2.3.3 Construction Innovation classified by Industry Types or Drivers

Another innovation classification is based on *industry types*. Such innovations originate from industries which are either (1) scale-intensive, (2) supplier-dominated, (3) science-based, or (4) have specialised suppliers (Pavitt[26], 1984). Innovations in the construction industry depend on suppliers and would match Pavitt types 2, and 4.

Yet another typology considers the *drivers* (reasons) behind an innovation. Lim & Ofori (2007) suggested a category for construction innovations based on three drivers: (1) clients are willing to pay, (2) construction costs will decrease, or (3) the innovation will give better competitive advantage through increased intangible qualities. A category not found by Lim & Ofori (2007) but often mentioned (e.g. Hardie, 2011b) and following reasoning of Porter & Van der Linde (1995) could be (4) imposed by regulation. Miller *et al.* (2009: 61) found a ranking of four construction innovations drivers (shown below in Figure 14).

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[26] Discussed in Castaldi (2009: 712); Mlecnik (2012).
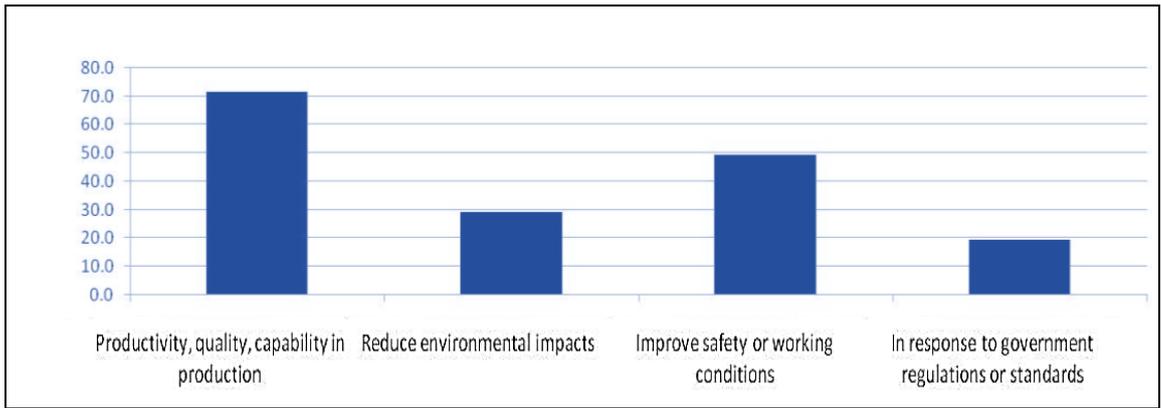
Figure 13: Drivers of innovation in construction companies (from Miller *et al.*, 2009: 61)

These four drivers focused on *direct effects from innovations* and did not include aggregated competitive, customer, or company level drivers. On a *company or owner level*, Sexton and Barrett (2003: 627) found three types of innovation motivations for small construction companies: *survival, stability,* and *development*. (See also §2.8.2).

2.2.4 Summary of Variables on Construction Innovations

The literature review for this research found a wide array of potentially-relevant (§3.2.4) variables on (construction) innovations (see Table 6 below). These variables could affect the exact nature of procurement management practices. As with variables in §2.5, §2.6.3, and §2.8.4, the variables could separately or conjointly affect the nature of procurement and innovation activities of the focal company. They could therefore act as moderating or confounding variables. Variables indicated with X were selected and analysed in the empirical phase of the research. (See §3.2.4).

Table 6: Characteristics found in literature on innovations (with sources)

Characteristics of innovations	Sources	Selected
(Non)-Patented (Intangible assets or not; license /support) Only patent, or also other know-how or production capability	Manley (2005) others Jell (2011)	
New to world – new to country / to industry (or to users) or a recombination of existing knowledge	Manley (2008), Barret & Sexton (2006) OECD (2005)	
Innovation phase when procured (concept versus proven technology)	Cooper (2013)	X
Diffusion stages with customers (concept versus proven technology).	Rogers (2003)	X
Incremental or disruptive (radical) to industry (users) Improving on existing process for product or introducing system innovation (for focal company and customers)	Mlecnik (2013) based on Slaughter (2000)	X
Focus on costs (efficiency or for customers) or on quality (functionality for customers); bespoke housing vs mass production housing	Koebel (2008), Miller (2009); Treacy & Wiersema (1995)	X
A one-off innovation, or serial innovations within the same company	Gambatese & Hallowell (2011)	
Developed during a short /long-term innovation supplier relation (intensity of relations)	Van Echtelt (2004)	X
Green aspect (benefit) that could be easily demonstrated to stakeholders.	Bos (2010)	X
Technological and economic uncertainty	Melander (1998) Fisher (1970) Wynstra (1998)	
Environmental or regulation	Vörösmarty (2015) Miller (2009)	X
New versus current suppliers Foreign versus domestic suppliers	Schiele (2010) (Jensen (2012)	X
On the adoption or benefits of open innovation	Schroll (2012) Knudsen (2007)	
In close cooperation or at a distance (intensity of relations)	Wynstra (1998) Le Dain (2009)	X
Associated with current operational activities of small contractor companies	Barrett & Sexton (2006)	
The nature of clients (informed clients)	De Valence (n.d.)	
Involvement of universities or research partners	Aouad et al. (2010)	
Company resources (finance, ambitions, time & skills, risk)	Hardie (2011b: 102)	X
Client and end-user influences (procurement system)	Hardie (2011b: 102)	
Project-based conditions (supply chain relations)	Hardie (2011b: 102)	
Industry networks (research & universities; ind. associations)	Hardie (2011b: 102)	
Regulatory climate (standards, authorities)	Hardie (2011b: 102)	X

To illustrate the wide array of variables, two comparable studies on drivers and barriers of construction innovations (NZ, UK, AUS) are discussed in more detail.

- Hardie (2011b; 102, 123, 134) investigated five variables that could affect successful introduction of environmental technical construction innovations. From a face-to-face interview survey with SMEs (*N*=21) she found that the drivers for affecting innovation delivery: and especially industry networks ranked least important; two other aspects ranked significantly higher (with a 5% error margin).

- Ozorhon *et al.* (2010: 9) found a ranking of 7 drivers and barriers for construction innovations in a survey of (*N*=30) leading-edge (UK) construction companies.

Both rankings of drivers partly differ as the following combined Figure shows.

Drivers	Mean
Performance (cost reduction, productivity, effectiveness)	4.8
Environment/sustainability	4.7
End-user requirements	4.6
Technological developments	4.3
Competition	4.1
Regulation and legislation	4.0
Aesthetics/design trends	4.0

Survey results from "high-performing innovators" in construction (from Hardie, 2011: 134)	*Drivers of innovation of "high-performing" construction companies (from Ozorhon, 2010: 9)*

Figure 14: Rankings of construction innovation drivers in high-performing companies

Both studies ranked regulatory aspects relatively high. Hardie (2011b) ranked industry networks relatively low. In comparable statistics on *actors*, Ozorhon *et al.* (ibid) ranked these higher. They found (ibid: 12) that suppliers and manufacturers (*M*=4.0) were believed to be the most important *actors* of innovation. These scored higher than clients (*M*=3.8), contractors (*M*=3.5) and subcontractors (*M*=3.4). Collaborative practices with partners (*M*=4.3) were believed the most important *enabler* and *best-practices* (ibid: 11, 12). This could be comparable with Hardie's project-based work.

Dominant enablers (Ozorhon *et al.*, 2010: 11) were leadership (*M*=4.6), supportive work environment (*M*=4.4), then collaboration with partners (*M*=4.4) and deep understanding of customers (*M*=4.4), and training & education policy (*M*=4.1). Three aspects prominently mentioned in the MBIE (2013a; §2.2.1) ranked low on the Ozorhon (ibid: 11) list of barriers: lack of awareness (*M*=3.0), lack of qualified staff (*M*=3.0), adversarial approaches (*M*=2.9).

This brief comparison shows that construction studies on similar topics could find different rankings in innovation drivers. This implied that comparing rankings (priorities) in variables could be problematic, and also that generalising findings on variables and practices from this research had to be done with caution. (See also Chapter 10).

Section summary-conclusion:
8. *This research focused on managing innovative suppliers in construction supply chains. The reviewed literature confirmed that this was a relevant research topic.*

9. *The New Zealand construction industry was less-innovative than other industries, and possibly also less innovative than comparable overseas construction industries.*

10. *Innovations were relevant to the New Zealand construction industry, but the industry experienced several innovation barriers.*

11. *Suppliers were often an important source for construction innovations.*

12. *The research applied a broad definition for innovations (§2.2.2). Such innovations could be classified to their newness, change, output, and drivers.*

13. *Literature suggested a wide array of potentially-relevant innovation variables which was probably not exhaustive. (Table in §2.2.4).*

14. *A comparison of two similar studies on construction innovation drivers and barriers revealed different rankings of partly different variables. These different results from seemingly similar studies could show the effects of different definitions, and especially of (visible) moderating variables or (invisible) confounding variables.*

15. *Therefore generalisation of findings on effects of innovation variables had to be done with caution.*

2.3 Procurement in the Construction Industry

This Section discusses aspects related to procurement (§2.3.1 to §2.3.3) and to procurement in construction supply chains (§2.3.4). It also discusses open innovation (§2.3.5, §2.3.6).

2.3.1 Procurement in General

Over the past decades the procurement function in large companies and in large public companies greatly increased in relevance (Spina *et al.*, 2013; Johnsen 2014: 5-7, 61; Wynstra, 2016). Similarly, procurement research developed as an academic discipline and witnessed a steep growth (Johnsen, 2014: 13-15; Van Weele, 2007; Wynstra, 2010; Van Weele & Van Raaij, 2014).

In the advent of procurement research, Webster & Wind (1972) identified that socio-psychological, organisational, and external variables influence procurement processes. Robinson & Faris (1968) distinguished between procurement processes as *new-task situation, modified rebuy,* or *straight rebuy*. The level of previous procurement experience therefore could affect the selection of procurement practices. Such practices could also be affected by variables as:

> (technical) product characteristics, strategic importance of the product, financial or commercial aspects, suppliers' markets, impact on the organisation or organisational linkages, complexity, risks, or uncertainties. (Van Weele, 2010: 24).

In their day-to-day activities focal companies would almost automatically apply procurement practices without consciously considering such variables. (§2.3.3).

2.3.2 Definition of Procurement as a Process

Procurement is often seen as a support process for primary business processes. (Porter, 1995). However, Van Weele *et al.* (2017, 78-79) and other often considered procurement essential for supplier innovations. Definitions and terms related to *procurement, purchasing, sourcing, buying,* or *supply management* vary and are also used interchangeably (Johnsen *et al.*, 2014: 10). For reasons of clarity, this research preferred the word "procurement" where others would equally use the word "purchasing", or e.g. from an open innovation perspective "acquisition". (See §2.3.5). Lyson & Gillingham (2003: 7) took a narrow and strategic position and saw purchasing (i.e. procurement):

> as concerned with rationalising the supply base and selecting, coordinating, appraising the performance of, and developing the potential of suppliers.

The definition describes important aspects but excludes operational procurement aspects as ordering, expediting, payments, after care (Van Weele, 2010). This research wanted a wider approach on procurement and included decisions on make-or-buy, transactional or longer relationships, choosing high versus low risk (value) suppliers. The research incorporated aspects of *financial means* to demarcate from non-financial adoption, pre-procurement activities, partnering, or network activities (such as knowledge exchange, or creating joint-ventures). Put briefly: *procurement* activities in this research *"result in an invoice from a supplier"* (Telgen, 1998: 2). Finally, it incorporated wider stakeholder interests on sustainability (Miemczyk *et al.*, 2012: 484) Hence the research adopted the following definition for procurement:

> Managing the company's external resources in such a way that the supply of innovative goods, services, capabilities, and knowledge in exchange for financial means is secured at the most favourable conditions for the focal company and with considerations of environmental, social, and ethical issues. (based on Van Weele, 2010, Telgen, 1994, Miemczyk *et al.*, 2012).

2.3.3 Size aspects: Focus on Procurement within SMEs

The focal companies in New Zealand construction supply chains were often small to medium-sized. This Subsection therefore discusses extant research from SME procurement. Some researchers, e.g. Bäckstrand (2016: 6), Ritvanen (2007: 146), and Pearson & Ellram (1985) saw similarities in procurement behaviour of SMEs and large companies. Others,

notably Ellegaard (2006), Carr & Pearson (1999), Ramsay (2007); Rodriquez (2014) Presutti (1988), Morrissey & Pittaway (2004), Morrissey & Knight (2011), Paik (2009, 2011: 20) also found differences between SMEs and large companies. (See also §2.5; see also Appendices of §2.3.3 and §2.3.6 for SME studies on several aspects). Therefore, this research posited that SME procurement was different from large-company procurement.

As an example: Established large-company research (e.g. Schiele, 2007, Foerstl *et al.*, 2013) concluded that higher procurement skills would lead to higher company performance, and then often recommend upskilling the procurement department. However, Overweel & Van der Zeijden (2007) found that 85% of (Dutch) SMEs do *not* have procurement departments (although manufacturing-oriented SMEs would more often have a procurement department than service-oriented SMEs). This percentage of small companies without a procurement department is probably higher in the New Zealand context. Nevertheless, Pearson & Ellram (1985) and Pressey *et al.* (2009) both found that a lack of formalized procurement (such as not having a formal supplier selection process or not having a procurement department) did not per se necessarily indicate bad procurement skills. Additionally, Ellegaard (2006, 2009) found that owners of SMEs could be "effective" in their (informal) procurement practices.

There also is a common perception that SMEs behave uniformly which is also shown in the common conception 'the Small and Medium Enterprises', only to be segmented by industry, turnover, and size. (See also §2.5). The overall nature of the SME means that we tend to find few hierarchical layers, a large influence of owner and management team, the use of intuitive strategy. Employees work on an operational and strategic level. They have a low degree of specialisation and could conduct several tasks. They manage (control) their own procurement practices and work informally. However in line with the contingency perspective (see §2.5) SMEs vary on organization, specialization, management other aspects. Consequently, procurement could differ within SMEs. (Ramsay, 2007; Paik, 2009, 2011; Morrissey & Knight, 2011).

Large companies have formalised procurement processes, focussing on maximising economic benefits (Van Weele *et al.*, 2017: 50).There is some debate (Ozmen, *et al.,* 2012: 95, 2014: 1) on whether buying behaviour of (Turkish) SMEs does include aspects of individual buying behaviour such as impulse buying. This buying behaviour is normally not associated with more rational large-company buying behaviour.

Procurement could play an important role within SMEs (Quayle, 2002; Pressey *et al.*, 2009; Paik, 2009abc, 2011)[27]. The procurement function within SMEs could be operated by the owner(s) or by one or more senior staff (Ellegaard, 2006: 273), depending on the owners' characteristics and ambitions, and the complexity and uncertainty (risk) of the purchase (Hagelaar *et al.*, 2014). The small company owner operates as relationship and network manager, and is loyal to current suppliers. (Hagelaar *et al.*, 2015a).

Considering the limited resources and ambitions of the SME owner, the research posited that only key procurement activities are conducted on innovation activities (based on Ellegaard, 2006: 279; Hagelaar *et al.*, 2015). Some literature (e.g. Paik, 2009) suggested that SMEs have a lower procurement proficiency. As mentioned earlier e.g. Ellegaard (2006) suggested that SME owners (<20 staff) are "efficient" in their procurement. Ellegaard (2006: 280) however also noted limited supplier market knowledge and limited procurement experience. Overall, the lack of resources and of procurement experience (Park & Krishan, 2001; James *et al.*, 2011) could have a negative effect on procurement of innovations in SMEs.

The review revealed 70+ potentially-relevant articles (§3.6.1.2) on SME procurement with numerous variables (for an overview see Appendix §2.3.3). These articles are partially discussed throughout this Chapter.

NOTE:
Additional literature from corresponding Appendix §2.3.3 on SME procurement was notably used in §6.1. That Section discussed inferential statistics controlled for company-size, i.e. large companies and SMEs.

2.3.4 Construction Procurement and Procurement in Construction Supply Chains

A considerable body of research describes the role of procurement in the construction industry. Definitions of "construction procurement" vary (for an overview of definitions, see Appendix §2.3.4).

This research sees *construction procurement* as a method in which clients (principals) contract a project organisation (a main contractor, project manager or consultant) to design, construct, or maintain buildings or assets for residential or non-residential purposes. The construction industry applies a "plethora" of procurement methods or strategies to

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[27] For general reviews on SME procurement see James *et al.* (2011: 27 articles); Morrissey & Knight (2011: 24 articles); Ellegaard (2006: 58 articles); Hagelaar *et al.* (2014: 20 articles).

successfully deliver building projects (Davis, 2006: 3). Cox (2009: 12-2) distinguished between construction clients' CAPEX (often *on-off*) projects and OPEX (often *repeat*) projects. In the latter category, facilities managers then often act as clients in non-residential construction projects. Related repeat projects could offer more opportunities for collaboration and for working with continuous supply chains, whereas one-off projects are often tendered on lowest costs with project-based supply chains (Cox 2009).

The main types of (hybrid) procurement delivery models as used in New Zealand are (MBIE, 2015: 21):

1. Traditional (conventional client-led design)
2. Design and build
3. Package based
4. Direct managed
5. Alliance
6. Public Private Partnerships (PPP)
7. Early contractor involvement
8. Panel of suppliers.

Tookey *et al.* (2001: 21, 28) pointed out that each construction procurement method has its own constellation of actors, risks, and responsibilities. Hence an "appropriate" application would depend on contingency variables. They concluded that because of these contingencies, procurement methods are difficult to conceptualize in industry reality. Procurement methods for contracting (sub)contractors or (sub)consultants generally vary with risk sharing, joint planning, or early involvement. Morledge *et al.* (2006: 105-120) provided an overview of eight factors[28] that would affect procurement methods for non-residential buildings.

The procurement methods that *clients* apply to their main contractors, project manager, or main consultants could affect procurement behaviour further upstream in construction supply chains (e.g. De Valence, 2010: 56). When a client e.g. focuses on lowest costs and risk reduction, this could stifle innovative behaviour of main contractors and of their upstream suppliers or at best lead to on incremental innovations or cost-reducing innovations.

However, construction procurement methods *as such* were not the focus of this research. This demarcation relates to the earlier definition of the construction industry (§2.1.1) and the construction supply chain (§2.1.2). This research limited *construction procurement* to

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[28] External factors; client resources; project characteristics; ability to make changes; risk management; cost issues; project timing; quality & performance.

the construction industry as primarily between clients (asset owners; project owner) and 1st tier companies (main contractors or asset & facility managers) Additionally, this research saw *innovation procurement in a construction supply chain* as referred to in this research as situated between 1st tier companies and 2nd tier companies, and between 2nd tier and 3rd tier companies. (See Figure 10, §2.1.2).

To some extent, this relation is affected by the client's procurement methods. The research considered these as indirect external or industry factors. The company would respond with customer and company strategies, which were considered part of this research (§2.8).

Main contractors could outsource 70% to 90% of the works (Van Lith *et al.*, 2015: 1033). Those construction procurement methods that engaged 2nd tier suppliers were only relevant to this research, if such suppliers were innovative. In short: the research did not investigate the effect of a specific procurement method. It did however assess the effect of company and customer strategies on managing innovative suppliers. (See §2.8).

2.3.5 Open Innovation in General

Open innovations are often seen as the opposite of closed innovations that are based on internal research (Gianiodis *et al.*, 2014). The last decades produced a wide body of open innovation[29] literature. Chesbrough *et al.* (2006: 1) defined open innovation as:

> the use of purposive *inflows* and *outflows* of knowledge to accelerate *internal* innovation and to expand the markets for *external* use of innovation, respectively" (italics added).

Kibbeling (2010) found that companies with more intense supplier relations collaborated with more innovative suppliers and performed better. The open innovation concept is based on the insight that knowledge creation could occur outside the focal company where the innovation is further developed or applied.

Gassmann & Enkel (2004) distinguished three forms of open innovation: *inbound* innovation processes (knowledge or technology enter the company; outside-in); *outbound* innovation processes (knowledge or technologies leave the company; inside-out); *coupled* innovation processes (knowledge and technologies enter and leave the company. For this research only *inbound* innovation processes were relevant. This related to exploration of knowledge and technologies from external parties such as suppliers, customers, universities, or

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[29] Related terms: distributed innovation, supplier(-led) innovation, inbound/outbound innovation, (Schroll & Mild, 2012). Also: (lead)-user innovation or customer innovation. (Von Hippel, 1986).

competitors. For inbound innovations, Dahlander & Gann (2010) additionally distinguished between non-pecuniary (non-financial) technology *sourcing* or *scouting*, which includes assessing and observing technology trends, and pecuniary technology *acquisition.* (See Table below)[30].

Table 7: Typology of inbound and outbound open Innovation (Dahlander & Gann, 2010)

	Inbound innovation	Outbound Innovation
Non-pecuniary (exploring)	Sourcing / scouting	Revealing
Pecuniary (exploiting)	Acquisition	Selling

This research focused on the *acquisition of inbound* construction innovations: focal companies procure access to supplier innovations through intellectual property transactions such as inbound-licencing practices, (almost-ready) technology acquisitions, or through co-development. The inbound open innovation literature was consequently relevant in three aspects:

1. The pecuniary phase was inside the scope of procuring innovations of this research.
2. It related to inbound knowledge (either as know-how / intellectual property) with inbound technology as products or services. This was within the scope of this research.
3. It discussed open innovations in large companies and increasingly also in SMEs.

Schroll & Mild (2012) concluded that the adoption of the 'open innovation' concept is increasing but that not all companies use this concept. Tidd & Bessant (2014) were more positive although they found that there was less research on open innovation with suppliers than with customers (2014: 5). Furthermore, that body of research often only related to large companies.

Some innovation research suggested that a more closed innovation model for (or a *less* open innovation model) would yield better results for SMEs (e.g. Teirlinck & Spithoven, 2013) as SMEs lack resources and have difficulties to protect their commercial or technology know-how. Companies would need specific results from their open innovation activities. Gronum *et al.* (2012: 272) found that open networks are only effective if this directly results in innovation improvements.

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[30] Note that *sourcing* in procurement relates to a commercial (pecuniary) procurement activity.

2.3.6 Size aspects: Focus on Inbound Open Innovation within SMEs

Open innovation in SMEs versus large companies seemed to be different. Conducting *inbound* open innovations in SMEs appeared to be more popular than *outbound* open innovations. Lichtenthaler & Ernst (2007) found that outbound innovations imposed higher challenges on SME management. One reason could be the related risks and uncertainties, and the lack of resources and capabilities within SMEs for e.g. outbound licencing. Nevertheless, the amount of research on inbound and outbound open innovation in SMEs seems similar[31].

A large part of open innovation research in SMEs focused on aspects of intellectual property without tangible products, which was out-of-scope for this research. Moreover, a large part focused on *non-pecuniary* (non-financial) aspects; which further narrowed-down the body of literature. Finally, the notion of open innovation started with publications by Chesbrough from 2004. Hence the review mainly found recent literature. (§3.6.1.2).

There was a small body of research on how SMEs acquire and manage innovations with supplying partners, with customers, or in networks. (See e.g. Pullen, 2010; Van de Vrande *et al.*, 2009; Verreynne, 2007; Brunswicker & Vanderhaverbeke, 2015; Savino, *et al.*, 2017). The review revealed 50+ of such potentially-relevant articles on inbound open innovations in SMEs, with numerous variables. (For an overview see Appendix §2.3.6). These articles and related variables were partly used throughout this Chapter.

NOTE:
Additional literature from Appendix §2.3.6 on inbound open innovations within SMEs was notably used in §6.1. That Section discussed inferential statistics controlled company size.

Section summary-conclusion:

16. *Procurement in construction supply chains could play an important role in large and SMEs for the introduction of construction innovations. The research applied a broad definition on procurement. (§2.3.2).*

17. *A (limited) body of research on 70+ articles on procurement in SMEs and 50+ articles on inbound open innovations in SMEs were revealed and analysed. (See corresponding Appendices). Various articles were used throughout this Chapter. Depending on specific findings, other relevant articles and variables were notably discussed §6.1.*

18. *The literature on procurement in SMEs often focussed on exploitation of current business, whereas literature on open inbound innovation in SMEs often focussed on exploration. Consequently, this would position SME procurement research more in the*

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[31] In Google Scholar "open innovation" and (inbound OR exploratory OR exploring) and (SMEs) gave 7,000 results; whereas "open innovation" and (outbound OR exploiting OR exploitation) and (SMEs) 6,600 results. "inbound" "open innovation" and "building/construction industry" and "supplier" gave 179 hits. (Accessed January 2017).

domain of operations management, and SME open innovation research more in the domains of entrepreneurship or innovation management.

2.4 Processes for procuring Construction Innovations

Sections §2.1-§2.3 helped to increase the understanding of the research context and topic within the context of the construction industry. This was done from the perspectives of innovation, procurement, and open innovation. These three Sections revealed several potentially-relevant variables (§3.2.4), which are discussed in detail in §2.6-§2.12.

This Section discusses procurement and open innovations processes. These processes could be affected by such variables.

2.4.1 Procuring Innovations in General and in Construction

Although sometimes neglected in main-stream innovation literature (e.g. Fontana, 2012; Hulbert *et al.*, 2013) innovations are often established by suppliers or co-created with such suppliers. There is a wide body of procurement research on the role of *procurement in acquiring innovations* (e.g. Johnsen *et al.*, 2011; Picaud, 2013; Pulles 2012; Schiele 2009; Le Dain & Calvi, 2012; Van der Vrande 2011; Luzzini *et al.*, 2015; Monczka, 2011; Brem & Tidd, 2011). From this literature, it appeared that the boundary-spanning business function of procurement (Day & Lichtenstein, 2006) in large companies has an important role in discovering, developing, and managing innovative suppliers. However this body of literature proved to have limited relevance for this research, as it discussed e.g. large projects, structural / organisational issues, or team capabilities from the perspectives of established and large procurement departments.

Two historical studies of innovations in the (Dutch) construction industry by Pries & Janszen (1995) and later by Pries & and Doree (2005) confirmed that suppliers constituted 78% of product construction innovations and for a large part (approx. 40%) introduced these to construction companies. These construction companies would then mostly focus on process innovations. Construction literature also discusses the sales or business development perspective in SMEs (e.g. Hardie, 2011b, Sexton & Barret, 2003, 2004), but not coherent from a procurement perspective[32].

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[32] Similarly, small business or entrepreneurship management research often seemed to focus on internal organizational issues, strategy, market, or customer related issues.

This research saw the procurement process of construction innovations as part of a wider adoption (& diffusion) process of such innovations (based on Rogers, 2003; Hardie, 2005; Weidman *et al.,* 2009). Such procurement processes with upstream suppliers would support the diffusion of innovations into the construction industry.

2.4.2 Procurement Processes and Procurement Practices

This research posited that managing innovative suppliers implied a pro-active and strategic role of the procurement function, instead of a passive or operational support role as witnessed in companies with routine buying behaviour or lower procurement proficiencies. (Reck & Long, 1998; Bemelmans, 2012; Van Lith *et al.*, 2015).

For classifying procurement practices, this research analysed the validated generic linear procurement process model of Van Weele (1988, 2010: 9), which is used in teaching, and in industry and public procurement. (Rotmann *et al.* 2015: 149; Johnsen *et al.*, 2014: 35). The model (see below) consists of three pre-order process steps (specify-needs, select-supplier, negotiate-contract); then one order process step, and two post-order process steps (expedite and follow-up). The model works on a commodity level; it starts with a request from an internal customer and ends with a supplier transaction and delivery.
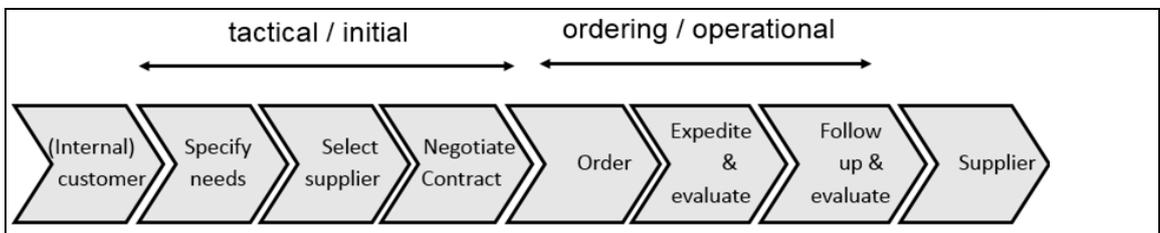
Figure 15: Procurement process model (from Van Weele, 1988, 2010: 9)

Scott (2011: 39) discussed a similar model with seven pre-ordering process steps and four post-order processing steps. The circular (cyclic) procure-to-pay process of Monczka *et al.* (2005) distinguished nine primary and six enabling process steps but these are on a higher (commodity-group, category) level. Echtelt & Wynstra (2008: 48) developed a 16-step cyclic model for strategic and tactical new product development in large organisations with innovative suppliers for complex technologies. Rotmann *et al.* (2015: 149) discussed several models which basically were variations on the Van Weele model.
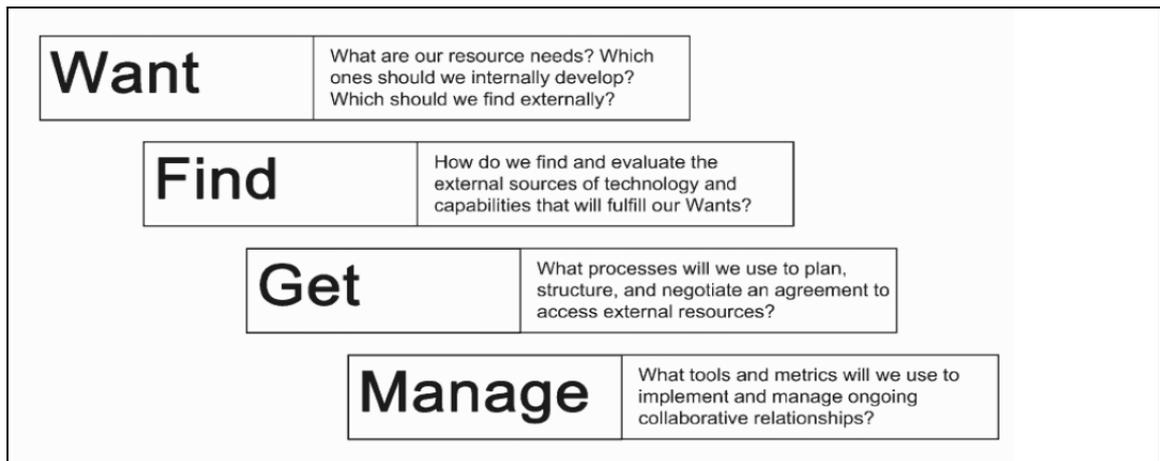
Figure 16: Four phases in Inbound open innovation (from Slowinski & Sagal, 2010: 39)

The domain of open innovation often uses a basic model by Slowinski & Sagal (2010) for describing the acquisition of inbound innovations (see Figure 17). This model has four basic steps. It starts with *wants* (needs) and ends with *managing* the consequent collaboration. Hultink & Van den Hende (2011: 14) found other open innovation process models varying from four to ten steps. Hence the amount and activities of procurement or acquisition steps could vary, depending on the objective, complexity and other (internal and external) variables.

As posited earlier (§2.3.3, §2.3.6) procurement in SMEs would not proceed as in large companies. Similarly, Morrissey & Knight (2011) suggested that SMEs must be approached with non-specialist procurement vocabulary. Ellegaard (2009: 294) followed a hermeneutic research approach for the following reasons:

- Participants were unaware of procurement models or language,
- Participants did not present an entire view of the procurement reality.

This research focused on procurement practices when companies managed innovative suppliers. For reasons of simplicity, this research used a generic (4-step) process model. As shown in the following Table, this model applied the first three tactical Van Weele steps but modified the three operational steps into one tactical step for management of supplier relations. It resembles the innovation process model from Figure 17. The research hence distinguished the following procurement process steps within focal companies: *specify innovation needs, find-select innovative suppliers, negotiate-contract, manage-relations with innovative suppliers.* (Explanations in Table 8 below).

Table 8: Four basic procurement process steps (based on Van Weele, *et al.* 2017)

Specify innovation needs	Find-select innovative supplier	Negotiate-contract with innovative supplier	Manage-relations with innovative supplier
Determine needs on several aspects: e.g. Functionality & technology; Critical skills & resouces levels logistics, quality pricing & costs environmental & social aspects	Supplier market research Draft a list of preferred innovative suppliers Request information Request proposal Evaluate proposal Select preferred innovative suppliers	Prepare negotiation strategy with innovative supplier. Conduct negotiations & draft contractual clauses Prepare implementation & work processes	Develop, extend, control, and maintain supplier relations that enable innovations Ensure that supplier delivers innovations (value) in line with company objectives. (process; metrics)

It must be noted that procurement process models need not follow a strict-step approach starting with *specifying innovation needs* and ending with *managing innovative suppliers*. Procurement process steps could be less-strict, iterative, or circular (Mosselman & Kemp, 2005: 19). For example, in line with the best-value procurement approach, the focal company could start with selecting a trustworthy supplier and proceed to develop detailed specifications from there (Kashiwagi & Byfield, 2002). Alternatively, the focal company could start with a negotiating a non-disclosure agreement, or the company could start new procurement innovation activities based on current supplier relations. It is expected that reality could see such variations and also fuzzy 'in-between' periods. In each step, focal companies could conduct several procurement management practices. These are discussed in §2.11.

Section summary-conclusion:

19. *Procurement literature confirmed that innovative suppliers could have a dominant role in introducing innovations into the construction industry.*

20. *This research adopted a procurement process model with four steps to classify procurement management practices with innovative suppliers: specify-needs, find-select suppliers, negotiate-contract, manage supplier-relations.*

2.5 Contingency Variables from Organisational Theory

This Section introduces the contingency theory. This theory is relevant to the following Sections that discuss several variable types.

Classic management started over a century ago with Taylor, Fayol, Weber, Mayo and their scientific management or behavioural management theories (see Huczynski & Buchanan, 2001: 409). Such large 'one-best-way' companies as described in Chandler's (1977) classic "*The Visible Hand*" exhibited bureaucratic features and were remarkably similar. Although

other types of companies have become popular and are the topic of research (Mintzberg[33], 1980), large bureaucratic companies are viable (Robbins, 1990). In fact, an article in The Economist (2016) suggested that large American corporations are stronger and more stable than 20 years ago due to their economies-of-scale, size, and reduced competition[34].

Nevertheless, the past decades saw a surge of research on SMEs as governments started to see such companies as growth engines (Oakley, 2010; Gray, 1998). These SMEs can better adapt to the environment and customer demands and to industry challenges (OECD 2010a, 2010b). They are more flexible, are relatively opportunistic, but are probably less likely to work in supply chains (Arend & Wisner, 2005: 409).

As introduced in §2.3.3, contrary to common belief, an increasing body of research such as Meijaard *et al.* (2005: 94); Keijzers *et al.* (2007), Mazzarol (2014), Reboud *et al.* (2011: 5), Julien (1995), and Torres and Julien (2005: 359, 363) suggested that SMEs differ from large companies and also mutually differ. SMEs are not "miniature versions" of large companies (Torrès & Julien, 2005) or "scaled-down" versions (Storey, 1986). For more details on effects of size differences, please see the Appendices with §2.3.3 and §2.3.6.

From his small business research, Julien (1990: 146) distinguished seven continuums: size, sector of activity, international competition, management type / governance, intuitive or formalised organisation, strategy, maturity or high-tech, which could affect the organisation structure. In line with Julien (1995), in her French research, Reboud *et al.* (2011: 3) saw a continuum from "SMEs Ordinaires" (traditional SMEs) to "SME Entrepreneuriales" (entrepreneurial SMEs), with differing characteristics and dynamics. Meijaard *et al.* (2005: 91) identified 9 organisational structures in their survey of 1,411 Dutch SMEs (1-99 staff). They found (2005: 92) that the majority (60%) of these 9 types (U-form, matrix organisation, M-form) either have "high" levels of formalization and/or similar levels of specialisation.

Hence the notion of a simplistic structure (§2.3.3), is too simplistic. The challenge was to identify other variables that affect procurement and performance in SMEs.

In the sixties and seventies of the last century the contingency approach (Robbins, 1990; Kieser & Kubicek, 1992) gained in popularity. This organisational theory argued that combinations of external and internal variables determine the most effective organisation structure and behaviour. Phrased somewhat differently: each management decision is

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[33] Mintzberg: entrepreneurial, bureaucratic, professional, diversified, ad-hoc companies. Note that the term contingency approach (configuration approach) may have different meanings with different scholars.
[34] So, exit Schumpeter's hypothesis on creative destruction as a good foundation for our capitalistic system.

affected by internal and external variables (Donaldson, 2001). Therefore, seemingly similar SMEs could have different organisational forms, due to different combinations of contingency variables (Villiers *et al.*, 2014).

How exactly SMEs realize their performance (Jennings & Beaver, 1997; Davidson, 2007) is still subject to study, in part due to the wide variety of SMEs. Over the past decades, innovation, entrepreneurial, and SME research tried to identify which combination of variables lead to survival, decline, growth, or increased profitability (e.g. Gianiodis *et al.*, 2010; Sarasvathy, 2004; Bamford *et al.*, 2004; Davidson, 2016). Such variables would, to a varying degree, also affect choices for procurement management practices and subsequent procurement performance in focal companies.

The nature of these variables had an effect. Pettigrew (1985: 25) cautioned on wanting to see change processes as being of a simple and linear nature. On the contrary he found that change is a complex and "untidy cocktail" of processes and with several moderating and confounding variables. Such variables relate to personal, group, organisational, social, political, business, and environmental aspects. According to Tidd & Bessant (2009) this processual or contextual theory is also applicable to innovation processes.

This made the contingency perspective relevant to this procurement research on managing innovative suppliers. Literature often distinguished the following basic contingency variables (taken from Huczynski & Buchanan, 2001: 506-516). Rozemeijer *et al.* (2003) used a similar set for procurement contingency factors[35].

Table 9: Examples of contingency variables (taken from Huczynski & Buchanan, 2001)

Variables	Sources	Selected
The technology an organisation uses	Burns & Stalker (1961) Woodward (1965) Lawrence & Lorsch (1967)	
The complexity of the organisation or the technical nature of the product	Perrow (1970)	X
The external environment, in particular the market of the organisation	Burns & Stalker (1961) Woodward (1965) Lawrence & Lorsch (1967 Argyris *et al.* (1972, 1996) Duncan (1972, 1979)	
The size of the organisation	Burns & Stalker (1961) Woodward (1965) Lawrence & Lorsch (1967	X
The differentiation or integration of an organisation	Lawrence & Lorsch (1967)	
Structure of the organisation	Burns & Stalker (1961)	
The task variety and task analysability	Perrow (1970)	

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[35] Rozemeijer *et al.* (2003) mentioned as procurement contingency factors: 1. Business context (market, technology and business environment), 2. Corporate organisation, 3. Corporate strategy, 4. Procurement maturity. These would impact procurement synergy, structure and performance. (Bals *et al.*, 2018: 42).

| The history, culture, or experience of the organisation | Burns & Stalker (1961) Woodward (1965) Lawrence & Lorsch (1967 | X |
| The expectations of the employees and customers of the organisation | Burns & Stalker (1961) Woodward (1965) Lawrence & Lorsch (1967) | |

It would go beyond the scope of this research to consider all contingency variables. As with the variables shown in the overviews of §2.2.4, §2.6.3, and §2.8.4, the above variables could separately or conjointly affect procurement practices when focal companies managed innovative suppliers. Hence, they can act as moderating or confounding variables. Variables indicated with X were selected and analysed in the empirical phase of the research. (See discussion §3.2.4).

Section summary-conclusion:

21. *The contingency perspective (§2.5) suggested that variables could separately or conjointly have moderating or confounding effects on procurement variables & practices and on procurement performance when focal companies managed innovative suppliers.*

22. *This multi-variate perspective increased the research complexity, but probably was an improvement compared to a focus on binary-type relations. Literature revealed a generic list of contingency variables. However, so far quantitative research had not found the unique mix of variables that were determinants for good performance.*

23. *This research took a contingency perspective, and was aware of possible effects from moderating or confounding variables.*

The following six Sections (§2.6 to §2.11) discuss potentially-relevant (§3.2.4) variables. Section §2.12 discusses performance measures.

2.6 Company Variables

This Section discusses company size, education & experience. These variables were identified from the literature review and selected as potentially-relevant (§3.2.4) for the empirical part of this research. The Section ends with an overview of other moderating or confounding variables, some of which were also used in the empirical research.

2.6.1 Company Size

This Section discusses aspects of company size in more detail, as (1) SMEs form a large part of the research's target-population, and (2) as extant research on SMEs shows the variety of companies.

2.6.1.1 Small Company Size Typologies

New Zealand companies are generally smaller than in other OECD countries, and New Zealand construction companies are generally smaller than the New Zealand average for all companies. According to the New Zealand definition, SMEs have <20 staff and are also called *small businesses* or *small enterprises* (MBIE, 2013b). This is in stark contrast with the USA or Canada where SMEs (often also called "small business") are companies with ≤500 staff and <31 million USD in annual turnover (Paik, 2009). German Mittelstand companies normally have <499 staff (Maass & Führmann, 2012: 1) but some Mittelstand companies can have substantially more. The European Union (2003) and also Japan defined SMEs as autonomous companies that have <250 staff and <43 million euro. (See the following Table).

Table 10: EU classification of SMEs on size, turnover, or balance sheet (EU, 2015)

Company category	Staff headcount	Turnover	or	Balance sheet total
Medium-sized	< 250	≤€ 50 m		≤€ 43 m
Small	< 50	≤€ 10 m		≤€ 10 m
Micro	< 10	≤€ two m		≤€ two m

Therefore, the size and related aspects of turnover or asset value for SMEs differed over countries. It also differs over industries. In their research on British construction innovation, Sexton & Barret (2006: 336) defined small (construction project-based) companies as having between 10-49 staff with maximum turnovers of several million British Pounds. Similarly, in their research on Australian SMEs, Hardie & Manley (2008: 4) followed an Australian definition of <100 staff in the construction manufacturing industry, and <20 staff in construction service industries (such as contractors). In a Dutch survey (*N*=1250), De Jong & Vermeulen (2006: 595) used five company size classes ranging from 0-9, to 100-499 employees.

Employee numbers in SMEs vary in boom and bust cycles, and definitions did not consider fixed or short term staff or partners. For this, NZIER (2014: 11) used the phrase "shadow company" as it recognised that employees from suppliers with long-term relationships are not counted as employees but can still be considered part of the extended company. As SMEs (e.g. Hagelaar *et al.*, 2015) tend to have long-lasting and close relationships with key suppliers, the number of 'shadow employees' within the extended company could be larger

than appeared from statistics. In this way, SMEs could combine resources and assets to improve their competitive position.

For an international comparison, the research used the following classification:

Table 11: Comparison of company-size classifications

Number of staff	European Union	New Zealand	Sexton & Barret	Hardie & Manley
0-4	(micro) SME	Micro company	Small	Small (M) Small (C)
5-9	(micro) SME	Small company	Small	Small (M) Small (C)
10-19	(small) SME	Small company	Small	Small (M) Small (C)
20-99	(small < 50) SME (medium≥ 50) SME	Small-Medium (< 50) Medium (≥ 50)	Small (< 50)	Small (M) Large (C)
100-249	(medium) SME	Large company	Large	Large (M) Large (C)
250-499	Large company	Large company	Large	Large (M) Large (C)
over 499	Large company	Large company	Large	Large (M) Large (C)

The research considered companies employing <99 staff as "small" and companies >99 staff as "large". Although research generally related company size to organisational behaviour and innovative performance, some literature (e.g. Villiers, *et al.* 2014; Adams, 2004) also suggested a more complex mixture of size with internal and external variables that affected behaviour and performance. Nevertheless, size is an often-mentioned variable (Paik, 2011). Consequently, the remaining part of this Subsection discusses size aspects in the construction industry and innovation.

2.6.1.2 Company Sizes in Construction

This Subsection discusses construction companies, and supplier companies. (See also §2.1, Figure 7). In New Zealand 92% of construction companies are micro-companies <10 staff (Page, 2013: 16). They work on smaller construction projects. In New Zealand only 4% of construction companies have >10 staff (PWC, 2016: 12). A large part of these companies was still relatively small; only a few construction companies had ≥50 staff (Page, 2013). Large companies were more often involved in bigger or more complex construction projects (Page & Curtis, 2013: 3).

Subcontractor companies and companies specialising in residential market segments were often smaller than companies operating in non-residential or in civil construction market segments. A breakdown on company-size in several construction sub-sectors is shown in the following Figure (See Page, 2013: 16).
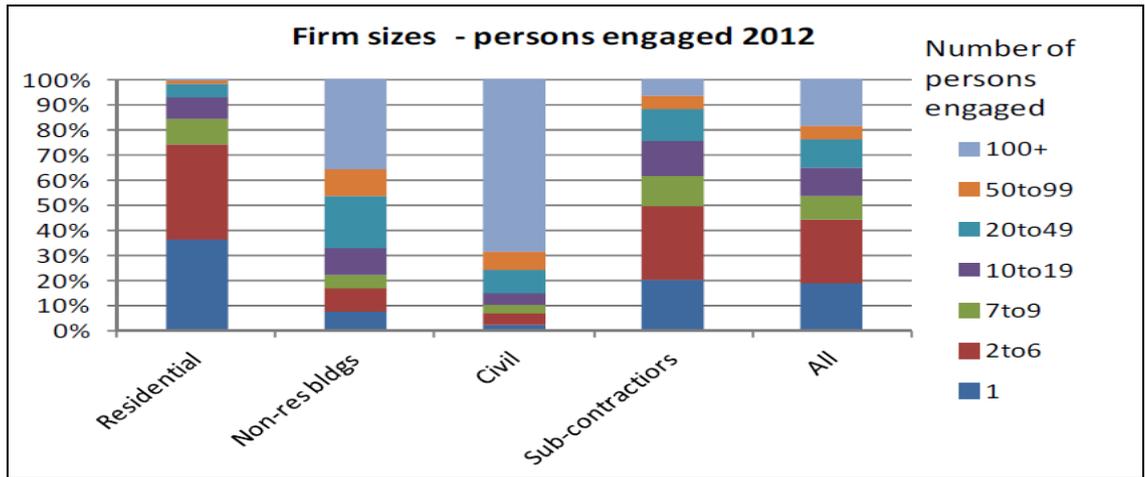
Figure 17: Company size distribution in the construction industry (from Page, 2013)

Supplier companies work in manufacturing, service, or wholesale industries. MBIE (2014) provided similar statistics for these four industries, with a few large companies and a large amount of micro or small companies. (See Figure 19).
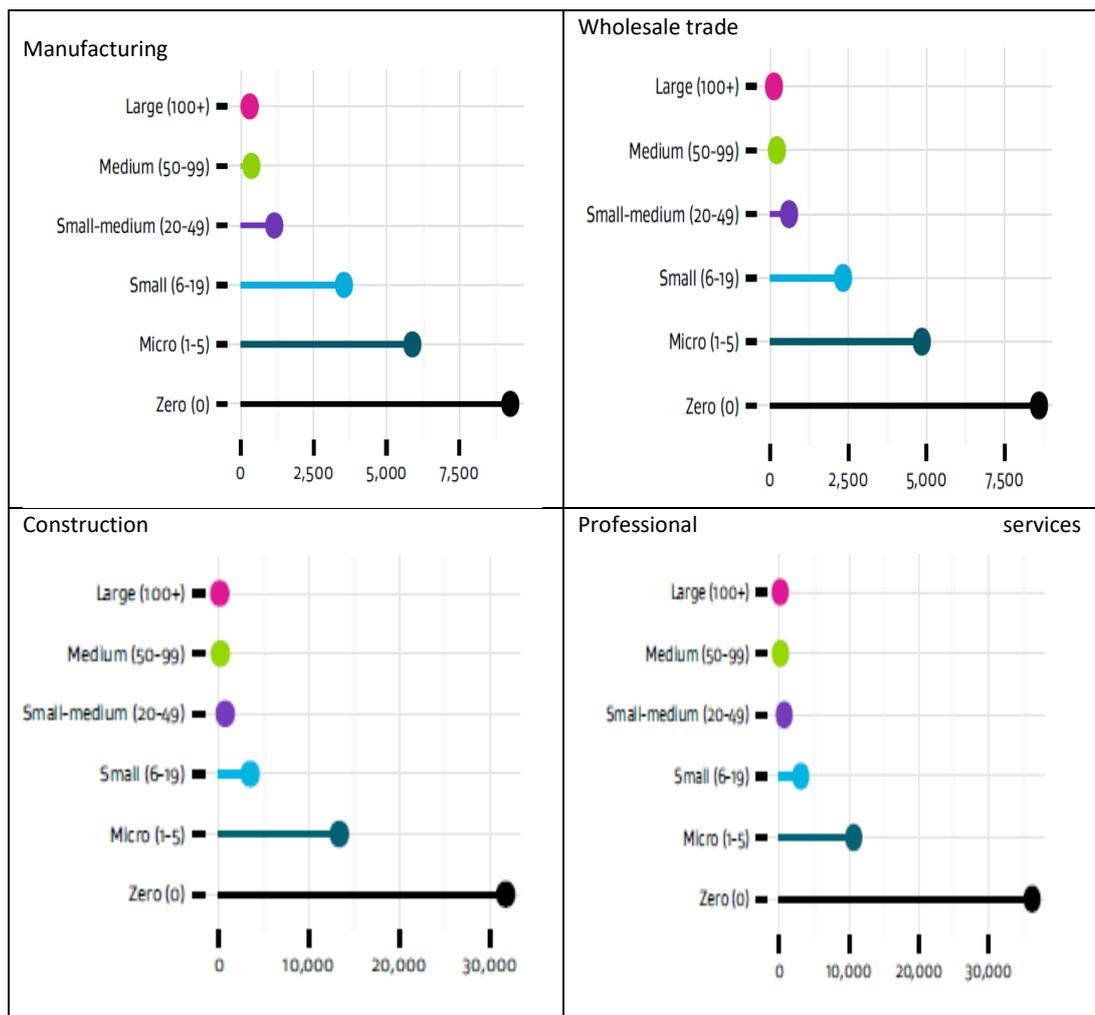
Figure 18: Companies numbers in New Zealand sectors; construction bottom-left (from MBIE 2013a)

2.6.1.3 Innovativeness in Construction and Company Size

Relative to the size of the focal companies, the debate is still out whether *small* or *large* companies are in a better position to develop innovations for the construction industry. Maass and Führmann (2012) stated that both types can be equally innovative, which was confirmed for the construction industry by Reichstein[36] *et al.* (2008: 620). They found that process innovations were mainly the domain of large contractors. Contrary to Pries & Doree (2005; see §2.4), Reichstein *et al.* (2008) found that suppliers were an important source for process innovations (but were a less important source for product innovations). They concluded (2008: 617) that especially small construction companies relied on suppliers for such process innovations.

From a multiple case-study with the title "*Against the odds – Small firms in Australia successfully introducing new technology on construction projects*", Manley (2008: 10) concluded that (some) small companies (<20 staff) could be successful. They could compensate for their small-size liability by operating in a nice market, employing internal efficiency, working with advanced (informed) clients, prioritising relationship-building strategies with clients and other stakeholders, and also by utilising patents. The traditional Resource Based View (RBV; §3.4) however suggested that large companies would be in a better position for successful innovation activities. In the New Zealand context this was indirectly confirmed by Battisti (2010).

Similarly, Koebel (2008) concluded: "*some* [… small contractor] companies can be highly innovative" [italics added], but he generally found that larger contractors adopted more innovative products (Koebel, 2008: 55). Koebel however also indicated that innovations with larger contractor companies are more complex, and that such companies could not or would not allow disruption in their operational processes in order to try out innovations. Furthermore Koebel (2008: 55) argued that lager companies were probably in a better position to negotiate for innovations with suppliers. Finally, Koebel and Cavell (2006: viii) concluded that small manufacturers were more likely to introduce new construction products.

In a New Zealand context, Verreynne and Meyer (2010) concluded in general that larger (and older) companies have a less distinct entrepreneurial and innovative approach. This latter view was supported by an innovation report OECD (2010: 16) that found that small

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[36] Based on Eurostat data from 2001–2007 on *N*=873 construction companies (SIC 45).

companies *(probably <100 staff)* are more active than large companies in "breakthrough innovations […] not just as knowledge exploiters but also as knowledge sources"

2.6.2 Education and Experience

There is a wealth of literature on 'hard' structure and strategy aspects (see e.g. Bygballe *et al.*, 2010) in managing procurement and innovations, but 'soft' aspects of people and culture should be equally important (Bossink, 2004; Kaats & Opheij, 2013; O'Connor & McDermott, 2004). Several researchers suggested that the attitudes of procurement officers and middle management towards supplier relationships and supplier risks are important in large construction companies (Crespin-Mazet, 2010; Hardie, 2007; Hinton, 2013; Kissy, 2009). This could equally play a role in SMEs: Pressey *et al.* (2009) found procurement preferences that differed with the attitude of the SME owner. In this context Fairweather *et al.* (2009: 15) remarked that construction innovations were resisted by "potentially affected groups who worked hard to defend their interests". Of course, this is not new nor specific to the construction industry, although Koebel & Cavel (2006) in their US study explicitly mentioned innovation resistance from subcontractors and construction workers.

Luzzini *et al.* (2015) found that the knowledge (experience) of purchasing managers directly affected both supplier collaborations and strategic sourcing in innovation projects, and indirectly also affected innovation performance. Axelsson & Larsson (2002) suggested that training in SMEs increased procurement performance. Adams (2004: 141) found that 68% of procurement managers had >6 years of experience, and 32% had a bachelor's level or higher. Maturity or capability models suggested a causal relation between maturity levels and performance. For example Schiele (2007), Paik (2009) and Adams (2004) found that the procurement or management experience related to the maturity of the procurement process and consequently to procurement performance.

Education levels in the New Zealand construction industry were generally lower than in other New Zealand industries (MBIE, 2013). The industry also had a lower percentage of professionals with tertiary education, although numbers increased somewhat from 2000 (PWC, 2016: vi). The low percentage of professionals with tertiary education and the high percentage of SMEs could hinder productivity growth and construction innovations (PWC, 2016: vii).

2.6.3 Overview of other Company Variables

This Subsection presents 20+ potentially-relevant variables (§3.2.4) related to internal characteristics of the SME. As with the variables shown in the overviews of §2.2.4, §2.5, and §2.8.4, the below variables could separately or conjointly affect procurement practices when focal companies managed innovative suppliers. Hence, they could act as moderating or confounding variables. Variables indicated with X were selected and analysed in the empirical phase of the research. (See §3.2.4).

Table 12: Potentially-relevant company variables (§2.3.3; §2.3.6)

	Variables	Source(s)	Selected
1	Age of SME	Start-up or mature: Verreynne; 2011, p 331) OECD (2010b: 16) Verreynne & Meyer (2010)	X
2	Size (turnover) of SME	Paik (2009); Gronum (2012: 265)	X
3	SME structure Organic versus mechanistic structure	Meijaard *et al.* (2005: 94) Verreynne (2011: 331)	
4	Procurement department (functional specialisation)	Pressey *et al.* (2009); James *et al.* (2012); Morrissey (2006); Adams (2004: 141)	
5	Procurement department or not	Morrissey & Pittaway, 2004; James *et al.*, 2011;	
6	Mature small company vs startup	Verreynne & Meyer (2011); Villiers *et al.* (2014)	
7	Skills needed by staff involved in procurement	Paik (2011: 14) Axelsson & Larsson (2002)	X
8	Learning and improvement capabilities	James *et al.* (2012)	
9	training & learning important	James *et al.* (2012) Cagliano & Spina (2002)	
10	Lack of procurement resources	James *et al.* (2012)	X
11	Education and experience of SME; work experience & education of team	Park & Krisnan (2001) Luzzini *et al.* (2015) Adams (2004: 142)	X
12	Multi-criteria supplier selection	Paik (2011: 14)	X
13	Procurement spend versus turnover Importance of NPR versus BOM	Overweel (2007); others Ozmen (2012: 50) James *et al.* (2012); others	
14	Procurement objective is TCO versus lowest cost	Paik, (2011: 14) Adams (2004: 129)	X
15	Long-term partnerships for critical commodities	Paik (2011: 14) Hagelaar *et al.* (2015)	X
16	Procurement objective is to contribute to competitive advantage	Adams (2004: 129)	
17	Service or a manufacturing company	James *et al.* (2012); Van Weele (2010); Adams (2004: 122, 143)	X
18	Past innovation successes	Gambatese & Hallowell (2011b)	
19	Incremental and not radical innovations	Johnsen *et al.* (2011: 7) Slaughter (1999)	X
20	Alignment procurement with company strategy; procurement & suppliers play and important role	Adams (2004: 129)	X
21	Owner is holistic, or traditional on procurement	Pressey *et al.* (2009)	X
22	Personal attitude or preference	Binder (2008); Ozmen (2012), Crispin-Mazet (2010); Pressey *et al.* (2009); De Clercq *et al.* (2015) Hinton (2013), Koebel & Cavell (2006); Hardie (2007).	X

Section summary-conclusion:

24. *This Section discussed company size from different perspectives. These insights were important as most of the focal companies had <19 staff, or even <6 staff, and as extant research was inconclusive om effects of company size. For an international comparison, the research à priori distinguished between companies with <100 and >100 staff.*

25. *SMEs should not be considered as miniature versions of large companies, and SMEs in the construction supply chain could vary in structure, organisation, or ambition levels. This would affect management of innovative suppliers within the focal companies.*

26. *New Zealand companies in construction were small. Research was inconclusive on whether small or large construction companies were more innovative. Education or experience was seen as a driver for procurement or innovation performance.*

27. *The research identified other moderating company variables. It selected several potentially-relevant variables for the empirical research. It was aware that moderating and confounding company variables could give unexpected effects.*

2.7 Entrepreneurship Variables

The research focused on companies that managed innovative suppliers as a means to achieving objectives. Such companies could exhibit entrepreneurial behaviour to realize growth. Contrarily, they could be also more lifestyle-focused on business-continuity, or could be working for survival. This Section discusses entrepreneurial orientation in general; Section §2.8 discusses company and customer strategies. An OECD study (2010a: 24) found that high-growth enterprises accounted for 2-8% of total company populations. Keijzers *et al.* (2007: 28) concluded that only 2% of (Dutch) SMEs could be considered innovative front-runners that conducted their own R&D. They found that another 28% of these SMEs were innovation adopters. Another group of followers (10%) adopted extant innovations; 60% of SMEs did *not* see innovation as part of their business operation.

For defining entrepreneurs, OECD (2010a: 33) proposed the following definition:

> Entrepreneurs are those persons (business owners) who seek to generate value, through the creation or expansion of economic activity, by identifying and exploiting new products, processes, or markets.

Shane & Venkataraman (2000: 4) linked entrepreneurship to innovation and defined entrepreneurship as an activity that involves "*the discovery, evaluation and exploitation of opportunities to introduce new goods and services as not previously achieved*".

Entrepreneurs pursue opportunities (Zortea *et al.*, 2012) and business objectives (growth, profits, or even continuity) are important drivers. However, only a minority of focal

companies could have a sustained entrepreneurial orientation *and* additionally create substantial growth[37].

2.7.1 Entrepreneurial Orientation

Entrepreneurship translates into an entrepreneurial orientation of companies. This orientation contains both an attitude and behaviour, and managerial activities to pursue opportunities under uncertain conditions (Wiklund & Shepherd, 2008). Covin & Slevin (1989) stated that entrepreneurial orientation includes characteristics of *(1) pro-active to innovation, (2) opportunity recognition, (3) propensity to risk-taking*. Lumpkin & Dess (1996) added (4) *competitive aggressiveness* and (5) individual *autonomy.* This latter autonomy construct is less often researched (Wales *et al.*, 2013: 366, 373) and did not match the objectives of this research (Lechner & Gudmundsson, 2014: 38).

Instead the empirical phase of the research added a *trust* variable with entrepreneurial orientation. Although *trust* was not considered an EO variable per se (e.g. Franz, 2018: 25-35), the research posited that *trust* nevertheless represented a behavioural attitude towards suppliers and customers that could drive the other four EO variables. (See §2.9.5 for more details). Table 16 below gives common definitions (based on Lumpkin & Dess, 1996: 43, 138).

Table 13: Definition of constructs on entrepreneurial orientation

Construct	Definition
Innovativeness	Tendency to support and encourage new ideas as well as experimentation and creativity, research and development
Risk-taking	Willingness to make large and risky resource-commitments which could have a reasonable chance of costly failure.
Pro-activeness	Exploiting first-mover advantages and anticipating future events.
Competitive aggressiveness	The effort (intensity) to challenge and outperform competitors, to overcome market adversaries by maintaining a confrontational posture (e.g. with price cutting). In this research also: the ability to actively challenge suppliers. (based on Schillo, 2011)
(For Trust)	*(See §2.9.5).*

NOTE:
The questions on entrepreneurial orientation in Survey I included aspects of trust with suppliers and customers. This trust variable-pair was reviewed in §2.9.5. Entrepreneurial strategies are discussed in §2.8.2.

2.7.2 Entrepreneurship in New Zealand

Considering the moderate position of New Zealand in the Global Innovative Index (Cornell University *et al.*, 2015) and the relatively low innovation rate in the construction industry

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[37] Moreover, companies may be entrepreneurial and not innovative on technology innovations.

(Page, 2011), the percentage of entrepreneurial companies in the New Zealand construction industry could be lower than OECD averages (2010a: 24). From a quantitative international comparison of entrepreneurship and performance, Frederik & Monsen (2011: 202) concluded that:

> Current Kiwi *entrepreneurial disequilibrium* of high entrepreneurial activity but lower economic development comes from a singular constellation of events that disfavour *creative destruction* in the Schumpeterian sense. (Italics in original).

Barriers could be comparable to the innovation barriers discussed in §2.2.1. Frederik & Monsen (ibid) found that several macro variables (e.g. the lack of adequate governmental interventions) hindered the creation of wealth from entrepreneurial activities. Battisti *et al.* (2010: 189) came to similar results with a survey amongst 1500 SMEs (<100 staff) and concluded that New Zealand needed more growth companies "rather than too many small companies". Deakins (2013: 3) concluded that competitive forces in New Zealand were generally relatively low due to the physical distance to overseas markets, and the small size of the domestic market. Following the reasoning of Schumpeter (1942) this would imply low innovation or improvement rates. However, the general opinion was that 2nd tier construction companies experienced fierce competition on lowest-price contracts (Bemelmans, 2012; Hinton, 2013). Nevertheless, price competition could be less dominant with material suppliers (Page 2013b). It could also be less dominant between 2nd tier companies and their 3rd tier focal companies, which was confirmed by Koebel (2008). (Compare Fig 2 in §1.1).

Deakins (2013) concluded that a lack of investment in business R&D hindered adoption of innovations in New Zealand. Rinne and Fairweather (2011: 77, 97) concluded that cultural attitudes in New Zealand such as the 'tall-poppy-syndrome' (where it is not done to boast of one's success in business), individualism, and a focus on lifestyle could generally limit the implementation of innovations. Basnet *et al.* (2010: 476, 480) found similar inhibitors for supply chain management in New Zealand, and mentioned limited knowledge, independent managerial mind-set, uncompetitive local market, and small company sizes as barriers for supply chain improvements.

Hence it was relevant to know to what extent entrepreneurial orientation in focal companies could affect procurement management variables & practices and subsequent procurement performance of supplier innovations. Entrepreneurial orientation is a construct measuring behaviour towards customer markets. As this research focused on

managing innovative suppliers, it was also relevant to know whether entrepreneurial orientation would affect interaction with supplier markets. This was not researched before.

The quantitative part of this research hence investigated: 1. Opportunities with innovative customers & suppliers; 2. Innovating with Innovative customers & suppliers; 3. Aggressiveness in customer or supplier markets; 4. Risk-taking towards Innovative customers & suppliers; and 5. Trust with innovative customers & suppliers.

Section summary-conclusion:
28. *Extant research suggested that a (very) small part of New Zealand companies in construction supply chains was entrepreneurial or innovative.*

29. *This research was unable to identify relevant research of entrepreneurial orientation on procurement practices with innovative suppliers.*

30. *This Section defined entrepreneurial orientation of focal companies into four variable-pairs based on Lumpkin & Dess (1996) towards customers and towards suppliers. (The trust variable as discussed in §2.9.5 was later added to this construct. See also §2.8 for entrepreneurial strategies).*

2.8 Company Strategy and Customer Strategy Variables

This research started from a commonly-used definition of strategy as "*the indication of the direction and scope of an organisation over the long term*" (Johnson *et al.*, 2008: 3). A strategy should realize an advantage for stakeholders in a changing environment and it does so by managing resources and competences. Related strategic management decisions are complex and uncertain. They change and affect the operation of the organisation and require an integrated approach (Johnson *et al.*, 2008: 7).

Company strategies are often (Verhage, 2016) related to growth strategies (Ansoff, 2007), competitor strategies (Porter, 1985) or customer strategies (Treacy & Wiersema, 1997). Companies often involve partners for realising their strategies (Chesbrough, 2004; Gronum *et al.*, 2012; De Jong, 2005; OECD, 2010a). Research suggested that this is especially true for SMEs, although some open innovation research suggested otherwise (§2.3.6; Teirlinck & Spithoven, 2013; Lee *et al.*, 2010).

Companies could use marketing strategies such as early-time-to-market or joint innovation strategies with customers or suppliers to gain competitive advantages. In such instances upstream and downstream networking and collaboration capacities are crucial for successful innovations. The specific strategy could affect procurement processes and

procurement performance. This Section describes three types of company strategies that were explored in the empirical part of the research.

2.8.1 Company Turnover Type: Turnover from Services, Products, Sales, or others

The ANZIC classification (see §2.1) distinguished three types of companies: construction companies, and companies supplying such companies with related services (architecture etc.) or supplying those with materials (manufacture, wholesaling).

Focal companies could apply procurement practices that differed with their offerings to customers, i.e. whether they provided services, manufactured products, or conducted wholesale activities (Cagliano & Spina, 2002). Van Weele *et al.* (2017) stated that wholesale companies would conduct procurement focussing on price and logistics. For primary materials or components, manufacturers would conduct procurement based on complex manufacturing or product criteria. Procurement would be less driven by price. Similarly, companies that provided services would conduct different procurement practices with their key subcontractors (versus their key material suppliers), especially when such services were visible to end-customers. Finally, some research suggested that manufacturing and retailing companies have higher procurement maturity levels than service companies (Van Weele *et al.*, 2017: 93).

2.8.2 The Company Strategy is oriented on Growth, Lifestyle, or Survival

Further to Section §2.7 on entrepreneurship, this Subsection investigated company strategies (Sexton & Barrett, 2003: 627) related to growth (company wants to increased profits), lifestyle (company wants a secure level of income and e.g. independence) and survival (company wants to remain in business). Morrissey & Knight (2011: 1150-1152) found differences in procurement behaviour with these three company strategies. For example, growth-oriented companies were more procurement-active and utilised their supply base better. Lifestyle companies relied more on trust with suppliers, whereas survivors had little time for supplier relations. Pressey (2009: 220) found different procurement capabilities in SMEs with holistic buying behaviour versus a more traditional buying behaviour. Additionally, this research posited that companies that were engaged in (less risky) incremental supplier innovations, could be less entrepreneurial, would focus more on business continuity, and could exhibit different behaviour towards suppliers.

Small business research often suggested (see e.g. Keijzers *et al.*, 2007; Davidson *et al.*, 2005; see §2.6, §3.1.3) that only 2%-10% of companies are directed to growth. However, MBIE (2014: 43) found that 35% of new business owners in New Zealand started their new venture for lifestyle reasons. The review was unable to find relevant literature on company strategies related to managing innovative suppliers.

> **NOTE:**
> In Survey I, the growth-oriented companies were designated as having an "entrepreneurial strategy".

2.8.3 The Customer Strategy or Customer Value Proposition

In line with supply and demand chain thinking, Treacy and Wiersema (1997) developed three generic customer strategies (customer value propositions) from the perspective of the market i.e. the value requested by customers. The basics of product leadership is that a focal company offers the best technical products or services. The basics of customer intimacy is that a focal company is agile and tries to meet (or exceed) customer requirements. The basics of operational excellence is that a focal company offers reasonably-priced products or services with a reasonable quality.

The following Table combines these three strategies with concepts of lean versus agile supply chains (Johnsen *et al.*, 2013: 213) and procurement performance in large and SME companies (Mikalef *et al.,* 2015: 635)[38].

Table 14: Value propositions features in supply chains (based on Johnsen ea 2013; Mikalef, 2015)

	Product Leadership	Operational Excellence	Customer Intimacy
Organisational focus	Provide customers with the best product or service available on the market	Achieve reliable and competitively priced (lowest total costs) products or services for customers.	Meet the deepest needs of the customer and to meet these needs
Value proposition	Innovation and best functional quality	Limited product portfolio, minimising costs	Optimising life-time value for customer
Supply chain	Agile supply chains	Lean supply chains	Agile supply chains
Types of relations	(?? No information available)	Contract binding & SLAs with small supply base	Ad hoc relations and networks
Supply base	Need large supplier base for competitive actions	System integration with preferred suppliers	Need large supplier base for changes in customer demands
Procurement behaviour	Probably new buy situations with new innovations	Purchasing repetitiveness (Repeat buy situations)	Probably modified or repeat buy situations

[38] Missing data from the original sources were indicated with "??"

Procurement organisation	Decentralised procurement SME: informal organisation => ineffective procurement	Procurement organisation: SME=centralised; Large=decentralised	Centralised procurement (both for large and SMEs)
Financial objectives	?? Cash flow with innovations	Reduces transaction and delivery costs	?? Cash flow for meeting customer demands

This research applied this basic set of three customer strategies as they recognized the possible effect on procurement. These value strategies would drive and influence procurement management with innovative suppliers and subsequent procurement performance.

2.8.4 Overview of Other Strategy Variables

This Subsection presents other potentially-relevant variables (§3.2.4) related to the strategy of the focal company. Similar to the variables shown in the overviews of §2.2.4, §2.5, and §2.6.3, these variables could separately or conjointly affect procurement practices when focal companies managed innovative suppliers. Hence, they could act as moderating or confounding variables. (Variables with an X were analysed in the empirical phase of the research. See §3.2.4).

Table 15: Company strategy variables as found in literature

	Variable	Source(s)	Selected
1	Owner ambition & motives Entrepreneur, lifestyle, survivor	Morrissey & Knight (2011) Davidsson (2007) Sexton & Barrett (2003: 627)	X
2	Three types of small company strategies prospectors (organic structure), analysers formal structure), reactors (no strategy)	Verreynne (2011: 331)	
3	Business model (Entrepreneur or market-oriented)	Zortea-Johnston et al. (2012)	
4	Formulated (planned) or intuitive (emergent) procurement strategies	James et al. (2012) Abbott (2006) Adams (2004: 129)	
5	Active supply chain involvement versus passive involvement, and financial performance	Brau (2007) (Internally, Adams, 2004: 129)	X
6	Attitude to innovation, change Innovative culture in construction companies	Songip–Brown (2013) Bossink (2004)	X
7	Open vs closed innovation preferences	(Several; see Appendix §2.3.6)	
8	Procurement perceived as important (strategic) or not	Quayle (2002); Paik (2011: 14); James et al. (2012) Pressey et al. (2009)	
9	Suppliers are considered an important resource	Paik (2011: 14)	X
10	Necessary (cost) / Opportunity (competitive advantage)	Cohen, 1989 (in Abbott, 2006)	
11	Procurement in SMEs should be structured to their business strategy	Bäckstrand (2016) Hagelaar et al. (2015a)	X
12	For contractors: competitive prices are most important, then quality and cooperation, and then know-how.	Hartmann & Caerteling (2010)	X
13	Selection first based on quality, only then price and service	Overweel & vd Zeijden (2007)	X

| 14 | Small SMEs: procurement must ensure continuity in production, they require quality and flexibility and performance from suppliers. | Ellegaard (2006) | X |
| 15 | Flexibility and service more important than discounts | Mosselman & Kemp (2005) | X |

Section summary-conclusion:

    31. This research distinguished three strategy types (company offering, company ambition strategies, customer proposition strategies). These strategy types could affect procurement management and procurement performance variables.

2.9 Supplier Types, Intensity of Relations, and Trust Variables

This Section discusses three basic supplier types and two common aspects on supplier-relations that were analysed in the empirical part of this research.

2.9.1 New versus Current Suppliers

As argued earlier, construction supply chains often had informal or loose ties. (Vrijhoef, 2011). Not all buyer-seller relations in the construction industry had formal pre-selection processes, but subcontractors or suppliers would often work for the same main contractor. Greenhalgh & Squires (2011: 60) distinguished three types of current suppliers. Selection is done by different stakeholders as shown below.

Table 16: Typology of (pre-selected) current suppliers or subcontractors

Domestic subcontractors or suppliers	These are normally selected by the main contractor
Named subcontractors or suppliers	These are normally selected by the designer
Nominated subcontractors or suppliers	These are normally selected by the client (employer)

As entry-level barriers for subcontracting work are generally low, main contractors can easily choose new subcontractors. This is even the case if existing subcontractors have previously shown to deliver good quality (Hartmann & Caerteling, 2010: 354, see also §2.9.5). Innovative subcontractors should prove that their improved processes interface well with other processes. Innovative products suppliers could have a better negotiation position through previous lock-ins or unique product features (Koebel, 2008) or entrance barriers (Page, 2013b). In some cases, a lock-in situation is created, which forces customers to buy from the same supplier. In case of commodities companies could easier switch to other material suppliers, although products still had to adhere to New Zealand building regulations.

For a variety of reasons, focal companies could use current innovative suppliers, or could search for new innovative suppliers or subcontractors. Literature suggested that especially

SMEs would remain loyal to current innovative suppliers (e.g. Paik, 2011: 14; Hagelaar *et al.*, 2015). However, when innovative products or services are not available, such companies could search for a new supplier (Johnsen *et al.* 2011, Schiele, 2010; see §2.2).

2.9.2 Small versus large Suppliers
Effects of company size were discussed in §2.6.1. Extant research revealed that both large and small construction companies can be active in construction innovations. This research is also interested in the size of the supplier.

Large focal companies could prefer (relatively) large and established innovative suppliers, as such suppliers could manage innovation risks and have sufficient skills and resources. Alternatively, they could prefer small specialist suppliers with unique technologies or capabilities. (Add source).

Furthermore, small focal companies could prefer small suppliers as counterparts. SMEs could experience difficulties in managing large or foreign suppliers (Jorgenssen & Koch, 2012), or could be "sceptical" of collaboration with large dominant partners (Morrissey & Pittaway, 2006).

2.9.3 Foreign versus Domestic Suppliers
All construction innovations must meet the New Zealand Building Code[39]. This could be an entry-barrier for foreign construction innovations, as the Building Code requires that the innovative product is fit-for-use, is safe-to-use and hence complies with standards. The innovating company must invest time and money to obtain consent for the product.

The Building Code accepts some foreign standards. Focal companies could be interested in innovations from foreign suppliers (for reasons of price, aesthetics, quality, or availability). However, either the focal company or the innovative foreign supplier must arrange consent for foreign construction innovations. Due to the market size and distance to overseas manufacturers' markets, the New Zealand construction industry might not be an attractive market to foreign innovative suppliers. (Add source).

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[39] https://www.building.govt.nz/building-code-compliance/how-the-building-code-works/

2.9.4 Intensity of Supplier Relations

In this research, the notion of *relation intensity* (Wynstra, 1998) was the amount of effort and commitment (in time, money resources and risks) that both buying companies and suppliers exerted in achieving innovation objectives[40]. Kraljic (1983) in general stated that buyer-seller relationships depend on the economic balance of power (profit impact) and the availability of alternatives (supply risk). Wynstra & Pierick (2000: 51, 56) discussed that supplier relationships in large innovation projects depend on the development risk versus the responsibility held by the supplier. Similarly, Cousins (2002) discussed that such relationships change with the level of trust (confidence) in the supplier versus the level of dependency.

Le Dain *et al.* (2010) also contrasted risk levels to levels of supplier responsibility (autonomy). (See Fig. below). Following Le Dain, this would lead to five types of supplier relations, and five related ways of developing specifications, either by the focal company, the innovative supplier, or in co-development. Dollinger & Kolchin (1985) found a positive relationship in small firms (<100 staff) with supplier relation intensity and their performance; Schiele (2010: 2) found that a positive relationship with innovative suppliers was necessary to attain a "preferred customer status". Van Lith et al. (2015: 1049) found in
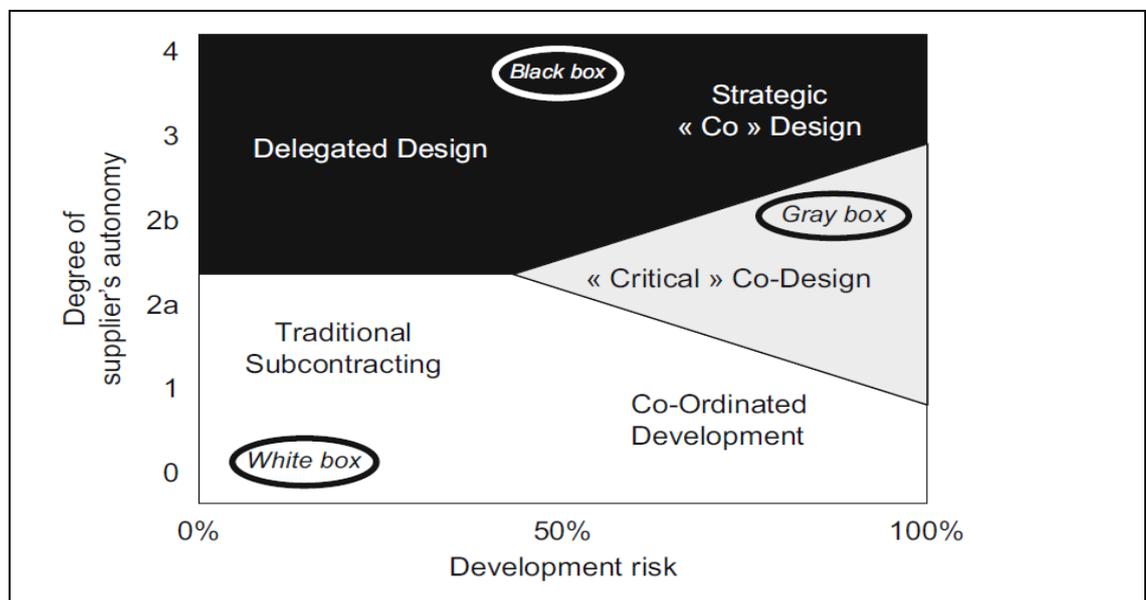
Figure 19: Typology supplier collaboration & specifications (from Le Dain *et al.*, 2010: 79)

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[40] Related terms: collaboration intensity (Fossas, 2010). In open innovation literature breadth: the number of partners or sources to collaborate with; depth: intensity and duration of each collaboration. See e.g. Grundström *et al.* (2014: 3). See also §2.10.1.

a longitudinal multi case-study that although main contractors might put efforts into forming relationships, they would not use such relationships for developing new technology or for sharing technology. Van Lith et al. (2015: 1034) confirmed the lack of long-term relations, a lack of integration, and adverse relationships between main contractors and subcontractors or suppliers. (See §2.10.2 on the intensity of supplier relations with product versus process innovations).

2.9.5 Levels of Trust with Suppliers and Customers

Trust[41] seemed an important reciprocal concept for innovative suppliers and focal companies. When suppliers wanted to cooperate, they needed to trust the company on protecting confidential expertise. Similarly, the focal companies needed trust to manage development risks (Brem & Tidd, 2014: xii). Trust takes a long time to develop and should be visibly demonstrated by both partners. Trust can also quickly be destroyed by the opportunistic behaviour of one or both partners. (Johnsen *et al.*, 2014: 112). Generally, in the construction industry 1st tier main contractors and their subcontractors had high levels of distrust. (e.g. Fairweather, 2009; Hinton, 2013). Hartmann & Caerteling (2010: 354; see also §2.9.1) found a subtle interplay between price, performance, and levels of trust. Main contractors became more confident when they assessed the quality of work in longer relations with subcontractors. The trust level increased and in turn this affected the selection of suppliers. However, subcontractors still had to submit favourable bids, to keep the main contractors' trust and remain on their preferred supplier lists. Price remained the most important selection criterion, irrespective of whether the main contractor had done business with the subcontractor or not (ibid: 359). Subcontractors with a good performance records could still lose a contract when the price was not competitive. However, main contractors still did business with a known subcontractor when it scored low on a quality aspect.

Trust can be a basis to reduce and manage risks (Cousins, 2002). There is literature to support the view that high trust levels with suppliers is a good basis for a supplier relationship that creates value and enables innovations. Especially SMEs have relations with suppliers based on trust (Brush, 2000; Cambra & Polo, 2008). Others however (Smets *et al.*, 2013: 1156) stated that constant levels of formal control (instead of trust) ensured efficient

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[41] Note that *trust* was classified with Entrepreneurial Orientation for Survey I. However in this review, trust was analysed separately. (See also §2.7).

and effective new product development activities. Adams (2004: 129) found that SMEs see suppliers as an important resource and that they see long-term partnerships as important. Johnsen *et al.* (2011: 7) suggested that companies could rely on trust with incremental supplier innovations, but on control with radical innovations.

Section summary-conclusion:

32. *Literature suggested that focal companies could use several supplier types. A particular supplier type could need different procurement management practices, and could have an effect on procurement performance.*

33. *This research selected three basic supplier type variables: new versus current innovative suppliers; small versus large innovative suppliers; foreign versus domestic innovative suppliers. It also selected intensities of supplier relations, and trust levels as variables.*

2.10 Innovation Type Variables

This Section discusses two basic innovation-type variables that were analysed in the empirical part of this research. It also discussed phases in the innovation process.

2.10.1 Radical versus Incremental Innovations

This innovation type was introduced in §2.2.3. Among others, Accenture (2013) concluded in a study with large American, British, and French companies that incremental innovations would bring fewer rewards. Radical-type innovations were riskier (more uncertain) but could bring higher levels of rewards. One of the risks was the non-adoption of radical ideas because it cannibalized current business or current customers would not want it.

In line with seminal work on innovation by Henderson and Clark (1990: 12), incremental innovation activities must be seen as *reinforcing* the current status whereas radical innovation activities can *change* the current status of either technology (concepts) or actors or companies (linkages) (OECD, 2010a: 76). According to Utterback (1994), infrequent radical product innovations can spur a wide range of incremental product innovations and process innovations in the industry. Kumar (2010: 54) found that the majority of SMEs would favour incremental innovations. (The defender or reactor strategy according to Miles & Snow, 1994). However, a small part would be successful in more radical innovations, often with partners "to overcome their liability of smallness". (Kumar, ibid: 54). (A prospector strategy according to Miles & Snow, 1994).

Regulation and voluntary standards can stimulate innovations. Kibert & Grosskopf (2005: 4154) suggested that green rating systems stimulated incremental innovations more than radical innovations. Tidd & Bessant (2009: 401) suggested that incremental innovation processes would proceed differently from radical innovation processes. Johnsen *et al.* (2012: 11) furthermore suggested that the two innovation types could require different supplier types and different roles of procurement departments. Mlecknik (2013; see §2.2.3.1) confirmed different supplier types for different types of construction innovations based on the Slaughter model (§2.2.3.1).

2.10.2 Product versus Process Innovations

Subsection §2.8.1 discussed service or product or sales offerings to *customers*. This Subsection discusses procuring product versus process innovations from *suppliers*. In general, procuring services differs from procuring products. Products can be stored in stock. Services are intangible, are created at the moment of delivery, and cannot be stored. Specifying services is also more difficult than specifying products (Van Weele, 2010). To this end, procuring services often needs more interaction and adjustments between the buying and selling organisations. (See also §2.9.4 on specification types).

Similarly, procuring construction products differs from procuring contractor services (Benton & McHenry, 2010). In the case of construction products, specifications could be drafted relatively easy, whereas defining construction services would need more interaction between the two companies after the specify-needs step. The focal company basically selects a service provider on production capacities, or on technical or logistical capabilities. The post-contractual phase is then critical for the successful delivery of a service (Van Weele, 2010). When a product does not meet requirements, an alternative is selected relatively easily. When a service (process) is not executed to requirements, it would need more interaction and cancelling this service provision could be more difficult.

Similarly, this research posited that procuring or developing product innovations with suppliers was different from procuring or developing process innovations.

2.10.3 Idea, Develop, and Business Phase in Innovation Processes

This Section discusses several innovation phases. For classifying innovation processes, this research analysed several classification methods (Slaughter, 2000: 4; Rogers, 2003; Gambatese & Hallowell (2011a), Cooper & Kleinschmidt, 2001: 40). Innovation processes

were found to be classified (sub-divided) in 3-step to 11-step process models. (See summaries in Appendix §2.10.3).

When studying the absorptive capacity of innovations on the Australian construction company level, Manley *et al.* (2014) used the 4-step model of Jiminez-Barrinuevo *et al.* (2010) *acquisition, assimilation, transformation,* and *exploitation*. The classic 5-step Rogers diffusion model (2003) was used by Gambatese & Hallowell (2011b: 556), Manley (2006), Rose & Manley (2012, 2014), Sheffer (2010b, 2012, 2013), and Taylor and Levitt (2004). Bernstein *et al.* (1998) as cited in Gambatese & Hallowell (2011a) promoted four steps for construction innovations. Ozorhon *et al.* (2010) applied a 3-step model to describe innovation value chains within UK contractor companies. Hence literature suggested various models.

Fairweather (2009) pointed out that construction innovation processes are often complex, with stages interacting with each other. Linear models assume that innovations start with the nucleus of an idea, and therefore need research and development, and with some good management are 'automatically' successful. In reality success rates of innovations are low (e.g. Hultink & Van den Hende, 2015). Hassel *et al.* (2003) mentioned two limitations of linear models: (1) they do not represent the iterative and complex path of innovations, (2) they fail to recognise innovations that mainly result from intuition, or trial and errors. This would imply using circular (cyclic) innovation models (Berkhout *et al.*, 2006; Buijs, 2012) which would also incorporate internal and external changes.

In an attempt to deal with the complexity in early innovation stages, Koen *et al.* (2001) developed an innovation process model for the "fuzzy" (i.e. unstructured and with high-uncertainties) ideation phase into five sub-phases. Tidd and Bessant (2009: 401) emphasized that especially processes for radical innovations could be "iterative and messy". Likewise, Sexton and Barrett (2003: 630) found that such processes in small construction companies could be fluid or disorganized. Similar to §2.4.2, considerations for selecting an appropriate model were:

- Participants had to be able to depart from different mental models, and apply subjective measures.
- Participants should be able to recognize the innovation process model and relate their innovation activities to the model.
- Innovation processes would not always follow straight linear pathways. The individual process steps would occur somewhere during an innovation process.
- Innovation processes within SMEs and with external stakeholders, could be more informal and should allow for a flexible, simple, and yet robust process model.

Therefore, the research applied a 3-step *innovation process model* as shown in the following Table.

Table 17: Innovation process model: three basic innovation phases used for this research[42]

Innovation Phase	Description
Idea	Idea formulation and assessment
Develop	Develop and test product
Business	Commercial use of product in market

Combining these three innovation phases with the four procurement process steps as discussed in §2.4.2, led to the related *classification model* shown in Table 18 below. This model should be on an adequately-high aggregation level to classify innovation procurement practices in focal companies.

Table 18: Classification model for procurement practices during innovation phases[43]

	Specify Need	Find-select supplier	Negotiate-contract	Manage supplier relations
IDEA: Generate & assess ideas for new products				
DEVELOP: Develop products or prototypes				
BUSINESS: Sell innovation to customers				

To obtain an optimal performance with a supplier innovation, the focal company could conduct practices in each of the 12 cells with an interaction between procurement practices and innovation activities. The exact nature of such practices would depend on several independent variables (as shown in conceptual model I).

Section summary-conclusion:
  34. This Section discusses three innovation type variables.

  35. The literature suggested that the procurement of radical versus incremental supplier innovations could be managed differently. Likewise, the procurement of product versus process innovations with suppliers could be managed differently.

  36. The literature provided several classification models for innovation processes. Based on four criteria, the research selected a simple three-phase innovation process model. The research combined this model with four procurement steps (§2.4.2) into a classification model (Table 18).
  37. This classification model would be used to classify procurement practices during innovation processes with suppliers.

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[42] Note that the business phase was only used during the exploratory interviews.
[43] Rows: the three innovation phases. Columns: the four procurement management steps.

2.11 Procurement Process Practices

This Section discusses procurement process practices[44] i.e. procurement process variables that would occur within each of the four procurement process steps (cf. §2.4.2). The research firstly defined a *procurement strategy* as:

> the *pattern of procurement decisions* on materials and services to support operations activities that are consistent with the overall company strategy. (Based on Carr & Schmeltzer, 1992. Italics added).

Decision making is making choices among several options. From a management perspective, such *patterns of decisions* consist of formalised or less formalised methodologies, activities, and practices[45]. Subsection §2.11.1 discusses procurement practices in general; Subsection §2.11.2 focuses on procurement practices in the context of this research.

2.11.1 Procurement Management (Best-) Practises in General

In line with the procurement process model from §2.4.2, the research wanted to analyse how procurement practices in the four process steps would affect procurement performance. Such practices then must be understood broadly as either (1) explicit management interventions shown by the (rational) use of tool, models, instruments, or even rules-of-the-thumb. (Staal *et al.* 2016). Alternatively, such practices can be (2) heuristic, implicit or unstructured as shown in emerging strategies, use of tacit knowledge or experience.

Practices could be seen as "*strategies and operational components*" (Brunswicker & Vanhaverbeke, 2015: 1245) of a procurement strategy for effective and efficient realisation of objectives. This implies that the (conceptual) strategy is made explicit in daily procurement operation of the SMEs in what Johnson *et al.* (2008: 15) called "strategy in action".

Cagliano & Spina (2002: 1368) argued that SMEs need procurement best-practises as a source of competitiveness. Tennant *et al.* (2014: 4) defined best-practices as "*those methods, techniques or processes that were deemed to be more successful than others*". Camp (1989) added the notion that such a best-practice is more successful within a

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[44] The research distinguished between procurement (management) *variables* and procurement (management) *practices*. In this research, procurement (management) *practices* were variables related to one of the four procurement process steps: specify-needs; find-select innovative suppliers; negotiate-contract; and manage-relations with innovative suppliers. (See §3.5). For definitions on procurement, see §2.3.2. For procurement variables, see §2.9.

[45] Hence what procurement practices, or procurement best-practices the company would apply.

particular domain. The New Zealand Construction Industry Council (NZCIC, 2006) defined best-practices in the construction industry as:

> The policy, systems, processes, and procedures that, at any given point in time, are generally regarded by peers as the practice that delivers the optimal outcome, such that they are worthy of adoption.

Extant literature on procurement in SMEs used different terms. For similar procurement processes or activities, Cullen (2012) used the term "best-practices", where Ubeda *et al.* (2015) used "levers", and Ritvanen (2007) used "procurement tools". (For details, see the Appendix §2.11.1. For a discussion of units-of-analysis and practices, see §3.1.2).

Consequently, best-practices in this research were considered of (1) *key importance* for future success, and (2) were executed *particularly well*. The notion of "key importance" (or similar terms as "critical", "major" "strategic", "essential", "dominant", or "important") was contextual and intersubjective. The same applied to notions as "good performance", "future success" or "particularly well". (See §.3.2.3).

NOTE:
Survey I investigated procurement <u>practices</u>; Survey II procurement <u>*best*-practices</u>.

2.11.2 Procurement Management Practices on Construction Innovations

So far, several Tables throughout this Chapter presented potentially-relevant procurement management practices that were identified via the literature review. Also, the detailed literature review on SME procurement and on SME open inbound innovation (see Appendices of §2.3.3 and §2.3.6) revealed such practices. For each step in the procurement process model (§2.4.2, §2.10.30), this led to a selection of nine procurement management practices[46].

The next four Tables present these selected practices with examples of sources on which these were based. The empirical research (mainly Chapter 8) analysed in more detail whether such procurement management practices could be rated as best-practices.

Table 19: Procurement specify-needs practices

##	Practice	Based on following sources
1	Our company focuses on economic value that suppliers provide our customers	Axelson & Wynstra (2002); Van Weele (2010); Rigby (2013: 15)
2	Our suppliers contribute to key functional specifications for innovations	Le Dain *et al.* (2010); Rigby (2013); Van Weele (2010)

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[46] The method to come to a selection of practices is discussed in §3.2.4.

3	Our company focuses on the technology the supplier provides	Axelson & Wynstra (2002) used the word functionality; replaced this with technology; Van Weele (2010)
4	Our company mainly determines key functional specifications for innovations	Le Dain *et al.* (2010)
5	Our customers mainly determine key functional specifications for innovations	Le Dain *et al.* (2010); Hardie (2011b) Van Weele (2010)
6	Regulations or standards mainly determine key functional specifications for innovations	e.g. Ozorhon *et al.* (2010), Hardie (2011b), Fairweather (2009)
7	We demand major contributions from key innovative suppliers	Pressey *et al.* (2009), Paik (2011), Quayle (2002), Bossink (2004), James *et al.* (2012) Manley (2002: 9): "high quality technical support from other organisations"
8	We use quite a formal process to determine the functionality we need	De Waal (2011), Cullen (2012), Miller *et al.* (2009: 62). Hughes & Weiss, 2007).
9	Innovative suppliers only contribute to technical specifications for innovations	Axelson & Wynstra (2002) used the word *functionality*; this research replaced this with *technology*. Compare with ##3; depends on strategic role of suppliers

Table 20: Procurement find-select practices

##	Practice	Based on following sources
1	We have a good knowledge of innovative supplier markets	Paik (2011), Axelsson & Larsson (2002) Echtelt *et al.* (2008: 196); Gann (1997); Manley (2002: 9): many construction suppliers to chose from
2	We use price and availability criteria to select our innovative suppliers	Pressey *et al.* (2009) Adams (2004: 129)
3	We use a wide range of criteria to select our innovative suppliers	Paik (2011); Pressey *et al.* (2009) Adams (2004: 129)
4	We know the resources and capabilities of our innovative suppliers	Axelson & Wynstra (2010), De Clerq (2014), Hughes & Weiss (2007); Manley (2002: 10): quickly become obsolete"
5	Our innovative suppliers must be large or stable	Jorgenssen & Koch (2012)
6	Our innovative suppliers must be flexible and cooperative	Morrissey & Pittaway (2006)
7	Our innovative suppliers need to know our customers' profiles and demands	Woodward (1965); Gurau (2011), Hagelaar *et al.* (2015) Rigby (2013)
8	We concentrate on selecting 1–2 key innovative suppliers	Frishammer & Horte (2005), Overweel & van der Zeijden (2007), Ram & Wilson (2009). Mosselman & Kemp (2005: 27)
9	We pro-actively scan overseas supplier markets for innovative suppliers	e.g. Cullen (2012), Esbjerg *et al.* (2012), Hayden *et al.* (2013), Ram & Wilson (2009), Sculley & Fawcett (1994), Agndal (2006), Cabham & Hamilton (2013)

Table 21: Procurement negotiate-contract practices

##	Practice	Based on following sources
1	We do compensate for our limited financial positions & low negotiating power	Pressey *et al.* (2009), Ramsay (2007), Lee *et al.* (2010), Esbjerg *et al.* (2012), Gadde (2001). Mosselman & Kemp: 2005: 22)
2	We focus on formal written contracts	e.g. Cullen (2012); James *et al.* (2011); Ellegaard (2006, 2009)
3	We are satisfied with a set of emails and verbal agreements	As with ##2; De Clerq (2014), Morrissey & Knight (2011), Padilla *et al.* (2013). Pressey *et al.* (2009)
4	We make arrangements with innovative suppliers on use of patents, trademarks or trade secrets	Urbina-Criado (2012), Drechsler *et al.* (2012), van der Vrande *et al.* (2009), Spithoven *et al.* (2013)
5	Our supplier negotiations focus on managing risks	Wynstra (1998), Ritvanen (2007), Chesbrough & Crowther (2006), Ellegaard (2008)
6	Our supplier negotiations focus on opportunities	Cohen (1989, in Abbott, 2006), Ellegaard (2008)

7	Our supplier negotiations focus on total costs	Cohen (1989, in Abbott, 2006), Ritvanen (2007), Hartmann & Cearteling (2010), Overweel & van der Zeijden (2007). Vörösmarty (2015); Rigby (2013: 15)
8	We reward innovative suppliers for successful innovations	Paik (2011), Nsimbilia & Jurriens (2012); Echelt et al. (2008: 196)
9	We prefer tri-party agreements for risky innovations	Spithoven et al. (2013), Parida et al. (2012), Miller et al. (2009: 62: 10% does not) Fagerström & Jackson (2002), Van der Vrande et al. (2009)

Table 22: Procurement manage-relations practices

##	Practice	Based on following sources
1	Our experience & skills are important for managing innovative suppliers	Paik 2011); Axelsson & Larsson (2002) Park & Krisnan(2001)
2	We mainly use contracts to manage innovative suppliers	e.g. Cullen (2012), Smets et al. (2013), Cambra & Polo (2008), Hayden et al. (2013) Adams (2004: 129)
3	We mainly use social relations to manage innovative suppliers	Paik (2011), Ellegaard (2006, 2009), Cousin (2002), Cambra & Polo (2008) Van Lith et al. (2015), De Clerq (2014)
4	Our relations are adversarial and innovative suppliers are managed rigorously	e.g. Hinton (2013); e.g. Bemelmans (2012) Van Echtelt (2004), Wynstra (1998), Le Dain (2009), Van Lith et al. (2015) Quayle (2002), Jones (1996)
5	Our relations with innovative suppliers are based on mutual goals	Van Echtelt (2004), Wynstra (1998) Wynstra et al. (2002), Van Lith et al. (2015)
6	Our relations with innovative suppliers focus on delivery of a specific innovative product	Wynstra et al. (2002); Vörösmarty (2015)
7	Our relations with innovative suppliers focus on mutual learning for future opportunities	Wynstra et al. (2002), Pressey et al. (2009), Van Lith et al. (2015)
8	Innovative suppliers are always involved early in innovation processes	Wynstra (1998); Rigby (2013: 15) Integrated, Adams (2004: 129)
9	We build trust and strong ties with innovative suppliers	Hinton (2013); Hartman & Caerteling (2010). Mosselman & Kemp (2005: 26)

Section summary-conclusion:

38. *The review identified a wide number of procurement practices for each of the four procurement process steps. This Section presented a selection of nine variables for each of the four procurement process steps.*

39. *The research selected those variables that were considered most relevant in the context on how focal companies managed innovative suppliers. This selection was based on the frequency of occurrence in literature, on feedback from informed academics, and on the industry and lecturing experience of the researcher. (See also §3.2.4).*

2.12 Performance Measure Variables

This Section discusses performance variables from literature that were analysed in the empirical part of this research. In the daily practice of the New Zealand focal companies, the performance from procurement practices and innovation activities would often be closely related and perceived as one result. Performance measures can relate to *input indicators, (forward-looking) process indicators, output indicators or outcome indicators.* (§2.2.2;

OECD, 2005; ISO 20400, 2017:22). This Section discusses and presents performance variables for this research.

2.12.1 Measuring Procurement Performance

Johnson & Leenders (2007), Gonzalez-Benito (2007), Foerstl *et al.* (2013) and Hartmann *et al.* (2012) provided overviews of large-company procurement performance measures. As this research argued earlier (e.g.§2.5) procurement in small company could differ from procurement in large companies, and the focal companies were both large and small. Complex large-company performance measures could not be directly applicable to SMEs. This research (see the following Table) identified SME output procurement performance measures from Adams (2005) as later amended and validated by Paik (2009: 363; 2011).

Table 23: Procurement performance measures (based on Adams 2005; Paik 2009, 2011)

1	Profit as a percentage of sales
2	Net income before tax
3	Return on investment
4	Purchased material price reductions
5	Order processing time reductions
6	Operating cost reductions

These output measures covered both efficiency and effectiveness (Batenburg & Versendaal, 2010; Foerstl *et al.*, 2013). They would (in)directly affect overall company performance.

2.12.2 Measuring Innovation Performance

Literature described success variables for innovations in general. Both Rose and Manley (2012) and Songip *et al.* (2013) used the Rogers (2003) diffusion model. However, this limited their focus on only diffusion (adoption of the innovation). For example Bos (2012: 102) used proxy outcome measures as manager-perceptions on reduction in energy, waste, carbon footprint etc. Gambatese & Hallowell (2011b) mentioned quality, new markets, and market share as output-performance. Pullen (2010) followed Cooper and Kleinschmidt (1995) and proposed the often-used *percent of sales.*

Additionally, Ozorhon *et al.* (2010) established an extensive overview of output and outcome innovation measures from literature. They applied these measures in a survey among 30 innovative small construction companies. This resulted in the ranking shown below. Note that the high-ranked measures contained intersubjective aspects.

Table 24: Prioritization of innovation outcomes (from Ozorhon *et al.*, 2010: 13)

Outcomes of innovation	Mean
Better company image	4.7
Improvement of services	4.4
Improvement of client satisfaction	4.4
Improvement of product quality	4.4
Improvement of processes	4.3
Increase in technical capability	4.3
Increase in organizational effectiveness	4.2
New services	4.1
New products	4.1
New processes	4.1
Market penetration and growth	4.0
Revenue growth due to new products or services	3.8
Short and long-term profitability	3.8
Improvement of organizational structure	3.6
Improvement of human resources	3.6
Intellectual property (patents, trademarks, designs)	3.5

2.12.3 Performance Variables for Focal Company and Natural Environment

Extant research hence suggested a wide variety of performance measures, depending on the purpose and organisational context. In part such measures were objective, in part such measures were intersubjective. (See also §3.2.3)[47]. This research needed a limited set of generic measures that were applicable to both large and small organisations.

Consequently, from the OECD innovation manual (OECD, 2005), the research selected standard *process measures* on innovation (e.g. number of people involved), and standard *output measures* (e.g. how many innovations over the past three years, and the turnover percentage over the past three years). Additionally, it used perceived *innovation-satisfaction variables* as an intersubjective proxy to measure outcomes of innovations processes (how satisfied is the respondent about innovation with suppliers, etc.). Similarly, it also applied perceived *innovation-benefit variables* as a proxy (how beneficial is the innovation for the company, and for the natural environment). This was in line with Lumpkin & Dess (1996) who suggested "various indicators of sales, growth, market share, profitability, overall performance and stakeholder satisfaction" as referred to by Franz (2018: 19). The use of intersubjective data is common, see e.g. Arend & Wisner (2005: 417). (See also §3.2.3; see Appendix §5.1 for survey questions).

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[47] Furthermore, some performance measures seemed objective. However research methods put limitation on obtaining hard and detailed data via interviews and surveys. The quality of such data then depends on the knowledge and attitude of the respondent. Hence also hard data can be intersubjective.

It must be noted that some research showed disagreement on measuring relations between operations and performance in survey studies (e.g. the meta study of Van Donk & Van der Vaart, 2005: 36-37). Similarly, Franz (2018) and Schillo (2011) both concluded that the effect of entrepreneurial orientation to firm profits could not always be proven[48]. Again, this implied that relations should be designed cautiously, and that findings should be interpreted with care.

Section summary-conclusion:

40. *Conducting innovation procurement practices could give economic, social, and environmental benefits to the company, to suppliers and customers, and also social and environmental benefits to other stakeholders.*

41. *Extant literature indicated a wide array of performance measures for innovations and procurement. The research selected a limited set of generic procurement performance[49] variables on process, outputs, and outcomes. Empirical findings should be interpreted with care.*

2.13 Gaps in Extant Research

The extensive, structured, and iterative literature review of this Chapter revealed *a lack of knowledge on how New Zealand companies managed innovative suppliers in construction supply chains.* This was exemplified throughout this Chapter in the 40+ Section summary-conclusions and in several Tables. Literature did not provide a coherent picture on how companies managed innovative suppliers in the context of this research. In more detail it was unclear:

1. What procurement management variables & practices focal companies used when they managed innovative suppliers in construction supply chains.
2. To what extent independent company variables had an effect when focal companies applied procurement management variables and practises to manage innovative suppliers.
3. What the resultant procurement performance was.

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[48] Based on Rauch *et al.* (2009) and Lumpkin & Dess (1995), Franz (2018: 19) mentioned the following moderating variables for the missing performance link: industry characteristics, dynamics of the environment, complexity, organisational factors (size, structure, strategy, resources, culture). In this context, Schillo (2011: 23-24) posited that effects could be curvilinear, and could also be smaller in business reality as academic journals could be biased towards reporting only research that found significant findings.

[49] Note that the research used the phrase "procurement performance", Other research would perhaps use "innovation performance" in this respect. However this research preferred procurement performance denoting *innovation* benefits (output / outcomes) from procurement activities with innovative suppliers.

This was a considerable knowledge gap, not only on the situation in New Zealand but probably also for similar companies in similar (construction) supply chains elsewhere.

The review in this Chapter 2 further identified a wide array of (sometimes starkly contrasting) variables, and only through an initial analysis could the researcher select variables that were *potentially-relevant* (§3.2.4) within the research context.

2.14 The Development of Conceptual Models I and II

Throughout this Chapter, conceptual model I (based on Staal *et al.*, 2015) was used to structure the literature review. Based on this review, the research was able to operationalise and simplify the conceptual model I into model II. This resulted in adopting chains of relations between the variables in three main constructs similar to an Input, Process, Output, Outcome model (Le Dain, 2009; Hardie, 2011b; Ram & Wilson, 2009; Wales *et al.* 2013).

This modified conceptual model II (below) analysed relations between independent company variables, mediating procurement management variables & practices, and dependent procurement performance variables. The procurement management variables & practices mediated possible relationships between independent company variables and the dependent procurement performance variables. For a part such relations could be correlations, for a part such relations could imply causation[50]. (For a discussion see *§*3.5).

Focal companies that scored high versus low on a particular independent company variable could therefore use different procurement management variables. This again could affect procurement performance in different ways. (Moreno & Casillas, 2008: 510). Alternatively, independent company variables could have a direct effect on performance variables. This model was applied and partially validated in exploratory interviews and applied in Survey I.

Note that this modified conceptual model II rearranged and re-named several variables. The organisation, entrepreneurship, and strategy variables were incorporated as *independent company variables*. Similarly, the procurement practices, the supplier and innovation type variables from the initial model were incorporated as *mediating procurement management variables*. Variables were added on priorities of procurement steps, on trust and relation

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[50] The research design could not be structured to define "causal relations", but the design was exploratory to reveal relations which could be mere correlations or possibly be causal. Interpretation of findings could then give an *indication of whether such relation*s were indeed causal. (Cramer & Howitt, 2004: 20, 75).

intensity, and on entrepreneurial orientation towards suppliers. The performance measures consisted of four (groups of) variables. (For an overview and discussion in Survey I, see §3.6.4.3). These changes did <u>not</u> necessitate structural changes in this review Chapter. Where necessary, a footnote or remark was added post-hoc for clarity.
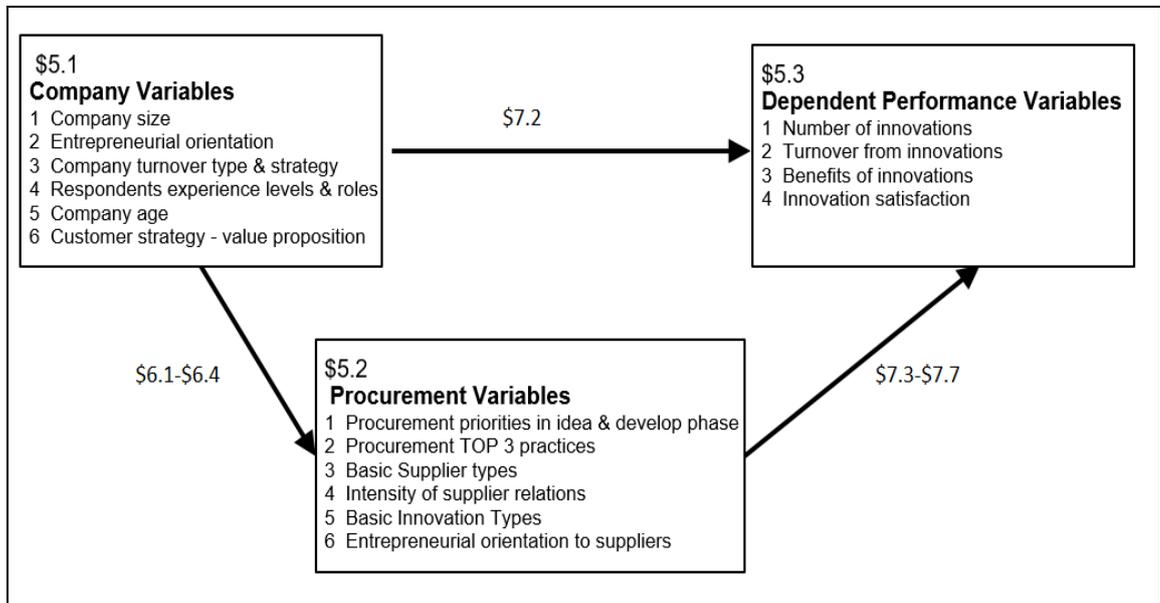
Figure 20: Modified conceptual model II based on the literature review

An example to show how this model II would work: the independent company variables *entrepreneurial orientation* could have a direct effect on the *turnover* from supplier innovations. For example, because the owner was good at getting such supplier innovations adopted by its customers. Likewise it could have an indirect effect on the suppliers types the company would engage with, which then again could have an effect on one of the performance variables.

NOTES:

1. This model II implied that the quantitative research investigated a large set of possibly-relevant variable-pairs to find relations. (See Chapters 5-8). This comprehensive analysis of possible relations was an adequate exploratory research strategy considering the early lifecycle of the research domain.
2. The research was designed broadly. (See §3.2.4). Moderating or confounding variables could have an effect, which could limit the possibilities to generalize empirical findings. Furthermore, conjunctions of variables combined could have intermingling effects that could limit the internal/construct validity and generalisability of conceptual model II.
3. Section §3.5 discussed whether relations between variables could imply correlation or causation.

> 4. Survey II used conceptual model III. (§3.5)

Section summary-conclusion:

> *42. The modified and simplified broad conceptual model II posited a relation between independent company variables, mediating procurement management variables & practices, and dependent procurement performance variables.*
> *43. Moderating and confounding variables and conjunctions of variables could have unexpected intermingling effects, and hence could limit internal/construct validity and also the generalisability of model II.*
> *44. The empirical research will try to assess whether relevant relations among variables suggest correlation or causation.*

2.15 Chapter Summary

This review aimed to answer the following structuring research question:

(RQ2) To what extent did extant literature give guidance on how New Zealand companies in construction supply chains managed innovative suppliers?

The context of the research was the New Zealand focal company that managed innovative supplier(s) in construction supply chains. The 44 Section summary-conclusions from this Chapter are summarised below.

1. The research analysed several research domains, and additionally focused on variables & practices from the context of small companies (SMEs) as (a) most focal companies were small, and (b) variables or practices from large organisations would probably not be applicable to small companies, and (c) there was a dearth of relevant research from the perspective of SMEs.
2. Hence it analysed articles on procurement and on inbound open innovations in SMEs. These articles were used in several Sections throughout this Chapter. Depending on specific findings, additionally-relevant articles were notably discussed in §6.1.
3. The research applied broad definitions on innovation and procurement. It developed a process model with four procurement process steps and three innovation phases[51] on how focal companies managed innovative suppliers
4. The contingency perspective suggested that the interaction of several variables could have varying effects on procurement variables & practices and on procurement performance when focal companies managed innovative suppliers. This multi-variate perspective increased the research complexity but was probably an improvement compared to a focus on a selected number of binary-type relations.
5. The literature revealed and selected a wide array of potentially-relevant and partly-conflicting practices and variables.

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[51] Note that the quantitative research only partly analysed the current business phase. (In Chapter 5).

6. The research selected practices and variables that were considered most relevant in the context on how focal companies managed innovative suppliers. This selection was based on the frequency of occurrence in literature, on feedback from informed academics, and on the industry and lecturing experience of the researcher.

7. These selected practices and variables were analysed in the empirical part of this research. (They were summarised in Tables throughout this Chapter, indicated with an X).

8. The research revealed potentially-relevant moderating or confounding company variables, which were not included in the empirical research. These variables could have unexpected intermingling effects that could limit the internal/construct validity and generalisability of the model.

9. Any selection of potentially-relevant practices and variables for the empirical part of the research could impose a limitation on the internal/construct validity and generalisability of the research.

10. The construction industry in New Zealand formed an important part of the economy, was generally considered low in productivity and sustainability, and not very innovative.

11. Suppliers could bring innovations into the industry; research revealed several innovation adoption barriers. This research developed a construction supply chain and typologies for focal companies and 2nd and 3rd tier innovative suppliers. This supply chain showed the variety of company types and variables.

The research question is discussed and answered in Chapter 9.

Chapter 3

Methodology of this Research

I keep six honest serving-men
(They taught me all I knew);
Their names are What and Why and When
And How and Where and Who.
R. Kipling (1865 – 1936).

Chapter 3

Methodology of this Research

The overarching objective of the research (§1.4) aimed to identify and explore relations between procurement management variables & practices, related company, innovation, supplier, strategy, and related procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains. Such an investigation was a "*complex task which requires a systematic approach to data collection and analysis if meaningful results are to be achieved*" (Naismith, 2007: 119).

This Chapter provides the rationale for the methodology and mixed-mode methods to achieve the research objective. It aimed to answer this structuring research question:

(RQ3) What was an appropriate research methodology to explore the research domain in order to achieve the research objective?

3.1 Topic of this Research

This research focused on both large and small companies. As presented in Chapter 2 there are differing definitions in what a small company is. Literature almost interchangeably used terms such as *entrepreneurs*, *small firms, micro companies, small businesses*, *micro businesses,* or *SMEs,* and definitions vary over countries, regions, or industry sectors (cf. §2.6.1). The focal company of this research managed innovative suppliers. This Section therefore defines the locus and the definition of focal companies, the units-of-analysis, and the target-population.

3.1.1 Locus of this Research and Definition of Focal Companies

A first description of the locus[52] of this research in construction supply chains is given in §2.1.2: *focal[53] companies and their 2nd or 3rd tier innovative suppliers in New Zealand construction supply chains*. Such companies were often SMEs but could also be large companies (§2.6.1). Based on the review, the research posited that company size could result in different innovation or procurement practices.

Micro-companies <5 staff most probably had simplistic structures. Decisions were informal and taken by the owners. Such companies were scarce on resources and probably did not exhibit much innovative behaviour. This was partly confirmed by Lu, Barret & Sexton (2004: 734) who found that innovation in small contractor companies "tends to come about in very fluid, informal ways" and mainly in face-to-face discussions. However, other research (OECD, 2010a) indicated that new micro-companies (e.g. start-ups) could be highly innovative. Therefore, this research included such micro-companies.

The research then identified two groups of *'small companies'* between 5-9, and between 10-20 staff. As discussed in §2.6.1, such companies could vary widely in management and organisation structures, in ambition levels and strategies.

Depending on definitions, *'small to medium-sized companies'* had between 20-50, or between 50-100 staff. In an international context such companies were often classified as SMEs. In a New Zealand context companies between 50-100 staff could behave as mature and were often classified as large companies (Verreynne & Meyer, 2011; De Waal, 2011: 4, 82).

The research included a group of '*large companies*' of 100-249 staff. In an international context these were often called SMEs; in a New Zealand context these were considered large companies.

Finally, the research included a group of *'large companies'* of >249 staff. In this research, such companies could be principal (main) construction companies, often non-residential businesses, or public asset owners or asset / facilities managers. Note that such large companies could be (semi-) governmental bodies (e.g. research institutes, universities, city councils) and could use public-procurement guidelines. As the research was interested in

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[52] Locus: a particular position or place where something occurs or is situated, or the effective or perceived location of something abstract. (Oxford dictionaries, accessed 18 October 2017).
[53] Focus: relating to the centre or most important part. (Oxford dictionaries, accessed 18 October 2017).

procurement practices on the dyadic level, it included such companies. These seven groups classified the focal companies of this research.

NOTES:

1. Classifying different organisation types simply as 'companies' was consistent with e.g. De Waal (2011:81) whose "small firm" NPD research included both SMEs and some larger government research institutes (New Zealand Crown Institutes).
2. There was some confusion in extant research on company types. Innovation research on "construction enterprises" by Hardie (2011b) included both contractors and material or system suppliers. SME procurement research by Adams (2004) included several company types without further specifications. In their small firm innovation research De Jong and Vermeulen (2006, 596) noted that their industry classifications were "broad".
3. This added to the reasons why the research for Survey I did not focus on company types (contractor, architect, subcontractor etc.) as such (§2.1.2; §3.2.4).
4. Instead this survey aimed to establish profiles via turnover types, company, or strategy variables. (§3.6.4.3). Nevertheless, the research distinguished company types in Survey II, as these could give context to findings from Survey I.
5. Extant literature was inconclusive about the relation between company size and innovative behaviour. (See §2.6.1.3). Findings from the review indicated that differences in innovative and procurement behaviour seemed contextual and could depend on several other variables. This research à priori distinguished several company sizes and was aware of possible effects of shadow employees (§2.6.1.2). It did not use rigid classifications as applying these could create a false sense of precision. It used a convenient classification to be able to conduct statistical analysis on the effects of company size on procurement management practices.
6. Generally, public organisations could be considered less innovative. They could stimulate supplier innovations (e.g. Rigby, 2013; Lenderink *et al.,* 2018: 990) to either stimulate innovations in the private sector, or to apply the innovative product or service within public organisations.

3.1.2 Units-of-Analysis in this Research

The units-of-analysis[54] in this research related to dyadic procurement practices (Johnsen *et al.*, 2014: 20) when a focal company (case company) managed a 2nd or 3rd tier innovative supplier. (§3.1.1). It was this level of activities that the research tried to understand and wanted to make generalisations on (Kenny, 1996). These procurement practices (§2.6 to §2.11) are affected by several independent variables and result in dependent performance variables. (§2.12, §3.4). The research did not investigate the full dyadic relation. Instead it

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[54] A unit-of-analysis is the major entity of study (Kenny, 1996).

chose the semi-dyadic perspective from the respondent or participant in the buying company, which was already a complex and important investigation. In fact, there was a dearth of information on such management practices, whereas those can be critical for introducing innovations into the construction industry. The research did *not* investigate the perspective of the supplier-half of the dyadic relation. This perspective is more common in procurement research on dyadic buyer-seller relationships (e.g. Morrissey & Pittaway, 2006; Pulles *et al.*, 2012; Spina *et al.*, 2013: 6), hence the phrase "*managing innovative suppliers*".

The research participant (respondent, see §3.2.2) in this research was an informed professional or decision-maker (manager, owner, or professional) on the dyadic relations between the focal buying company with suppliers. The focal company could procure or manage more than one innovation from more than one supplier. The *unit-of-analysis* was a specific buyer-seller relation for one specific innovation. The research could consequently relate to more than one unit-of-analysis within one focal company.

The hierarchy of the unit-of-analysis within focal companies is shown in the following Table. This model was based on a value chain process-orientation and was adapted from Collier & Evans (2013: 143). It depicts the alignment of daily operations with overall company strategies and distinguished three levels of measurement: the *strategic* (company or business) level (S), the *functional* or *tactical* level (T) and the *operational* level (O). These three levels roughly indicated different scopes, different risks and impacts on needed resources, and different timelines (Johnson *et al.*, 2008: 7).

Table 25: Levels of procurement practices in focal companies (based on Collier & Evans, 2013)

Level	Hierarchy	Research context	Definition	I/O
S	Company strategies	the focal company	A network of processes on the value chain level to deliver the value proposition to customers.	In
T	Procure-ment strategies	Functional alignment with company strategies	Group of procurement processes aligned with company strategies to deliver value to customers.	In
T	Procure-ment processes	Operatio-nalisation of procurement strategies	Group of related procurement activities needed to create an intermediate or final output to an internal customer. In a process one or more inputs are transformed so that resulting output(s) add value to customers.	In
O	Procure-ment practices	Operationalisation of processes	Group of related procurement activities or tasks required to create a key intermediate or final output to customers.	In
O	Procure-ment activities	Operationalisation of practices	Group of procurement tasks required to create an output within a practice	Out
O	Procure-ment tasks	Subdivision of activities (assigned to individuals)	Specific unit of work required for an output within an activity.	Out

S=strategic level; T=Tactical level; O=operational level.
In/Out: means within-the-scope or out-of-scope of this research.

The *strategic* level is on the level of the value chain and delivers (realises) the value proposition of the company to its customers. This was inside the scope of this research (§2.2.1) as this research treated customer strategies as independent variables. The *tactical or functional* levels on procurement were also within the scope of this research. The same holds for practices on the *operational* levels. Procurement activities or tasks are the most basic units-of-work required to get an output within a practice. These last activities were considered to be too detailed to be within the scope of this research.

Extant literature used different terms for the in-scope activities in this model (see §2.11.1) This research preferred the term "procurement management practices", denoting either *procurement strategies, systems, procedures, processes,* or just *practices*. The Evans & Collier model (2013) did not provide for the concept of "best-practices". For a discussion on best-practices, see §2.11.1.

3.1.3 Target-population for this Research

The exact population of focal companies[55] in New Zealand construction supply chains that managed innovative suppliers was unknown. Publicly available statistical data on the construction industry included data on small and large *construction* companies (NZ stats; PWC, 2016; Page, 2013; §2.1), but did not include material suppliers, specialist service providers or business end-users in the wider part of construction supply chains. Based on the data available, this research assumed that approximately 55,000 to 60,000 companies in New Zealand were active in construction supply chains. A large part of those companies would not actively engage with innovative suppliers to introduce innovations into the construction supply chain. Based on three approaches, the population of focal companies that managed innovative suppliers was roughly estimated between **3,000 to 6,000** companies:

1. Companies could be members of one or more relevant New Zealand industry associations (§3.6.4.1) that promoted innovations in construction supply chains. This research estimated that on average 30% to 50% of these members had email addresses on association websites and that approx. 5% to 10% of companies could be members of two or more associations. Desk research on the Internet (§3.6.4.1) enabled the selection of approximately 1,491 downloadable (and 1,097 usable) internet addresses of relevant

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[55] See footnote #6 on the distinction between focal and case companies.

company members within such associations (§3.6.4.1). Hence the number of relevant companies could approx. be 3,000 to 4,500 companies.

2. NZSTATS[56] registered 1,656 construction businesses with "innovations activities". It registered 525 construction businesses that in total invested NZD 18 million in innovations on staff, machinery, and material. The NZSTATS definition was narrower than used in this research[57]. When combined with PWC (2016) ANZIC staff data from §2.1, and under the assumption that construction companies and construction-related companies have equal sizes, this would lead to at least 2,158 relevant companies. Nevertheless, numbers could still be higher or lower.

3. Industry data varied with the source and definitions used. This research assumed that roughly 5% to 10% (§2.2.1) on the population of companies within the New Zealand construction industry was innovative and/or engaged with innovative suppliers. The total population was roughly estimated at 55,000 to 60,000 companies. Hence the relevant population could be 2,750 to 6,000 companies.

Section summary-conclusion:

1. *This research focused on companies that managed innovative suppliers. The research à priori classified focal companies in size. (The research was aware of possible limitations of this segmentation variable).*

2. *The units-of-analysis within these focal companies were procurement practices that were conducted when such companies managed innovative suppliers for each specific innovation.*

3. *Accurate data were not available. The New Zealand target-population for this research was roughly estimated between 3,000 and 6,000 companies.*

3.2 Companies, Participants; Variables & Practices; Inter-subjectivity
This Section discusses the sampling frame and sampling method of the research.

3.2.1 Selection of Case Companies of this Research
This research identified and analysed the target-population of companies that managed innovative suppliers. (§3.1.3). It used qualitative methods (interviews and focus-group discussion) and quantitative methods (on-line surveys). Hence it had to define measures to select such focal companies. In the context of the New Zealand construction industry:

1. Focal companies *procured construction innovations* and/or could conduct *innovative activities with suppliers* and use or sell such construction innovations.
2. These companies either *generated value* or had a *potential to generate such value* when they conducted said procurement practices*.

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[56] NZ.stats (2013, Table 12, Table 14). (Accessed 23 November 2017).
[57] This research included supplier and service companies not classified in ANZIC class E. (§2.1; §2.6.1.2).

3. This *value* (benefit, performance) was the difference between the procured value from suppliers versus the (potential) value provided to customers and other stakeholders.
4. This *value* for customers and other stakeholders could be monetary (economic, business) or non-financial (economic, business) benefits or performance. It could also relate to the effect on the natural environmental.

3.2.2 Profile of Research Participants and Survey Respondents

The research participants (respondents) within focal companies should be knowledgeable on one or more of the following areas: procurement, operations, marketing-sales, innovations, or product development. Participants should be well-acquainted with the strategy of the organisation and (strategic) activities with innovative suppliers (Adams, 2004).

Focal companies and participants were selected on these characteristics. These were checked before the interviews and the roundtable discussion, and during the surveys. (See §3.6.2.2 for selecting interview participants; §3.6.3 for selecting roundtable participants; §3.6.4.1 for selecting respondents of Survey I, and Survey II).

3.2.3 Intersubjective Perception of Variables & Practices

Section §3.4 discusses the pragmatic philosophical perspective of this research between the positivist and realism paradigm. "Beauty is in the eye of the beholder" (Hungerford, 1855-1897) and so is value. This also holds for the innovative aspect of suppliers in this research. The appreciation (Vickers, 2010) whether an improvement from a supplier was a *radical* or an *incremental* innovation would vary (1) with the company's position within the construction supply chain and (2) with vested interests of stakeholders. This appreciation could also vary (3) with time or experience, or (4) with the geographical region (Gambatese & Hallowell, 2011a, 2011b). Similarly, Manley (2002: 5) let respondents decide whether an innovation belonged to the "top quartile" and whether it was original or not.

For stakeholders involved in this research, the procurement performance and hence the increased value by the innovation(s) was related to their perception of change. The time-aspect was also relevant as <u>past</u> activities could have resulted in *realised* value with successful innovations, or *non-realised* value in abandoned innovations. Alternatively, <u>on-going</u> activities could (in future) result in a *potential* value (OECD, 2005: 59). Value could have been realised within other New Zealand industries or in overseas construction

industries, but not (yet) within the context of the New Zealand construction industry. Value could hence be *realised* or *potential* value*.*

This research tried to understand such value from the position of the respondent in the focal company. This included the respondent's perception of value for suppliers, customers, and for other stakeholders, also considering aspects of time, industry, and geographical position. The perceived added-value from procurement practices, i.e. the procurement performance could be measured via qualitative or subjective performance schemes (Rose & Manley, 2012, 2014; cf. §2.12).

Participants and the researcher could show biased behaviour in exploratory interviews and focus-group discussions. The selection and phrasing of online survey questions could also cause intersubjective bias. The design of these methods should minimise but could not eliminate these intersubjective effects. Additionally, triangulation (see §3.7) with surveys should help minimize these effects.

3.2.4 Immature domain; Selection of Variables & practices in this Research

The literature review on SME procurement and SME inbound open innovation (§2.3.3 and §2.3.6) suggested that this research domain was young and immature (Langerak, 2014). To determine the life-cycle of a research domain, Wallace (1971), distinguished the following three stages: (1) *explore*, observe, and describe phenomena; (2) *build theory* and adopt constructs from other domains; this often includes a theoretical reflection; (3) *test theory* with the objective to confirm, refine or reject other theories. Spina *et al.* (2013: 9) argued that procurement grows from Wallace's stage 1 to stage 2 and 3. This could be true for 'mainstream' large-company procurement, but considering the sparse amount of research on SME procurement and especially SME procurement on innovation, this current research would be firmly positioned in Wallace's stage 1.

In this respect, Edmondson & McManus (2007: 1160) developed a contingency framework that distinguished between nascent, intermediate and mature theory domains. This current research should be placed under their nascent theory, as it has "attracted little research or formal theorizing to date". This type of research would:

> propose[.] tentative answers to novel questions of how and why, *often merely suggesting new connections* among phenomena.
> (Edmondson & McManus (2007: 1158); italics added).

The associated research questions would "include understanding how a process unfolds, developing insight about a novel or unusual phenomenon [or] digging into a paradox". According to Edmondson & McManus (ibid, 1162) such research questions would be "more open-ended" compared to questions in more mature research domains.

Hence, the research was designed for breadth rather than depth (De Waal, 2011: 146). For each of the constructs, the literature review in Chapter 2 was able to identify several practices or variables. The review found that it was unable to convincingly define lists of evidence-based variables and practices with high occurrences. This could be attributed to the nascent state of the research, and would be in line with a contingency perspective (§2.5).

One objective of this research was *to identify variables & practices that companies used when they managed innovative suppliers*. Consequently the research design involved an eight-step approach to find and select such variables & practices. Moultrie *et al.* (2014) and Le Dain *et al.* (2008, 2011) used similar approaches for designing management tools.

1. Conduct a systematic and iterative review of the literature.
2. Pay particular attention to variables & practices mentioned in SME literature.
3. List and analyse these practices and variables in Excel files. (See §2.3.3 and §2.3.6).
4. Design simple conceptual models to classify these variables & practices.
5. Try to assess relevance of these variables & practices based on research objectives, and on a general understanding from industry practice and academic knowledge.
6. Try to assess occurrence of practices.
7. Select variables & practices based on relevance and occurrence.
8. Validate selection with informed academics, in exploratory interviews or roundtable discussions.

This selection approach was aided by the researcher's industry and teaching experience in procurement and innovation. Survey I then tested and validated frequencies and relations of company, procurement and performance variables. This further led to a selection of key-variables on innovation and supplier types and procurement best-practices which were tested and validated in Survey II. It must be noted that this empirical part of the research could only *assume causality* between variables. (See §3.5).

NOTE:
Although the process of identifying variables & practices from the literature was thorough and iterative, the selection process to a certain extent remained intersubjective as it was influenced by the researcher's perceptions and experience. This was recognized in the empirical part of the research; hence respondents had the opportunity to report or discuss other variables or practices.

Section summary-conclusion:

4. *Section §3.2 defined in more detail the profile of focal companies and of the research participants or respondents. Focal companies would procure supplier innovations or cooperate with innovative suppliers. Respondents or participants should be knowledgeable with the research domain.*

5. *The research had to consider intersubjective perceptions of participants or respondents. The research domain could be considered immature.*

6. *The research applied an 8-step approach to identify and select potentially-relevant variables & practices from extant literature.*

3.3 Overall Research Structure

This Section discusses a hierarchical model and introduces §3.4, §3.5, §3.6, and §3.8.

Table 26: Hierarchical research model in this research (Giannakis, 2012; Jankowicz, 2005: 221-224)

Research methodology	Fundamental research paradigms and philosophical research assumptions which can be appropriate for the research topic and objective.
Research approach	Deciding whether qualitative or quantitative research or a mixture of both was appropriate. (§3.4)
Research design	The overall structure and orientation. The research strategy which was determined by the research methodology, the form of research questions, and the control over the variables. (§3.5)
Research methods	The actual research approaches for the collection and analysis of data to obtain information. (§3.6)
Research tools	The particular step-by-step procedures, techniques, protocols or tools for collecting and analysing data. (3.6, §3.8)

In §1.6, this research developed several research questions, viz. "*the precise questions [for] doing research*" (Jankowicz, 2005: 389). This research successively applied qualitative and then quantitative research. The quantitative research questions were supported by high-level hypotheses. (Tashakkori & Creswell, 2007). Finally, Punch (2009: 64) identified the following requirements for research questions. They should: (1) organize, give directions, and coherence; (2) delineate, and show boundaries; (3) provide focus and a framework; and (4) give direction on the data collection.

The overarching research objective (§1.6, see the following Table) was to know *what* happened in innovation procurement of focal companies. Furthermore, it wanted to know *how* focal companies managed innovative suppliers, and hence *how* these companies then managed or reacted to certain phenomena (independent or mediating variables) for procurement performance. This was an ambitious and broad research approach that was suitable for Wallace stage 1 (§3.2.4).

Table 27: Research objectives based on Kumar (2005) and Saunders *et al.* (2009: 590-592)

	Research type	Explanation
1	Exploratory research (**What** is going on?)	Has the objectives either to explore an area where little was known or to investigate the possibilities of undertaking a particular research study.
2	Descriptive research (What **exactly** is going on?)	Describe a situation, problem, phenomenon, service or program, or describes an attitude towards an issue.
3	Explanatory research (**How** & why does it happen?)	Clarify how and why there was a relationship between two aspects of a situation or phenomenon.
4	Correlation research (How **exactly** does it happen?)	Discover or establish the existence of a relationship / association / interdependence between two or more aspects of a situation.

Contrary to design science research (as used in applied sciences, engineering, or medicine (Andriessen & Schuurmans, 2017)), this research could not primarily develop solutions of a generic nature that could help professionals or managers in the wider field (Van Aken, 2004). Constructs in social sciences and hence in business research are context-based and must be interpreted (what Weber (1865-1920) described as "Verstehen" or "understanding"). This entailed an approach that required a good understanding of the research topic.

The research objectives varied during the research process (Short *et al.,* 2008). This made the initial part of the research more exploratory and descriptive, and the latter part of the research to a *limited* extent also theory building and testing. (For possible implications for research and management, see Chapter 10).

The iterative literature review started inductively with a somewhat grounded approach (Yin, 2003; Saunders *et al.*, 2009: 490, 501) as the current procurement research area was relatively immature or new (Langerak, 2014; Wallace, 1971; Spina *et al.,* 2013: 9; Edmondson & McManus, 2007: 1160). Although the construct of the four procurement and the three innovation process steps (see §2.4.2; §2.10.3) was built on extant research, the literature gave limited guidelines on applying this central construct in the context of focal companies. First a relatively stable and broad conceptual model I was developed from Staal *et al.* (2015). The desk research could then apply a deductive approach on a higher level, and inductive on a more detailed level. (See Table below). This helped to structure the review in Chapter 2.

An inductive approach also supported and guided the researcher in the early phase of the empirical work (the interviews) and enabled the researcher to modify research methods or tools. This approach resulted in a validated and modified conceptual model II which covered the broad research topic. The latter part of the empirical research had a deductive approach as it tested and validated preliminary findings from the inductive research in Survey I. This

resulted in conceptual model III that focused on a limited number of key-variables and best-practices. It was partially validated in one roundtable discussion and then used in Survey II.

Table 28: Summary of research methods

	Lit. review	Interviews	Survey I	Focus-group	Survey II
Inductive or Deductive	First inductive, then high level deductive, detailed level inductive	High level deductive, detailed level inductive	deductive	On high level deductive, detailed level inductive	deductive
Structure	Structured	Unstructured	Structured	Semi-structured	Structured
	Exploratory	Confirmative / validation	Exploratory Descriptive Explanatory	Exploratory Confirmative / validation (in part)	Exploratory Discriptive Explanatory
Theory	Theory building	Theory testing	Theory building	Theory building	Theory testing
Qualitative or Quantitive	Qualitative	Qualitative	Quantitative	Quantitative in qualitative setting	Quantitative
Model	Broad conceptual model I	Broad modified conceptual model II		Focused conceptual model III	

Related to the above was the issue, whether qualitative or quantitative research could offer the best research method(s) to deliver the objectives of this research. In an analysis on 101 construction research papers, Dainty (2008: 6) found that 75% used quantitative methods. Only 25% used qualitative methods of which three used focus-groups or workshops. He criticised the *quantitative* papers in their relevance to practice and questioned their ability "to provide a rich and nuanced understanding of industry practice" (Dainty, 2008: 7). On the other hand, Dainty also criticised the qualitative papers for only relying on semi-structured interviews. On procurement research, Spina *et al.* (2013: 6) found that surveys were equally popular as case-studies. Entrepreneurial research seems to use quantitative methods and (especially in Europe; Welter & Lasch, 2008: 244) also a wide array of qualitative methods.

Yin (2013) and Saunders (2009) mentioned valid reasons for using one approach or for combining the two approaches. Considering this research wanted a deeper understanding of the research domain, it first utilized a qualitative approach. The second phase of the empirical research was more quantitative as the research wanted to increase the understanding of relations within the research domain. (See earlier Table).

Thorngate (1976) postulated that it was impossible for a theory in social behaviour to be simultaneously general, accurate and simple. (Woodside, 2010: 73). Hence using mixed-mode research would have trade-offs on the quality of the research. Nevertheless, the research needed acceptable levels of rigor, notably on reliability and validity (see §3.7; see Chapter 10).

A "theory" could be described as a plausible explanation or a prediction of a cause-and-effect relation. (Based on Engeldorp Gaastelaars, 1998: 263; Christiaans *et al.*, 2004: 27; Saunders *et al.*, 2009: 602). Theory development can either be done à priori (deductive), or à posteriori (inductive). Cornelissen (2017: 3, 20) used the phrase "the craft of theorising" and noted that a theoretical contribution needs: (1) a clear audience and an important gap; (2) an interesting and compelling explanation (storyline); and (3) new and falsifiable hypotheses or propositions. On yet another level, a contingency perspective guided the researcher to explore the external validity and generalisability of findings from this research. (See §2.5)

Section summary-conclusion:
7. *The research objective varied during this mixed-mode exploratory research.*

8. *The research started exploratory and descriptive with an inductive (and qualitative) approach and then did limited theory building (and limited testing) with a deductive (quantitative) approach. This was an appropriate approach for this research domain.*

9. *Hypothesis testing during the empirical research was done qualitative and on a high level.*

3.4 Research Domains and Philosophical Perspectives

This business research was concerned with management processes and activities and was positioned within the management or business domain with links to social sciences, law, economy, and to technology (Engeldorp Gaastelaars, 1989). More specifically, the research was positioned within the context of construction supply chains and largely drew from five research domains (see Figure 22 on the following page).

For this research, the construction supply chain was considered a context and not a separate research domain. Moreover, contrary to common practices as e.g. stated by Rosenwasser & Stephen (2000: 9), this research à priori did *not* apply a strict philosophical or theoretical lens (Johnson, *et al.*, 2008) during the literature review. Furthermore, it allowed for literature and insights to emerge from other philosophical perspectives or research domains. This was in line with a grounded approach as e.g. advocated by Edmondson & McManus (2007: 1160).
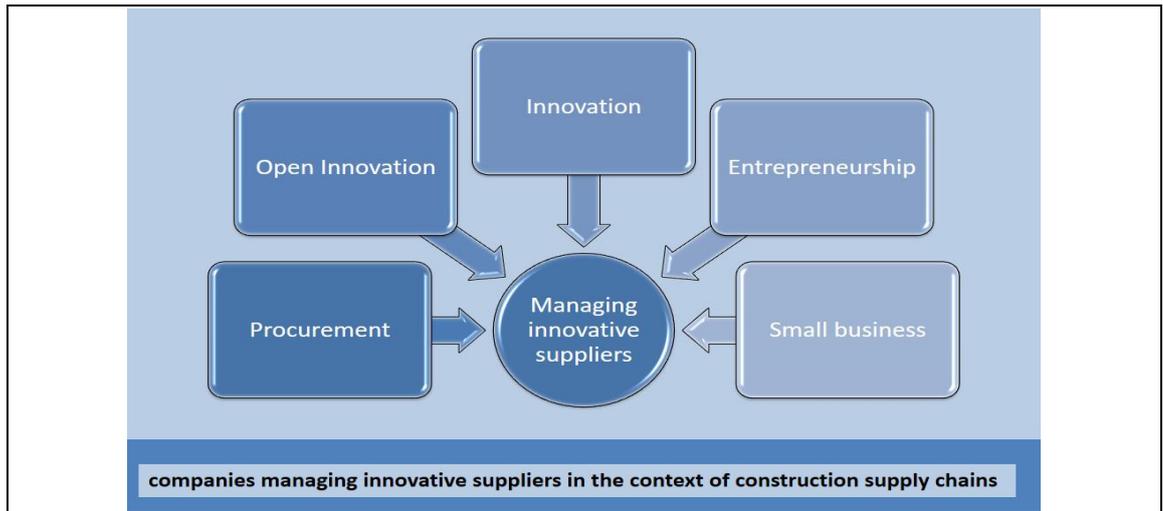
Figure 21: The five research domains in the context of construction supply chains

Postponing a strict philosophical perspective enabled the researcher to remain receptive to differing opinions and to suspend judgement as also advocated by e.g. Morrissey & Knight (2011) in SME procurement research, and by Davidsson (2016: viii) on entrepreneurial research. To give one example: two dominant theories from the procurement domain: resource-based view and transaction-cost economics (see below) would posit that procurement behaviour in companies was rational. However, this review found research on SME procurement by Ozmen (2014) who concluded that in SMEs such behaviour was more emotional or subjective than with large companies. Similarly, Boodie (2018) noted a gap in procurement management practices versus procurement management theory. The current research was interdisciplinary as it "sourced" or "synergized" (Siedlok & Hibbert, 2014: 4, 32) from several domains. In this respect Davidsson (2016: viii) used the phrase "eclectic literature review". These domains are now discussed.

The main domain was procurement. This body of literature often takes the perspectives of the transaction-cost economics or the resource-based view (see e.g. Johnsen *et al.*, 2014: 13; Spina *et al.*, 2015: 5). This seemed appropriate for procurement in large companies. Procurement of innovations however is probably different, both in large and small companies. Consequently, insights from domains of innovation management, entrepreneurship or small business perspectives should add value.

Procurement can be considered a part of the larger domains of supply chain management or of operations management. (Spina *et al.,* 2013; Johnsen *et al.,* 2014: 36). Potentially-relevant theories from the procurement domain that also related to innovations (based on Chicksand *et al.,* 2012) were:

1. The Resource-Based View which holds that procurement can generate competitive advantage when the focal company acquires resources that add value, are rare and costly to imitate and have no substitutes. Hence procurement can bring important advantages when it can identify and manage value-adding innovative suppliers. This made this theory relevant for this research (Barney, 2012)

2. The Resource-Dependency Theory which works similarly and posits that effective relationships with suppliers are important sources of competitive advantage. However, this theory is more aware of power plays and power differences (Pfeffer & Salancik, 1978). Hence it related well with the uncertainties and risks of innovating partners in this current research.

3. The Stakeholder Theory which takes a more holistic view and acknowledges the existence of different stakeholders related to the focal company. These stakeholders have different values and want different financial and non-financial results from company activities. Companies that meet such demands can better deal with their industry and macro environment, can satisfy more stakeholders, and can also achieve good company performance. This theory also seems relevant for this research (e.g. Shankman, 1999: 322; Kibbeling, 2010: 24)

There exist several theories on entrepreneurship, innovations, and small businesses. These theories have different (or even conflicting) definitions and underlying assumptions (e.g. Tidd, 2014, Davidson, 2016). This research considered the following theories as potentially-relevant:

4. The Effectuation Theory which posits that entrepreneurs start with means available to them, instead of starting with defining company (or innovation) objectives. Focal companies would favour partnerships and leverage on contingencies or unexpected situations (Sarasvathy, 2001).

5. The Industrial Marketing and Purchasing Theory posits, that although key internal resources need to be protected, focal companies increasingly need access to external resources. (Hakansson, 1987).

6. A Supplier-Entrepreneurial Theory which is based on the behaviour of suppliers and outcomes. In this research these focal companies "and not customers, legislators or natural forces exercise entrepreneurship" (Davidsson, 2016: 7, based on Kirchner)and would introduce innovations into the construction industry. Such supplier companies provide business or end-customers with new choices and potentially add value. This then triggers incumbents and other new entrants to also improve market offerings.

7. Small Business Theories describe SMEs as being funded, owned, and managed by one owner or a small number of people. The personality of the owner-manager plays an important role. The company is seen as flexible and various key business functions are conducted by limited numbers of staff. The company is scarce on resources (people, financial, equipment) and either has a lifestyle strategy or a growth strategy (Storey, 2016; Burns, 2000).

8. Entrepreneurship according to Shane & Venkataraman (2000) involves the discovery, evaluation, and exploitation of opportunities to introduce new goods and services as not previously achieved. In this research the focal company would meet customer demands with supplier innovations. (See also §2.7).

9. Several Innovation Management Theories as discussed in §2.2.2. (For example Schumpeter, 1942; Drucker, 1985, Tidd & Bessant, 2013).
10. Acquiring technology as a subdomain of Open Innovation Theory (Dahlander & Gann, 2010) was considered part of this research. In general, Chesbrough (2003) implied that open innovation was necessary for focal companies. Useful knowledge is widely distributed, and focal companies need to source and acquire such external sources for innovations. This innovation concept is a more dynamic, participatory, decentralised approach to innovation. (§2.3.5, §2.3.6).

Furthermore, the research used the contingency approach (§2.5) to explain the wide number of possibly-relevant variables. Related to this was the complexity theory, based on the thinking of Eisenhardt which could help to explain the "messy world" (Johnson *et al.*, 2008: 17, 36-41) of the focal company. This complexity theory could help to explain how a company reacted to the outside world and generated ideas i.e. innovations.

After the empirical phase, this research post-hoc established how and to what extent these theories were useful in interpreting the findings of this research. (Chapter 10).

On a more philosophical (ontological[58]) level, this research adhered to a pragmatic position in social sciences and hence in business research. Social entities can exist in (objective) reality but can also be created from our (subjective) perceptions and actions.

As an example for this research: a focal company could have one owner, two innovative suppliers, and three supplier innovation projects. The owner and the suppliers could however disagree on the complexity, the importance, and the success of these three innovation projects. (based on Saunders *et al.,* 2009: 110).

On an epistemological level[59], this research related to the knowledge it applied and developed, i.e. to what extent knowledge on focal companies that managed innovative suppliers was acceptable. The researcher agreed with the positivistic paradigm that reality (facts) can be observed. Hence from a survey, it could appear that on average 50 focal companies were engaged in five innovation projects. This was in line with classic scientific and engineering thinking (Remenyi & Sherwood-Smith, 1998), which over the past 200+ years has brought technological progress, prosperity, and safe or even beautiful buildings.

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[58] Ontology: A set of concepts and categories in a subject area or domain that shows their properties and the relations between them. (Oxford online dictionary; accessed 26 March 2016).It studies the nature of reality or being (Saunders *et al.*, 2009).
[59] Epistemology: The theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion. (Oxford online dictionary; accessed 26 March 2016).

In such instances, the researcher would agree with the positivistic paradigm (see the following Table).

Table 29: Dichotomy of research paradigms (from Amaratunga *et al.*, 2002)

Theme	Positivist paradigm	Realism paradigm
Basic beliefs	The world is external and objective Observer is independent Science is value-free	The world is socially constructed and subjective Observer is part of what is observed Science is driven by human interests
Researcher should	Focus on facts Look for causality and fundamental laws Reduce phenomena to simplest elements Formulate hypotheses and test them	Focus on meanings Try to understand what is happening Look at the totality of each situation Develop ideas through induction from data
Preferred method in the research	Operationalising concepts so that they can be measured Taking large samples	Using multiple methods to establish different views of the phenomena Small samples investigated in depth or over time

However, human beings construct reality and can only partially observe reality in all facets. Although a survey could e.g. report that 50% of supplier innovation in focal companies failed, it would be hard to distil from this data how entrepreneurs perceived such failures (Singh *et al.*, 2015) in their own contexts (§3.2.3). These researched phenomena were subjective and individual perceptions (e.g. Zou *et al.,* 2014: 318) and would need be elaborated with additional questions and preferably interviews or case-studies. The interpretation of these individual perceptions and interactions would develop subjective meaning and knowledge. Hence, in such instances, the researcher would agree with the realism paradigm. (Again, see the above Table).

Hence the researcher took a pragmatic 'middle ground' depending on the exact research question at hand and the related research method. This pragmatic "paradigm pluralism" (Teddlie & Tashakkori, 2012: 779) allowed the researcher to appreciate positive aspects of both quantitative and qualitative research methods. This avoided (fruitless) debates over qualitative versus quantitative research or over concepts of truth, reality or knowledge.

Section summary-conclusion:
10. The research discussed several research domains. This research was positioned in the primary research domain of procurement, and several theoretical perspectives from other domains (small business, innovation, entrepreneurship) could add important contributions.

11. *However, the literature review and the empirical part of the research did not apply such theory as a theoretical lens. This enabled the researcher to allow for literature and insights from other perspectives. (See also notes on contingency theory in §2.5).*

12. *On an ontological and epistemological level and in consideration of the research objectives, the researcher took a pragmatic approach. This enabled the researcher to apply mixed-mode approach to achieve the research objectives.*

3.5 Conceptual Models used in this Research; Assumed Causality

Following the research hierarchy model in §3.2, this Section discusses the three conceptual models for this research: initial broad model I used for the literature review based on Staal *et al.* (2015); modified broad model II covering the research domain; and model III that focused on a limited set of key-variables and best-practices. (See also §1.4 and §2.14).

Various definitions on frameworks or models exist for designing and managing research. Quinlan (2011) stated that research rests on a conceptual framework, which is contained in the main research question.

Others used the term "conceptual model". Berman & Smith (2013) stated that such a conceptual model helps to scope and shape the research work. Maxwell and Loomis (2003: 253) noted that a conceptual model is "*the basis for reframing the research questions and […] for making tentative predictions about possible outcomes of the study*". Verschuren & Doorewaard (2010: 279, 280, in translation) additionally defined a conceptual model as: "*a collection of key concepts (constructs with variables) that relate to phenomena from reality, and a collection of assumed causal relations between these concepts*". Causal relations within the model can be constructed as testable assumptions, propositions or as hypotheses (Swanborn, 2013: 52; Christiaans *et al.*, 2004: 62; Forza 2002: 156).

This research first designed conceptual model I based on the selected unit-of-analysis (§3.1) and on initial theoretical insights from extant literature. These insights were gathered during the preliminary phase of the research, i.e. while drafting the research proposal. (Staal *et al.*, 2015).

Similar causal procurement models were applied in Hagelaar *et al.* (2014), Schneider & Wallenberg (2013), and Bals *et al.* (2018: 43). The following Figure shows this initial broad conceptual model I with the *posited* causal relations between concepts with related variables. This model guided the literature review of Chapter 2.

Where possible, the research tried to establish in Part II whether relations between variables were indeed causal or merely correlations. (Cramer & Howitt, 2004: 20, 75). As the research was exploratory, any causation or correlation was treated cautiously based on the conceptual models or extant literature. Hence this research applied qualifiers such as "seemed affected", "could affect", "could have an effect", "findings seemed", or "findings suggested". Also where such qualifiers were not used, discussed relations were interpreted with care. (See also §3.2.4; §10.4).

This was in line with reasoning on the nascent state of the extant theory as presented in the seminal article by Edmondson & McManus (2007). The literature review and the empirical part of this research consequently could only:

> propose tentative answers to novel questions of how and why, often *merely suggesting* new connections. (Edmondson & McManus (2007: 1158); italics added).
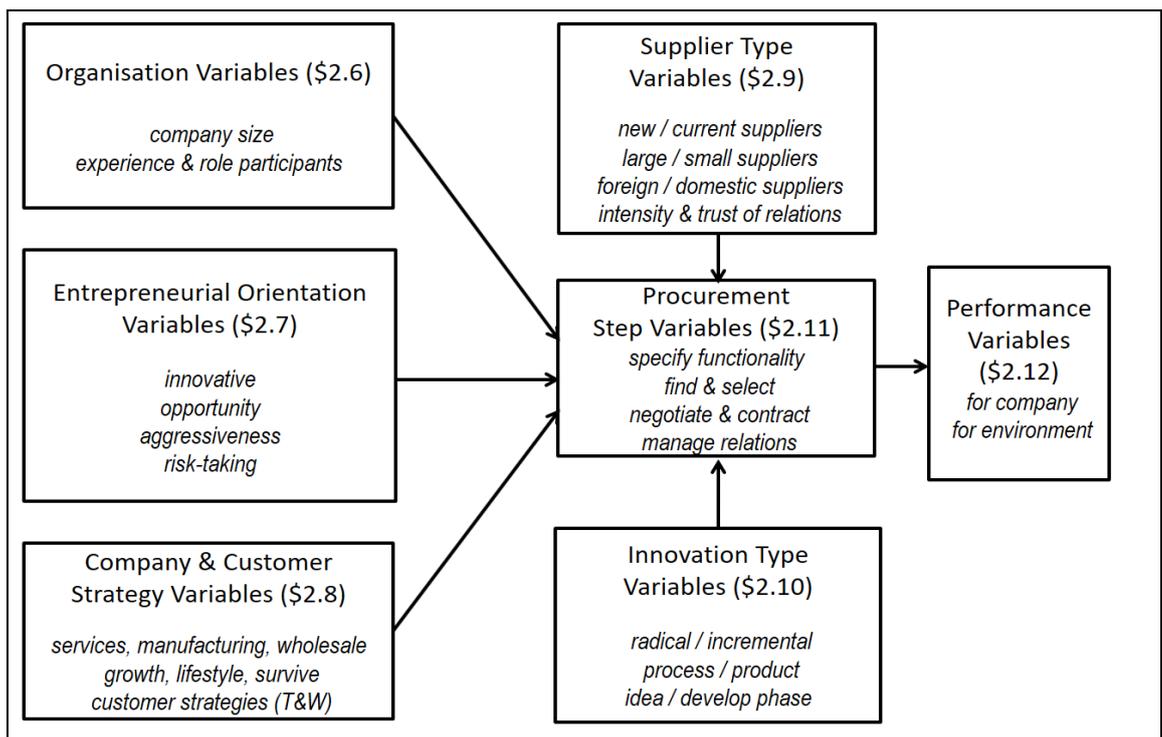
Figure 22: Initial broad conceptual model I with constructs & variables. (Copy from §2.1)

The research was then able to simplify conceptual model I, based on the manageable amount of expected data and findings from Chapter 2. This conceptual Model II was partially validated with insights from exploratory interviews as discussed in Chapter 4. This broad conceptual model II is shown below and was used as a basis for Survey I. Results (findings) are described in Chapters 5-7.
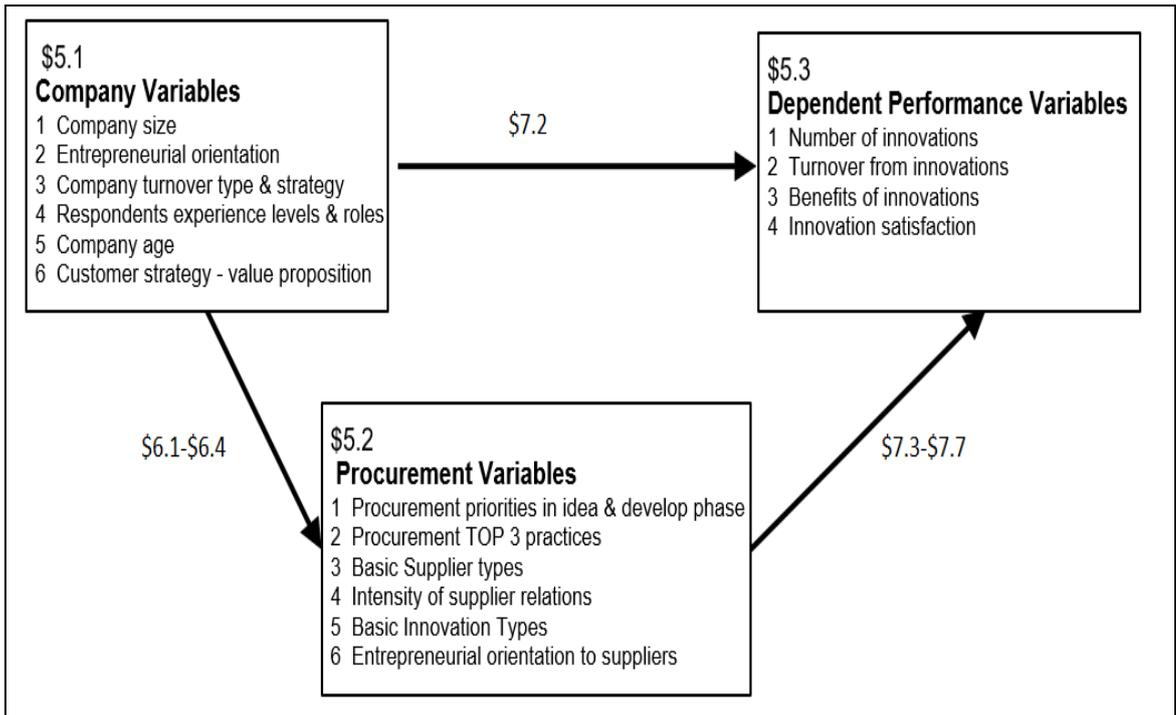
Figure 23: Modified broad conceptual model II after literature review (Copy from §2.13)

Finally, conceptual model III was developed based on findings from Survey I, to analyse in more detail relations among procurement management variables (i.e. a limited set of key-variables) and procurement best-practices. This more-focused model III is shown below. It was partially validated in one roundtable discussion and then used as a basis for Survey II (see Chapter 8).
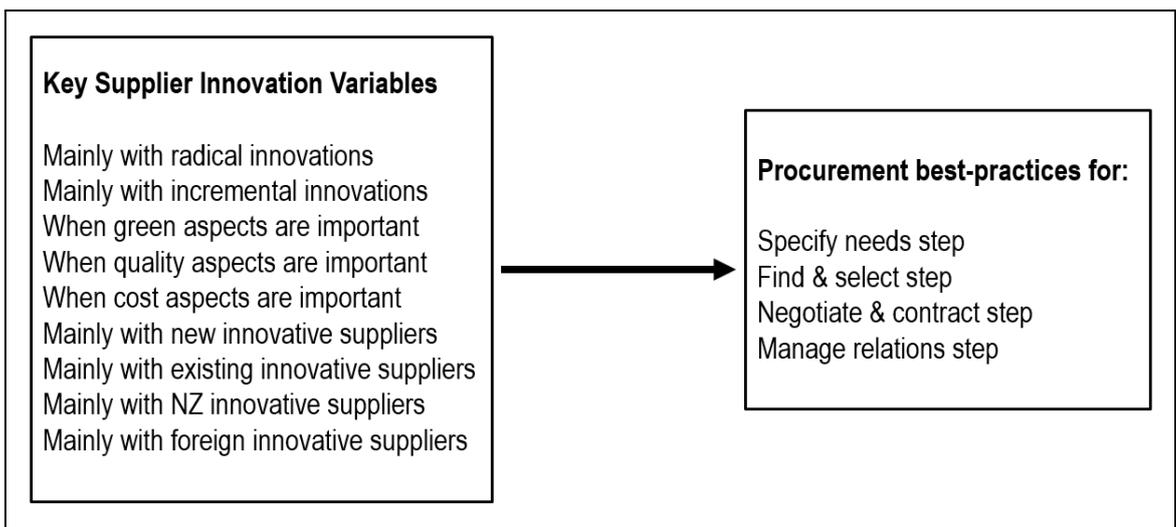
Figure 24: Focused conceptual model III as used in Survey II (Copy from §8.1)

Hence conceptual models II and III helped to design surveys for hypotheses testing (i.e. explained differences in variables) which led to new theoretical insights (Chapters 9-10).

> **NOTES:**
> 1. Several variables from model I were rearranged in model II.
> 2. Chapters 6 and 7 did not investigate all company and procurement variables for inferential statistics. (See Model II at the beginning of the respective Chapters).

Section summary-conclusion:

13. The research applied a broad model definition to develop conceptual model I. This model visualised the relation between several research questions. After the literature review and the exploratory interviews, this model I was modified into Model II and used for Survey I.

14. Based on findings from Survey I, the research developed conceptual model III that focused on relations with a limited set of variables and procurement best-practices. It was tested in one roundtable discussion and used for Survey II.

15. Considering the nascent state of the theory, the research could only assume correlation of causal relations among the variables in the conceptual model. Hence this research applied qualifiers such as "seemed affected", "could affect", "could have an effect", "findings seemed", or "findings suggested". Also where such qualifiers were not used, discussed relations were interpreted with care. (See also §10.4).

3.6 Research Methods used in this Research

The research project was designed in a flexible manner and research methods were amended during the project. This Section explains the research methods of this research. The project started with an initial literature review for the PhD research plan (Staal *et al.*, 2015). After that, it applied the following five main research methods:

1. *Literature review.* The study used an iterative and structured literature review.
2. *Industry consultation.* This study used semi-structured interviews in an exploratory manner with classic case-study methodology.
3. *Survey I.* The study used a quantitative survey for limited theory building & testing.
4. *Focus-research.* The study used a roundtable discussion where academics & practitioners generated, refined, and tested knowledge.
5. *Survey II.* The study used a quantitative survey for limited theory building & testing.

With this design, the research aimed to obtain sufficient qualitative and quantitative data to achieve the overarching research objective. Section §3.3 explained the overall research structure; this Section explains the research methods in more detail. Further details are provided in each empirical Chapter.

3.6.1 Literature Review in this Research

An iterative (Saunders *et al.,* 2009) and structured (Tranfield *et al.,* 2003) literature review was carried out via the University's library resources with Web of Science and with Google Scholar, mainly between December 2013 and January 2017. It applied three search strategies separately or in combination:

1. Conducting searches with combinations of key words;
2. Conducting searches with author's names or journal names.
3. Conducting reference and citation searches;

The review started inductively. Gradually and iteratively, additional sources yielded no new understanding of the research domain and new database searches produced the same references and authors (see Appendix §3.6.1 for the search strategy). Conceptual model I then helped to structure the more deductive review.

Potentially-relevant literature was identified from analysing the title, author(s), abstract, and citations and references. Although PhD theses were not cited often, special attention was paid to references in several such theses as they would give extensive literature reviews, and as the quality of these reviews was considered high. This resulted in a body of potentially-relevant literature (downloaded in PDF and stored via Dropbox) that was subsequently made accessible via the software programme EndNote. This enabled the researcher to search full text and annotate papers. Gradually, a relevant body of literature emerged. Relevant articles or authors were analysed in Google Scholar on newer articles. Initially this also led to new authors and key words, which were then used to produce further relevant literature (see Appendix §3.6.1 for an overview of key words used).

As explained in the introduction to Chapter 2, two bodies of literature had been analysed in more detail: on SME procurement, and on SME open inbound innovations. These are discussed below.

3.6.1.1 Review Strategy on Procurement and SMEs

The review started with material from Morrissey & Knight (2011: 1146) and added more details and publications of earlier or younger authors (notably American literature). It included a review of 70+ articles. (See §2.3.3; see Appendix §2.3.3).

Relevant literature from before 2000 was limited. More importantly, older literature did not consider the general growth in procurement proficiency (Johnsen *et al.*, 2014; Van Weele, 2010), nor the impact of globalisation and information technology on procurement. Information technology both changed the process of supplier selection as the Internet

produced more information about potential and current suppliers, and changed management of supplier relations e.g. via email, smart-phones, and information systems (Kauppi *et al.*, 2013). Therefore, the focus was on literature from 2000 onwards which discussed e.g. strategic aspects, processes, drivers, or supplier relation management. The articles had to include data on the context of the procurement practices (company size, industry, etc.). The review excluded single case-studies. Exclusion criteria are summarised below.

Table 30: Exclusion criteria for the research body of SME procurement

No.	Criteria	Reason for exclusion
1	No focus on articles from before 2000	After 2000 the impact of Internet and IT changed the nature of procurement. although some older publications were relevant
2	No articles discussing procurement in large companies	The focus of this research was on SMEs, and such companies had different contingency factors. Learnings from procurement of companies limited to no value.
3	Unit of analysis	Exclude articles where the unit of analysis was not the SME, or did not discuss processes within the SME.
4	Generalisation of results	Exclude articles describing a single company.
5	Perspective	Exclude articles that exclusively focus on supply chain management (logistics), operations management, strategy, marketing or sales management, alliance or network management. The focus was on procurement where companies procure innovations in exchange for financial means.

3.6.1.2 Review Strategy on open Innovations and SMEs

Whereas the literature on SME procurement was sparse, as was also indicated by established researchers in that area, the body of research on open innovations in SMEs was broader. this research therefore devised an iterative approach. It first identified the broader field of open innovation, and then focussed on the inbound aspect of open innovations with "pecuniary" aspects (Dahlander & Gann, 2006: 705). This revealed a body of 50+ articles. (See §2.3.6 and corresponding Appendix). Exclusion criteria are summarised below.

Table 31: Exclusion criteria for the research body of inbound open innovation of SMEs

No.	Criteria	Reason for exclusion
1	No focus on articles from before 2000	The open innovation research started with Chesbrough (2003), although some older publications were also relevant
2	No articles on supplier innovations in large companies	The focus of this research was on SMEs, and such companies had different contingency factors. Learnings from innovation of large companies had limited to no value.
3	Unit of analysis	Exclude articles where the unit of analysis was not the SME, or did not discuss processes within the SME.
4	Generalisation of results	Exclude articles describing a single company.
5	Perspective	Exclude articles that exclusively focus on supply chain management (logistics), operations management, strategy, marketing or sales management, alliance or network management.

		Exclude articles that exclusively focus on outbound innovations, or on non-pecuniary (sourcing) aspects of information exchange. (Hence no articles on inbound IPR licencing). The focus was on open innovation where SMEs acquire innovations in exchange for financial means

3.6.2 Exploratory Case-study Interviews in this Research

The objectives for the exploratory interviews were to discuss and refine assumptions from the literature review as a preparation for the quantitative part of the research. This Subsection discusses (§3.6.2.1) strategies to prepare and design interviews and protocols, and then discusses (§3.6.2.2) preparation and execution of five case-study interviews. Meredith (1998: 443) defined a case-study as:

> A case-study typically uses multiple methods and tools for data collection from a number of entities by a direct observer(s) in a single, natural setting that considers temporal and contextual aspects of the contemporary phenomenon under study, but without experimental controls or manipulations.

Basically, case-study research distinguished between structured interviews, semi-structured or unstructured interviews (Saunders *et al.*, 2009). With the first type, researchers use a predetermined list of (standard) questions. With semi-structured interviews, researchers use themes and questions for the interviews, although the exact questions could vary per interview. Unstructured interviews may be less formal and non-directive, and researchers do not work with a pre-determined list of questions.

This research needed qualitative information from case companies to explore the general research topic (Saunders *et al.*, 2009), and especially to validate findings from the literature review. The research opted for semi-structured case-study interviews. Hochschild (2009: 2) called these "elite interviews" as the selection of respondents was based on their specific and unique knowledge and position. Interviews are often an important tool within case-study research, although elaborate case-studies can also employ other tools, especially in single mode research (Swanborn, 2013).

This research only used part of the case-study methods and tools available for data collection, which is fairly common practice (see e.g. Seuring, 2008: 134). It could restrict itself to single interviews as the selected companies were relatively small and as respondents had a good overview of the units-of-analysis within their company. (For the selection process of the interview-participants, see §3.2.1, §3.2.2 and §4.1). Furthermore, the research did not need company documents or observations for this qualitative research.

Nevertheless, a researcher needs to know what aspect to explore. The interviewees discussed their experiences or opinions on managing innovative suppliers. Hochschild (2009: 7) stated that a researcher had to be well-informed to "probe more deeply into the respondents idiosyncratic or non-rational stances". Similarly, Yin (2017: 117) suggested to make the person interviewed part of the discussion[60]. The researcher used some power-point slides to describe the locus and focus of the interviews and had prepared a topic list. (See Appendix §4.1). In order to allow for the variety of the case companies (see Figure below), the research opted for 5 exploratory interviews.

	Single cases	Multiple cases
Typical	One case	Several cases
When to use	When the case: - is a critical case to test a well-formulated theory - is an extreme or unique - reveals a previously inaccessible phenomenon	When the aim is to develop a rich, theoretical framework by replication - predict similar or to show contracting results among replications
Advantages	Depth of the study - Can richly describe the existence of a phenomenon	- Augment external validity - Smaller observer bias - Allow case comparisons - Provide a stronger base for theory building
Limits	- Generalizability - The risk of misjudging the representativeness - The risk of exaggerating easily available data	- Less depth per case - May require extensive resources and time

Figure 25: Differences in single and multiple case-studies (from Voss *et al.*, 2002: 203)

3.6.2.1 Discussing an Interview Strategy

This research used a process-step approach as advocated by Eisenhardt (1989: 533) and explained by Stuart *et al.* (2002) and Seuring (2008). This method found wide use in case-study research (see below, with additionally consulted sources).

Table 32: Process steps in case-study research (based on Eisenhardt, 1989)[61]

	Eisenhardt steps	Comments	Additional sources
1	Getting started		
2	Selecting cases ##	Important here was (1) finding cases which match this research objective, and (2) finding enough cases (Yin, 1984: 48) to gain compelling results.	Swanborn (2013: 71-102) Dubois & Araujo (2007: 179)
3	Writing instruments & protocols	Plan multiple data collection methods to strengthen grounding of theory.	Dubois & Araujo (2007: 173) Lim & Ofori (2007: 969) for conducting interviews.

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[60] Yin preferred the word 'informant', instead of 'respondent'. This research preferred the word 'research participant' for face-to-face interactions, and 'respondent' for the survey research.
[61] The corresponding Appendix discusses the steps with hash signs (##) in more detail.

4	Entering the field	Collect and analyse data at the same time; it shows omissions in the data and emergent themes.	Swanborn (2013: 155)
5	Analysing data ##	Within cases; and across cases using several techniques.	Bacharach (1989: 496) Dubois (2007)
6	Shaping hypotheses ##	Try to find logic across cases.	Bacharach (1989: 496)
7	Comparison with literature (& other data sources) ##	Improves validity and sharpens findings.	Bacharach (1989: 496) Swanborn (2013: 127)
8	Reaching closure	Try to get to theoretical saturation.	

Much has been written on analysing rich qualitative data such as interview texts. Any analysis needs to structure and organise data in such manner that the large amount of data are reduced to "relevant chunks" (Malhotra & Birks, 2000: 196). This process of data reduction and data classification is called *coding* and can be done in multiple ways. A basic distinction is whether coding could be used *inductively* to build meaning and theory from the data. (Grounded theory: the theory emerges from the data; Glaser & Strauss, 2009: 46). Although perhaps less popular with inductive-adepts (Rowley, 2002: 18), coding could also be used *deductively* to confirm a conceptual model or theory. (Dubois & Gadde, 2002). Both methods have their advantages and drawbacks. These should match the research objective and philosophical perspectives. A mixture of inductive and deductive coding is also possible (Fereday & Muir, 2006; Miles & Huberman, 1994, Dubois & Gadde, 2002).

The literature review led to a modified conceptual model II which had to be validated. This validation was done deductively during the semi-structured exploratory interviews. However, to avoid researcher bias, interviews were fairly open-ended. This allowed participants to also discuss concepts or categories which did not match the pre-selected coding frames or interview topics. Hence the interviews helped to reveal to what extent conceptual model II was valid for the research domain. Therefore, coding during the interviews was mainly done deductively and selectively (Gibbs, 2011). Section §4.2 shows the coding frames used to analyse the interviews.

3.6.2.2 The Interviews in this Research
Companies were selected based on their membership of the New Zealand Green Building Council (NZGBC) or the New Zealand association for prefabrication (PrefabNZ). Based on the nature and objectives of these associations, it was posited that such companies were relatively *entrepreneurial or innovative*; based on the literature review is was also posited that such companies would use *innovative suppliers*. Interview participants preferably had at least 2-3 years of relevant expertise[62] (Nicolas & Ledwith Perks, 2011: 237). This should

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[62] Adams (2004: 141) reported that 60% of SME procurement professional managers >6 years of experience, and had a bachelor's degree. Hence this research used 2-3 years as a safe threshold level.

enable them to reflect (compare & contrast) on interview topics. Participants had positions in management, procurement, operations, innovation management, or marketing-sales. Participants could either be owners (or general managers) or senior staff (senior practitioners). The research preferred manager participants, as they generally have a better overview than employees or specialised staff (Saunders *et al.,* 2009).

The fact that owners (general managers) of the case companies operated an independent commercial company assumed extensive industry experience. Employees within focal companies were invited via owners or general managers. Having a formal business responsibility (as appointed by senior management) assumed extensive industry experience; this fact was verified while making an appointment.

Approximately 20 potential participants (Eisenhardt, 1989) were invited per email and with a telephone call several days later (see §3.8). This resulted in five interviews in the period December 2015 – January 2016 as discussed and analysed in Chapter 4. (The corresponding Appendix discusses in more detail aspects of coding, intelligent transcription, anonymisation, and reformatting into paragraphs).

3.6.3 Group-type Studies in this Research

This Subsection assesses four major types of focus-group research[63]. The following Table summarises these methods. (See corresponding Appendix for a discussion of the group-type studies).

Table 33: Comparing group-type studies (based on Schiele, 2014; Landeta *et al.* (2011)

	Focus-group	Delphi method	Nominal Group Technique	Research world-café
Objective	Understand / interpret theoretical knowledge in a new or different context.	Obtain reliable data from certified experts through strategically designed surveys. Rearch consensus.	Two or more rounds of brainstorming, open discussion of ideas or problems and voting to refine and prioritize.	Generate or refine and 'test' knowledge relevant to practitioners & researchers.
Setting	Face-to-face discussions of interacting experts.	Online with 1-3 rounds or enquiry.	Physical location (or webbased) for several times with exchange of large amounts of data.	Preparation 'online'; and then moderated discussions in one phycical location. (One of two days)
Role of academics	Researchers.	Researchers.	Co-researchers?	Co-researchers.

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[63] The research used the phrase "roundtable discussions" to adhere closer to participants' expectations.

Role of participants	Experts.	Experts (co-researchers?)	Co-researchers	Co-researchers.
Documen-tation	Transcripts.	Qualitative and quantitative survey results.	Quantitative data on complex influence / confounding variables.	Transcripts / notes, flip charts; pictures.
Time efforts participant	Less time consuming for participant.	Long throughput time. Risk of losing participants.	Less time consuming for participants.	Less time consuming for participants.
Potential weaknesses	Bias due to potential dominance of group members. Costs & logistics of experts. Complex data analysis. Needs 6–10 participants.	Selection process of experts; present problems; Nbr of rounds & efforts from experts; con-sensus process; feedback. Little interaction. Need 10-15 participants.	Cost and logistics or experts. Need higly qualified panel. Less reliable than Delphi. Needs 5-9 participants.	Selection process of experts. Cost and logistics or experts. Need 10-15 participants per round.
Validation	Mostly by researchers.	Mostly by researchers.	Joint validation with stickers / voting etc.	Joint validation with stickers / voting etc.
Source	Schiele, 2012 Landeta, 2011	See also Hallowell & Gambatese 2009 Landeta, 2011	Toole Hallowell, 2013; Hallowell & Gambatese, 2009 Landeta, 2011	Schiele, 2012
Method described in	Kruger, 1994 Landeta 2011, with references.	Hallowell & Gambatese, 2009 Landeta 2011, with references.	Erffmeyer & Lane, 1984; Gallagher, 1993; Landeta 2011, with references	Hoffmann, 2011 Huttinger, 2013 Schiele, 2014

On a high level the focus-study was deductive as it was geared towards testing and validating results from Survey I; on a more detailed level the focus-study was inductive as participants could discuss their opinions with fellow-participants. This helped to validate the focussed conceptual model III for Survey II.
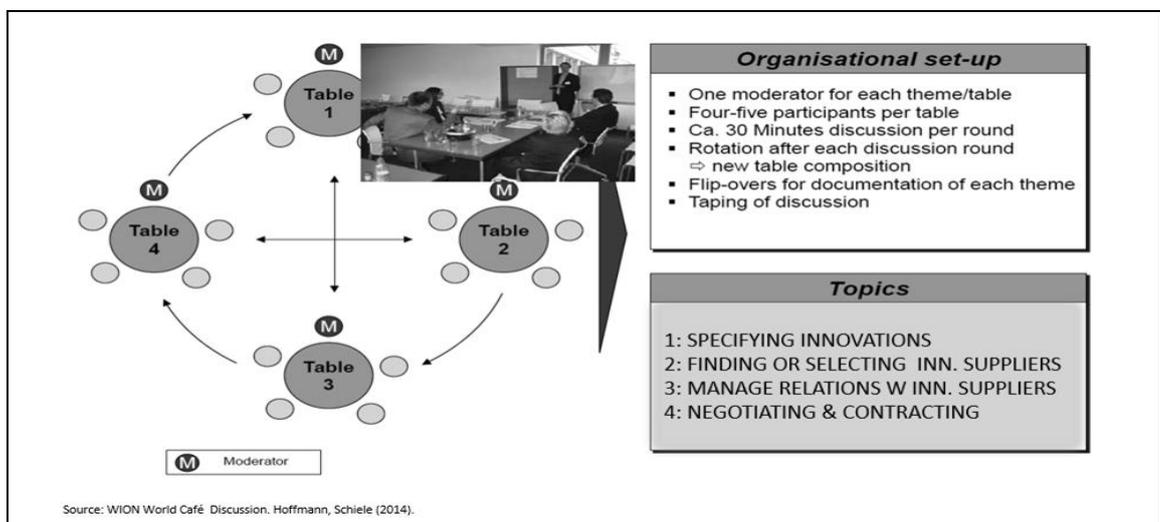
Figure 26: Process of the roundtable discussion (based on Schiele, 2014)

Several respondents from Survey I indicated they were interested in participating in the research. These were selected and invited via email and phone. Again in line with Nicholas & Ledwith Perks (2011: 237), participants preferably had at >3 years of expertise in general management, strategy, procurement, construction innovation, or marketing-sales. This should enable participants to reflect (compare & contrast) on their own experience with research findings and opinions of the fellow participants. In total 15 respondents with three moderators participated in discussions which were held at the University's premises (see §3.8; §8.2).

3.6.4 Survey I and Survey II in this Research

The semi-structured qualitative approaches discussed in the two previous Subsections allowed the researcher to collect rich data from a limited group of respondents. To meet the overarching research objective, the research also needed a quantitative approach on empirical data from more respondents in the target-population. This research designed Survey I based on findings from the literature review (§3.6.1) and the exploratory interviews (§3.6.2). It designed Survey II based on findings from Survey I and the focus-group discussion (§3.6.3). It used the following survey definition:

> A data collection strategy in which each individual from a sizable target-population is asked to respond to the same set of questions in a predetermined order (based on Saunders *et al.,* 2009: 599, 601).

3.6.4.1 Getting Access to the Population for Survey I and II

The target-population was estimated between 3,000 and 6,000 New Zealand companies (§3.1.3). It was not feasible and not efficient to approach all companies of a target-population, and hence the research surveyed a representative sample. Surveys can be administered via post, in person or online. For practical reasons of efficiency, this research used online software of SurveyMonkey[64]. The research selected potential respondents from Internet sources (§3.1.3, §3.2.2). It collected email addresses from representatives of 1,491 companies. (See Table in the corresponding Appendix).

The research used three strategies to obtain survey responses. As recommended by AUTEC, it applied a *pull strategy* with *self-selection sampling* via promoting the survey to industry associations, via networking, LinkedIn groups, and a PhD-blog. It also applied a *push strategy*

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[64] https://www.surveymonkey.net/ The software was selected on usability and flexibility. Data could be uploaded in SPSS.

with Survey-invites to selected industry representatives of the target-population, and a *referral strategy*. The strategies supported each other, although the push strategy appeared most effective. Survey-invites were consistent with the AUT Ethics Approval 15/237 (see §3.8) and were based on *convenience sampling*:

1. The research selected *N*=1,491 companies from publicly available lists of email addresses from several industry associations whose members were active in the New Zealand construction industry. These companies were mostly small-medium in size. Based on the nature of these associations, companies were selected that could be managing innovative construction suppliers.
2. The research selected publicly available or personal email addresses of FMANZ / CIPS members, who often work in large companies or organisations.
3. The research selected companies from publicly available email addresses of two industry associations (NZGBC and PrefabNZ). These organisations explicitly promote construction innovations either focussing on sustainability (NZGBC) or on increased productivity, life-cycle-cost, or quality (PrefabNZ). Both provide an online member segmentation tool which was used as a selection method for this survey research.
4. The research also selected *referrals* via the network of the researcher and via web-links on websites and in LinkedIn groups.

A limitation of surveys is often a low response rate. To avoid this, Dillman *et al.* (2009) suggested to use a research design with a relatively short questionnaire and a non-complicated process. The survey should contain a cover letter or introduction and a follow-up procedure on non-response. In this respect Dennis (2003) suggested at least two follow-ups within a limited period. Forza (2002) provided a process-guide for conducting surveys that was consulted for this research.

The gross survey population (*N*=1,491) as collected in a password-protected database contained 1,057 email addresses with first names. It was assumed that survey invitations with a first name (SurveyMonkey, 2016) and focussing on the respondents' context and interests would yield higher response rates (Forsgren, 1989). Hence survey invitations were semi-personalised where possible with first names and focussing e.g. on sales or marketing staff, or on innovation or procurement staff (see §3.8). Similarly, members of four industry associations (CIPS, FMANZ, NZGBC, and PrefabNZ) received industry-specific invitations to complete the survey. As extant small business research suggested that SMEs could yield lower response rates, in part invitees were especially invited to submit their findings when the size of their organisation was <100 staff.

The nett survey population was estimated to be no more than *N*=1,097 (See Figure below). First, the number of referrals in the survey population (see Table above) was 114. It was

unclear how many referrals forwarded the two survey invites but the researcher assumed *100* referrals did not forward the survey-invite. Furthermore, a total of *44* Survey-invitees (3%) responded per email that they were not interested in completing the survey. Those invitees received an acknowledgement of receipt (See §3.8) and their email addresses were removed from reminder waves. The survey software of SurveyMonkey indicated that *230* survey-invitees (18%) 'bounced' (SurveyMonkey terminology), i.e. the delivery to these invitees failed. The researcher received 22 "out of office" replies, or replies that invitees were no longer working for the company. It assumed that *20* of such invitees did not complete the survey. Consequently, the exact nett population for Survey I was unknown but was not >**1,097** respondents from the target-population. (See Table below; see §3.1.3).

The research used accessible proxy companies (*N*=1,097 out of *N*=3,000 to 6,000 companies) as a sub-population for increasing the understanding of the research domain (Stacks & Hocking, 1995). The Survey-invites to the 1097 respondents resulted in a gross population of *N*=121 for Survey I, and a nett population for Survey I of **N=112** (see below). This could have caused a small-sample bias and a representation bias. (See e.g. Bartunek *et al.*, 1993; Cramer & Howitt, 2004).

The unknown total population of companies in the NZ construction supply chains: manufacturers, specialist service providers, wholesale & distribution, main & subcontractors, FM business customers.

N = 55,000 – 60,000 companies. Approx. 100 companies have 100+ employees.

Population of NZ companies managing innovative construction suppliers is unknown; roughly 5 – 10 % of above poplulation,

N 3,000 – 6,000 companies that manage innovative suppliers

Population of selected and accessible NZ companies via (1) several industry associations and (2) with publicly available and downloadable email addresses. (N gross = 1491)

Nnet = 1097 with active email addresses

Gross survey sample n = 121 respondents

Nett survey sample n = 112 respondents

Figure 27: Nett company sample related to the New Zealand construction industry

Survey I covered a broad industry scope as respondents had different roles and came from different company types. Respondents hence described their procurement practices from different contexts. This broader scope increased external validity, but could decrease internal validity as it reduced possibilities to measure and control for background (latent) variables. (Mullen *et al.,* 2009: 290).

The researcher knew approximately 10% of (named) Survey I respondents via industry networks or from former lecturing activities. Survey data were however obtained independently (Field, 2009) as the researcher was unable to control behaviour of known and unknown invitees.

The research tested and subsequently conducted Survey I from 9 May 2016 to 1 July 2016. All representatives received one semi-personalised invite and two reminders. Erroneously, on 15 May 2016 an email was submitted which invitees could not open. This was corrected with an apology email on 17 May 2016. Most invitees responded within three to four days. The invites and the reminders were conducted in waves (Table & Figure below) to enable better survey management.

Table 34: Invitations were sent to Survey I population in three waves (year=2016)

	29 April	2-6 May	13-15 May	20 May	25 May	3 June	10-12 June
Wave 1	First invite		First reminder		Last reminder		
Wave 2		First invite		First reminder		Last reminder	
Wave 3				First invite	First reminder		Last reminder
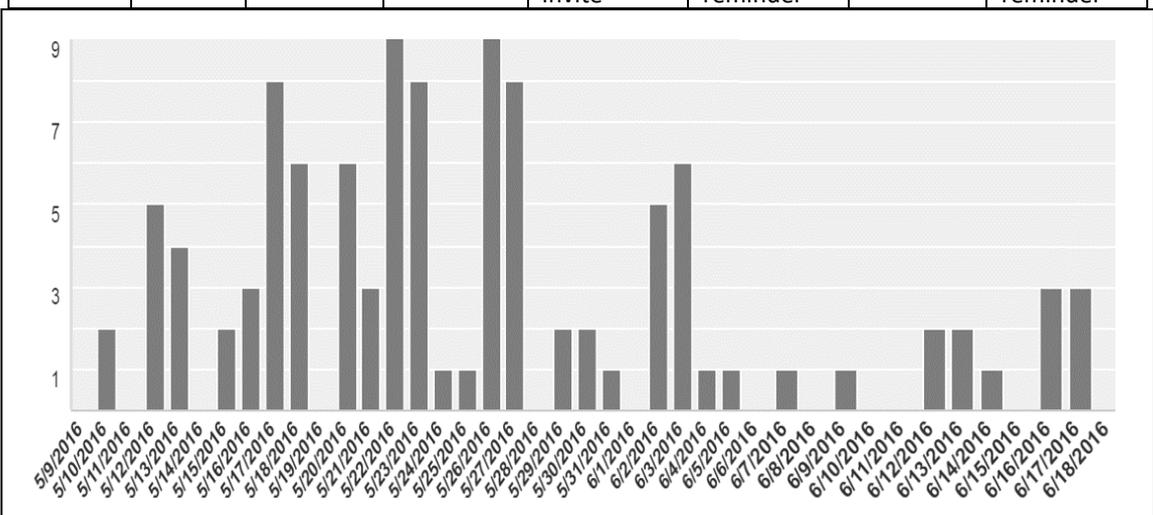
Figure 28: Survey I responses from 9 May 2016 – 18 June 2016 (*N*=121)

The next step was cleaning the raw SurveyMonkey data of N=121 for statistical analysis[65]. This was done in five steps:

1. <u>Data conversion from SurveyMonkey to SPSS</u>. The raw SurveyMonkey data were downloaded into Excel and then cleaned and restructured. To increase internal validity, several ordinal variables were recoded into 2-point or 3-point Likert-scales.
2. <u>Identify and remove outliers in SPSS and determine nett sample size.</u> A total of nine cases were removed from the dataset. Another eight cases had partially missing data but were not removed as the data provided by those respondents on Q1-Q21 contained no outliers and were considered useful. The nett sample size n=112 respondents. (Response rate=10.2%)[66].
3. <u>Analyse the nett sample response rates on question levels</u>. A non-response analysis was conducted on the question level to analyse reliability of the individual respondents. Non-response rate per questions did not reveal anomalies, and also did not suggest a survey fatigue.
4. <u>Analyse distribution for appropriate testing</u>. Checks on normality of data were important to determine the adequate choice of parametric versus non-parametric tests. Basically, parametric tests are for continuous variables with normally distributed data (with a bell-curve distribution); non-parametric tests are for categorical variables with non-normally distributed data (e.g. a skewed or kurtosis distribution). The research hence had to check for (1) normality, (2) data type, and often (3) other assumptions. For subsample sizes >30 the research also posited that the categorical data would behave as normally distributed (Cramer & Howitt, 2004).
5. <u>Determine adequate statistical tests</u>. The descriptive tests determined means, mean ranks, frequencies, and standard deviations. The inferential tests determined significance (with p<.05) and Pearson or Spearman correlations where possible. The research was aware that the extent of correlations can be classified in several ways, also depending on the research purpose (Hattie, 1992; Cohen, 1992; Knoke, Bohrnstedt & Mee, 2002: 150). Requirements for specific statistical tests followed guidelines of Malhotra & Birks (2000:474, 480) and Field (2009) and are discussed in with the specific analysis of data in Chapters 5–8.

The Appendix §3.6.4.1 provides a discussion and details on each of the five steps. Note that for Survey II, the research sent invites to the same contacts as Survey I (See Table below). Survey II ran September – November 2016 and received N=33 usable responses. Dataset cleaning of Survey II went identical to that of Survey I.

Table 35: Data on Survey II

Gross total number of invitations	1,097
Bounced	43
Opted out	52
First wave with gross number (N=1,097)	11 September 2016
Second wave with nett number (N=1,002)	13 October 2016

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[65] Based on De Waal (2011: 103).
[66] Removing too few or too many outliers could increase Type I or Type II errors. (VanVoorhis & Morgan, 2007: 44). See §10.4.3 for a discussion on response rates.

Reminder with nett number (*N*=1,002)	17 November 2016
Complete responses	36
Partial responses	3
Nett responses after cleaning data	33
Response rate	3.9%

Chapter 10 (§10.4) discusses the effect of response rates.

NOTES:

1. Survey data were by default anonymous and the respondents' identities and company names could not be traced back in published survey results. Respondents were informed on the possibility to check a PhD blog for updates on the survey. Moreover, respondents who were interested in survey results or wanted to participate in the research were invited to submit their names, addresses, and phone numbers. Data were stored in password-protected files.

2. Furthermore, when (non) normality was not obvious from SPSS analysis, this research combined non-parametric and parametric tests . This increased the power of the statistical tests. This strategy recommended by for example VanVoorhis & Morgan (2007: 46-47) was notably applied in Chapters 6 and 7.

3. The research in Chapter 6 and 7 analysed statistically-significant relationships relative to the total number of relations between coded and uncoded variables. The uncoded variables had somewhat larger sample sizes, which should help in finding significant results. The recoded variables focused on extreme (high versus low) values. Such extremes should also help to find significant results. Tests were therefore conducted twice.

4. Any statistical significance did not necessarily relate to significance in managerial practice. For once, the research could not analyse all possible (complex) statistical relations due to limitations in sample size, homogeneity or variety of the sample, and limitations in the survey and hence data structure. Moreover the research had to apply broad conceptual models, ignoring effects from mediating or multiple variables.

3.6.4.2 Survey I Structure, related Questions, and Question Types
The first objective of Survey I was to analyse relationships between the independent company variables and mediating procurement management variables & practices; the second objective was to analyse relationships between the independent company variables and dependent procurement performance variables; the third objective was to analyse relations between the (mediating) procurement management variables & practices and dependent procurement performance variables. Various Tables in the corresponding Appendix discuss sources of the actual survey questions and provide additional details per survey question.

3.6.4.3 Survey II Structure, related Questions, and Question Types
The objective of Survey II was to validate relationships between several key supplier and innovation variables and key mediating procurement process practices. To ensure internal

validity and reliability on the survey data (Saunders, *et al.,* 2009: 371), the research designed Survey II based on findings from Survey I and the roundtable discussion (§3.6.3). Survey II was designed much shorter and less complex than Survey I, as it was expected that invitees did not want to complete a 2nd long survey. The structure of Survey II in SurveyMonkey was similar to Survey I. (See corresponding Appendix; for rigour aspects, see §3.7.2).

Section summary-conclusion:

16. *This Section discusses in detail five research methods. In combination these should help to achieve the overarching research objective.*
17. *The iterative and structured literature search revealed findings from several research domains, notably from procurement and inbound open innovation in SMEs.*
18. *The exploratory case-study interviews were used to discuss and refine assumptions from the literature review and conceptual model II. Participants were selected from two innovative industry associations (PrefabNZ and NZGBC).*
19. *Survey I was built from conceptual model II. Participants were selected from sources available on the Internet and approached via convenience sampling, and to a lesser degree via referrals and self-selection sampling.*
20. *Cleaning methods were applied so that the survey data contained no obvious outliers, and that the research could apply adequate statistical tests with optimal results on Type I and Type II errors. Consequently, the research applied a significance level of α=.05.*
21. *Most data of Survey I were nominal and ordinal. Several ordinal variables were recoded into shorter Likert-type scales. Data of nine respondents with obvious outliers were removed from the gross sample size (N=121). Partial-respondents were accepted. The cleaned dataset had a nett sample size of N=112 respondents.*
22. *Non-response rates on the cleaned dataset of Survey I did not suggest a survey fatigue; standard SPSS tests did not reveal further outliers. Hence it was reasonable to assume that respondents fairly conscientiously answered survey questions. However, this à priori did not imply that the data were unbiased or representative for the target-population.*
23. *Not all data were normally distributed. For each inferential analysis, the research had to choose between parametric or non-parametric tests. Relevant statistical tests were summarised.*
24. *Survey I was received by no more than approximately 1,097 professionals, managers, company-owners, or professionals in the target-population of companies that managed innovative suppliers. This nett survey population was a small part of over 60,000 companies in construction supply chains but should well-represent the estimated target-population of 3,000 to 6,000 New Zealand companies that managed innovative suppliers.*
25. *A roundtable discussion (world-research café) was designed for industry representatives and consultant experts. The roundtable discussed conceptual model III, i.e. which (TOP 3) procurement practices participants would use when controlled for a set of supplier-innovation variables.*
26. *Survey II was designed to validate findings from the roundtable discussion.*

3.7 Research Rigour – Reliability and Validity

Different scholars defined rigorous research differently, and in part also preferred different terms. (Lincoln & Guba, 1985; Quinlan, 2011: 307, 324). Research is generally considered rigorous if the research design is reliable and valid (e.g. Saunders *et al.,* 2009: 156), and if the research process is conducted systematically (e.g. Quinlan, 2011: 482). The rigour of findings also depends on the philosophical stance. (See §3.4). This research took a pragmatic approach, was aware that exploratory research could produce contradicting results, and accepted that rigour varied with sample sizes and research methods.

Quinlan (2011: 484) presented the following hands-on definition for reliability:

> "Reliability is the dependability of the research, to the degree to which the research can be repeated while obtaining consistent results".

Saunders *et al.* (2009: 600) added the aspect on the transparency "*in how sense was made from the raw data*". Considering *reliability* should help to limit bias or errors: the *reliability* of findings can be increased with clear and accurate operational definitions, accurate measurements and protocols (Christiaans *et al.,* 2004: 118).

Quinlan (2011: 484) presented the following broad definition for validity:

> "Validity relates to how logical, truthful, robust, sound, reasonable, meaningful and useful the research in question is".

Yin (1994: 33) mentioned identical terms for rigour in qualitative and quantitative research (*viz.*: reliability, internal validity, external validity, and construct validity). These terms, with additions from Quinlan (2011) and Saunders *et al.* (2009) were applied in this research. (See the following two Subsections).

Validity can be increased by using triangulation (Edwards & Holt, 2010: 29. See below). This research combined triangulation types #1, #4, and #5.

Table 36: Main triangulation types for mixed-mode methods (from Edwards & Holt, 2010)

Type ID	Description(s)	Short explanation
1. Data	Data triangulation Triangulated data sources	More than one method of data sampling strategy and/or more than one way of data analysis is employed (e.g. may be single source taken in slices over time or related to space or origin)
2. Investigator	Investigator triangulation	More than one observer is employed in data collection and/or more than one investigator is employed in data interpretation
3. Theory	Theory triangulation Theoretical triangulation	More than one theoretical scheme or theoretical standpoint is employed to interpret the phenomenon (e.g. via data)
4. Method	Methodological triangulation	More than one method of data collection and/or analysis is employed (e.g. may include a mix of quantitative and qualitative sources)
5. Multiple	Multiple triangulation Hybrid triangulation	Any combination of different observers, perspectives, data sources, theories, methodologies (etc.) used in the same investigation

Sources: Adapted from Jack and Raturi (2006); Bryman (2008)

This Section continues to discuss rigour in the *design* of qualitative and quantitative methods for this research. (§10.4 discusses limitations of the *execution* the research).

3.7.1 Rigour in the Design of Qualitative Methods for this Research

This Subsection starts with a quote attributed to Eisenhardt: "*case-study research is a soft research method which is hard to apply*" (No source). This especially applied to safeguarding rigour with regards to the validity and reliability.

The exploratory interviews and focus-group discussion involved a limited number of respondents and were fairly non-standardised. (See §3.6.2, §3.6.3). Hence *reliability,* i.e. *replicability* to new interviews or new focus-group discussions (Quinlan, 2011: 482) was potentially limited. However, this risk was limited as the research had carefully selected interview participants, prepared interview topics, transcribed interviews, and had applied interview and focus-group discussion protocols, and participant information sheets. (See §3.8). These enabled an external review.

The *internal validity* of the qualitative research referred to how sound or truthful, useful, (credible) the interviews and roundtable discussion were designed. (Quinlan, 2011: 484). Inevitably, the internal validity had some limitations due to the design and the limited sample size. However, this risk was limited as the data were (1) co-constructed with informed research participants, (2) documented, (3) triangulated with quantitative research. Additionally, the position of the researcher was explained, the researcher was well-prepared and in part had relevant industry experience. (Based on Creswell, 2003).

Another potential limitation of this qualitative research was the *external validity*, i.e. *generalizability* of findings to a wider population[67]. This however was not the primary purpose of the qualitative research, and was managed via triangulation with the quantitative research. (Christiaans *et al.,* 2004: 248-252). Moreover, participants were selected with care. Finally, limitations on *construct validity* in the design were limited by the extensive and iterative literature review and use of conceptual models. The following Table summarises the rigour measures for the qualitative research.

Table 37: Rigor measures for the qualitative research (based on Yin, 1994: 33)

Measure	Definition	Addressed in this research
Reliability	How well can exploratory interviews and focus-group discussions be reproduced?	The transcripts, protocols and slides used during the interviews and focus-group can help to reproduce the events.
Internal validity	How well can the interviews and the focus-group discussion establish causal relationships?	Constructs were assessed via triangulation.
External validity	How well were the research results (i.e. new theoretical insights) generalisable to another theoretical domain?	The research had the New Zealand construction industry as context and generalisation to other domains needed to be done with caution.
Construct validity	Having the right measures for the constructs being studied	The constructs as discussed in the interviews and focus-group discussion were based on a review of the literature. The interview drafts had been sent to respondents for feedback. Focus-group results were discussed with one moderator

3.7.2 Rigour in the Design of Quantitative Methods for this Research

At *prima facie*, the reliability and the validity of quantitative research methods was easier to defend. After all, Surveys I & II used a standardised form which made *reliability* (replicability or repeatability) to new respondents easy, and the wording of the questions and concepts was done with care (Saunders, *et al.,* 2009: 383-393). The analyses applied standard forms of statistics, with standard software (SPSS) and standard protocols (such as given by Field, 2010). Nevertheless, the surveys had to be designed carefully.

Saunders *et al.* (ibid: 389) recommend a survey length between four and eight pages. Survey I was structured over 13 pages and grouped into seven sections. Testing however suggested that completion within 10 minutes was possible, and the on-line version used a progress meter for respondents. The introduction section of Survey I explained purpose, thanked respondents, and mentioned ethical considerations; the closing section again thanked respondents (Saunders, *et al.,* 2009: 375-389). The survey started with straight-forward questions. The longest section on innovations was in the middle, shorter profiling questions and a reflective matrix question were positioned at the end. (See Appendix §5.1). Survey II

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[67] Generalisation would me more feasible for similar supply chains, either in NZ or in construction.

was designed much shorter, with three pages and seven questions. Testing suggested that completion within 3-5 minutes was possible. (See Appendix §8.1).

A *reliable* survey enables consistent data collection. (Saunders *et al.,* 2009: 371). Testing for *reliability* (Quinlan, 2011: 336) is often done via (a) split-halves method, (b) the test-retest method, and (c) the internal consistency method using Cronbach coefficient α as an indicator for reliability (Field, 2010). For Survey I, the split-halves method was not feasible as respondents with different profiles were added during the test period. Moreover, (applicable to both surveys) the test-retest method meant that a set of respondents were invited to complete the same survey again, or that the survey used multiple questions asking opinions on the same (or very similar) topics. This was also not applicable. Nevertheless, this research could use some questions from Survey I for test-retesting in Survey II. (See §8.1).

The survey intended to measure intersubjective constructs (§3.2.3). Using single respondents per company could introduce a bias. Likert-scales can help to decrease but do not eliminate such bias. In part, the survey was structured such that the entrepreneurial and performance constructs had several (multi-item) variables. (See below). A Cronbach's α coefficient was calculated to assess the internal reliability of these two multi-item variables (See §5.1.2). The resultant values above .7 or .6 are often seen as acceptable for this type of research (Field, 2009: 675).

Relevant extant research was inconclusive on the required levels of measurement details when applying Likert type scales. Some recommend a 7-point type scale as this gives a larger accuracy. Adams (2004) e.g. applied such a 7-point scale in SME procurement research. Others preferred a shorter, e.g. a 5-point type scale as this is easier for respondents. In comparable research on innovation tools, Tidd & Bodley (2002: 132) and on SME procurement tools Ritvanen (2008: 85) both used 5-point scales. In line with extant SME research, the current research preferred simplicity over accuracy and used Likert-type scales with mostly 5-points, but also with 4-points or 3-points. The research posited that using relatively simple Likert-scales facilitated higher response and completion rates from survey participants, and at the same time provided sufficient detail for statistical analysis. This was in line with Saunders *et al.* (2009: 379). Note that in Survey I longer Likert scales were recoded into shorter Likert scales.

A *valid* survey helps to collect accurate data. (Saunders, *et al.,* 2009: 371). To ensure *internal validity* on the data (Saunders, *et al.,* 2009: 371), the research first designed and tested Survey I and II before using re-designed versions. (See corresponding Appendix §3.7.2)

The topics of Survey I as shown in the conceptual model I were based on literature. Most questions were adopted or adapted from common variables in extant literature (c.f. Saunders, *et al.,* 2009: 374) which increased the *external validity* and the *construct validity* of the survey. The following Table summarises rigour measures for the quantitative research.

Table 38: Rigor measures for the quantitative research (based on Yin, 1994: 33)

Measure	Definition	Addressed in this research
Reliability	To what extent can Survey I and II be reproduced by future researchers?	The research documented and explained the processes to define and conduct Surveys I & II and subsequent analyses.
Internal validity	Content validity: How well was the phenomenon[68] from the conceptual model represented in the Survey? How did the data collection methods (scale or measurement instrument) measure what it was designed to measure? Instrument validity: How well can the standard, criterion or instrument used make accurate predictions?	Survey I: had been developed from literature and interviews and had been pre-tested in a pilot and with experts Survey II: had developed from Survey I, and had been pre-tested with a focus- group and experts. The multi-variable constructs were assessed via Cronbach α. All constructs were assessed via triangulation. The applied standard statistical and sampling procedures should be able to correctly reveal significant differences between the variable types (IV, MV, DV).
External validity	How well were the research results generalisable to all relevant contexts (or to other groups)?	Generalisation was possible to a limited extent. The samples were representative to the population, but sample sizes were small. Moreover, the research had the New Zealand construction industry as context, and generalisation to other groups needs to be done with caution.
Construct validity	How well do the measurement questions actually measure (represent) the presence of the constructs they were intended to measure?	Both surveys were based on a validated conceptual model. The surveys were adopted or adapted based on constructs and variables from extant literature. Surveys had been pre-tested.

Section summary-conclusion:
27. Aspects of reliability and validity were discussed for the design of the quantitative and qualitative research. The research was designed for adequate reliability and validity. Chapter 10 discusses limitations from the execution of the research.

3.8 Protocols, Participants, and Ethics Approval

The researcher was conscious of the fact that selected research methods and activities could have an effect on individuals who participated in this research. (Saunders *et al.,* 2009). In strict accordance with the AUT Ethics Guidelines, this research developed protocols, consent forms, email exemplars, and information sheets to engage with (potential) research

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[68] Phenomenon: situation or fact that is observed to exist or happen, especially whose cause is in question. (Oxford Dictionaries, accessed 6 June 2018).

participants. (Yin, 2003: 69; Ates, 2008: 108-109; Hardie, 2011: 84). (See Table below; related documents can be found in Appendix §3.8, §5.1 and §8.3).

Table 39: Documents developed for interaction with research participants

Name of Document	Version
Protocol & Topics (Indicative Questions) for Exploratory interviews	March 2015
Participant Information Sheet – Exploratory interviews	March 2015
Consent Form – Exploratory interviews	June 2015
Participant Invitation and Information for Survey I & II	May 2015
Consent and Information Statements for Survey I & II	May 2016
Moderator Protocol & Questions for Focus-Group (Roundtable) Discussions	April 2015
Participant Information Sheet – Focus-Group (Roundtable) discussion	June 2015
Consent Forms – Focus-Group (Roundtable) discussion	April 2015
Exemplars (emails direct contacts, associations, referrals; website) to invite participants	May 2015
Exemplars (emails) for communicating with identified potential participants	June 2015

At New Zealand universities, ethical research principles are based on the Treaty of Waitangi (1840). This declaration of sovereignty was signed by 540 Māori rangatira (chiefs) and by representatives of the British colonial government. The Treaty signified the beginning of the state of New Zealand and should respect the rights of the indigenous Māori. Its principles are: Partnership, Participation, and Protection.

For a discussion on the application of the Principles for this research, see Appendix §3.8. An estimation of time requirements for participants is found in the same Appendix.

Section summary-conclusion:
28. The research was designed and executed to respect the Principles of Waitangi, i.e. minimize risk to participants, protect their privacy and confidentiality, minimize possible deception, and operate within the consent of participants.

3.9 Chapter Summary

This Chapter presented the methodology for the current research. It aimed to answer this structuring research question:

(RQ3) What was an appropriate research methodology to explore the research domain in order to achieve the research objective?

The 26 Section summary-conclusions of this Chapter are summarised below:

1. The New Zealand target-population for this research was roughly estimated between 3,000 and 6,000 companies. The units-of-analysis within these focal companies were

procurement practices that were conducted on the level of a specific innovation when such companies managed innovative suppliers.

2. The iterative literature search was structured to reveal findings from several research domains, notably from procurement and inbound open innovation in SMEs.

3. Exploratory case-study interviews were designed to discuss and refine assumptions from the literature review and conceptual model II. Participants were selected from two New Zealand industry associations.

4. Survey I was built from conceptual model II. Participants were selected from sources available on the Internet and approached via convenience sampling, and to a lesser degree via referrals and self-selection sampling.

5. Conceptual model III was designed based on Survey I findings. A world-research café / roundtable discussion was designed with industry representatives, academics, and consultants. The roundtable discussed model III. Survey II was then designed to validate and expand findings from the roundtable discussion.

6. Aspects of reliability and validity were discussed for the quantitative and qualitative parts of this research. The research was designed to meet the requirements for reliability and validity.

7. The research was designed and executed to respect the Principles of Waitangi, i.e. minimize risk to participants, protect their privacy and confidentiality, minimize possible deception, and operate within the consent of participants.

Chapter 9 discusses and answers research question 3.

You have reached the end of Part I.

Part II discusses empirical results.

PART II

No man is an island.
J. Donne (1572-1631).

Introduction to Part II

No man is an island. Companies that interact with innovative suppliers operate from their organisational context and with dynamics depending on the type of innovation and the characteristics of suppliers and customers. In line with e.g. Maylor (2001) it would be inadequate to study procurement practises as single factors. Procurement practices are not used in isolation and need to be understood in their contexts. For this research, the context of such practices was the focal company and its innovative suppliers in New Zealand construction supply chains.

The objectives of Part II were: (1) to identify and explore procurement management variables & practices; (2) to identify and explore company variables that influence such practices; and (3) to increase an understanding in relations between procurement practices, company variables and ultimate procurement performance. (See §1.5).

Part II addressed several research questions supported by several high-level hypotheses.

It contains five Chapters and gives a detailed account from empirical findings.

- Chapter 4 discusses results from five exploratory interviews.

- Chapter 5 discusses descriptive statistics on the main variables. (Survey I).

- Chapter 6 discusses procurement management variables controlled for company variables. (Survey I).

- Chapter 7 discusses procurement performance variables controlled for company variables and for procurement management variables. (Survey I).

- Chapter 8 discusses the relation between a specific set of company variables and a specific set of procurement practices in more detail. (Survey II).

Part II applied two conceptual models as shown below. (See §2.13, §3.5). Conceptual model II shows four independent variables, six mediating variables and four dependent variables. This would imply analysing 48 combinations with each one or more statistical tests. For

simplicity's sake, the Chapters explored most promising combinations in more detail. Also, as is discussed in §5.1, the initial Likert measurement scales of several variables were simplified. The model is validated in Chapter 4 and used throughout Chapters 5–7.
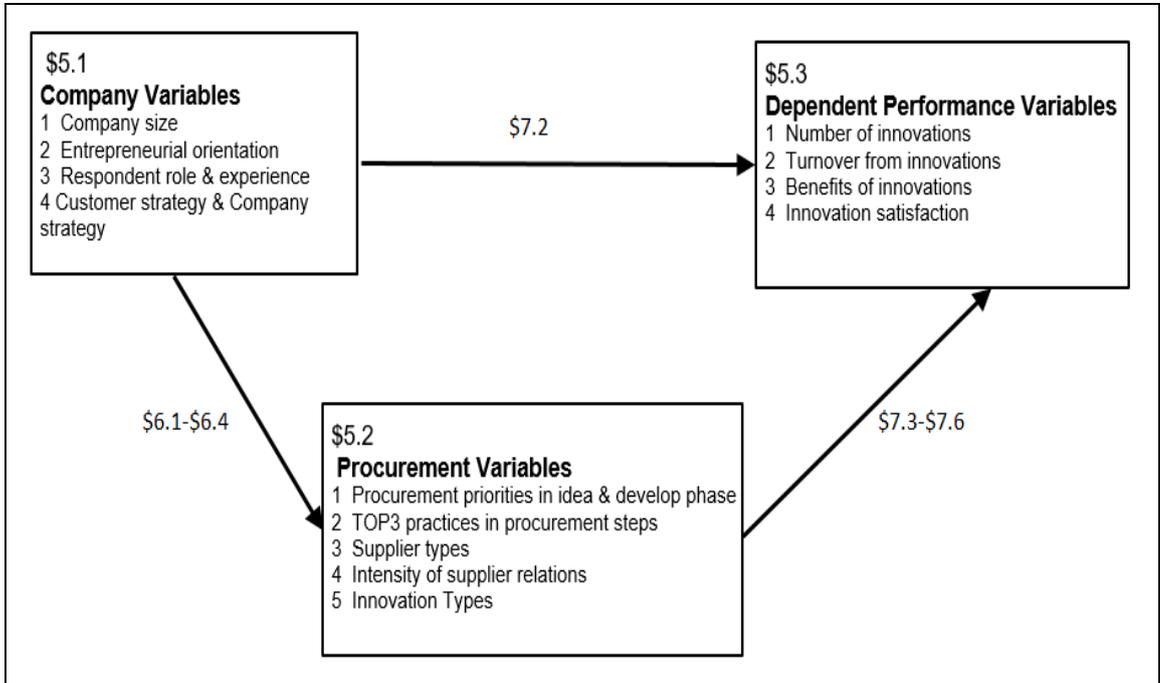
Figure 31: Model II with company, procurement, performance variables of Survey I (Copy §3.5)

The focused conceptual model III (see below), investigated relations between selected key-variables and selected best-practices. This is discussed in Chapter 8.
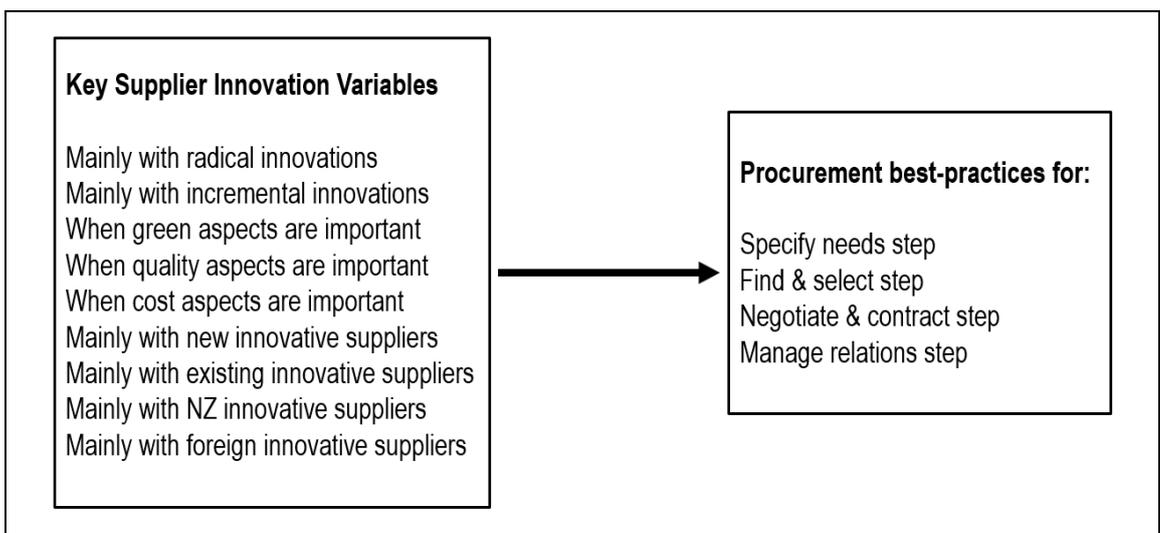
Figure 32: Model III with supplier-innovation variables and best-practices of Survey II (Copy §3.5)

Chapter 4

Exploratory interviews on Industry Practice

Nothing ventured, nothing gained.
English proverb.

Chapter 4

Exploratory interviews on Industry Practice

This Chapter discusses findings from exploratory interviews. The objective of this Chapter is

to answer the following empirical research question:

(RQ4) To what extent did exploratory interviews in five New Zealand companies on how they managed innovative suppliers in construction supply chains increase the understanding of the research domain, and validate the variables and conceptual model II from Chapter 2?

To deepen the understanding on how companies manage their innovative suppliers, this

Chapter contrasts empirical findings with conceptual model II. (See below). These

qualitative findings offered insights that served as input for the quantitative research in the

following Chapters.
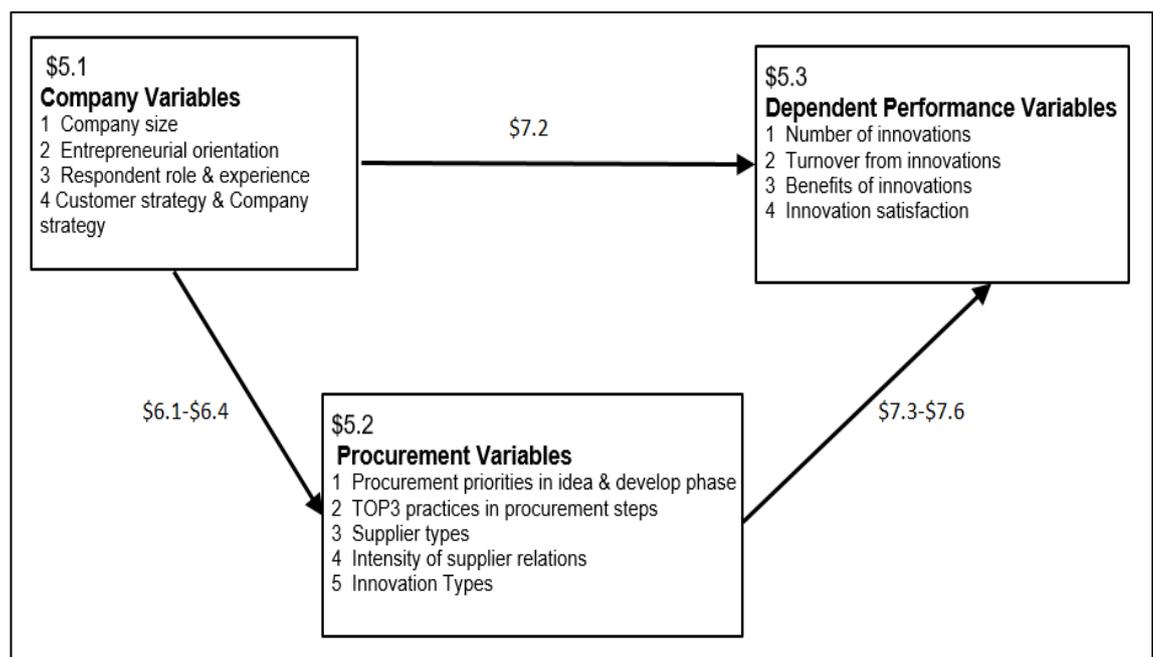
Figure 34: Conceptual model II as input for the interviews (Copy §2.13; §3.5)

4.1. Profile of Participants and Companies

An inclusion criterion for the exploratory interviews was that the companies had to be innovative and that participants had to be experienced with supplier innovations. To obtain ample and rich data from the interviews, this research targeted members of the industry associations NZGBC and PrefabNZ[69]. Based on information on their websites, members of these associations were found to have innovative product or service offerings. Companies were selected based on their memberships with one of these organizations and on complementary company information from the Internet.

Interviews focused on how companies managed suppliers that were considered innovative or had been innovative in the past. The research posited (see Chapter 2) that supplier innovations in construction supply chains could result from 2nd or 3rd tier companies. (§2.1.2 and §2.2). Consequently three material suppliers, and two specialist service providers were found to be eligible. These companies supplied innovative goods or services to main or sub-contractors, asset owners or asset users (such as facilities managers). The interviews were exploratory and hence open to semi-structured (§3.6.2), which allowed participants to discuss topics relevant to them. Understandably, the resultant interview data varied to a certain extent; combined the interview data sufficiently covered the research topic.

The following Figure summarises the profiles of participants and their organisations. Three companies had <5 staff, one company approximately 20 staff, and one company between 100-150 staff. All five participants were male and had 10+ more years of industry of management experience. Interviews were held in Auckland from December 2015 to January 2016 and lasted between 50-85 minutes. (See also §3.6.2.2).

Participant #1: Owner of building consultancy company. (Company est. 1998. two employees; unknown number of permanent partners; member of several industry associations). The participant had a doctoral degree and 30+ years of experience and owned a consultancy company since 1998. This company focused on providing solutions to the public and New Zealand building industry e.g. related to health effects caused by building defects. The participant's expertise included regulation related to building, construction contracts, alternative solutions, un-authorised construction, due diligence/assessments, investigating failures and defects, building maintenance, construction management, dispute resolution, expert evidence, and technical opinions. He worked together with construction and building companies, building Surveyors, structural engineers, architects, research institutes, and property owners and developers. The company operated over New Zealand, but mainly in Auckland and Wellington.
Participant #2: Co-owner & partner of a new importing & operational services company. (Company est. 2015. 2-3 employees; some permanent partners; member of CIPS, other memberships unknown). The participant had a masters' degree in chemistry and in business administration. He had a 10 years of management experience, both in Europe and in New Zealand.

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[69] NZGBC: New Zealand Green Building Council has over 450 member organisations. (Website). PrefabNZ: non-profit organisation with over 300 members on innovative construction in New Zealand. (Website).

At the time of the interview he was involved as a co-owner in a new business venture. This company imported and distributed (sold) innovative machine equipment and product innovations to the industry. Via one permanent partner (service provider) the company also delivered operational (cleaning, maintenance) services with such innovative equipment. The venture had one permanent employee, two owners, and one permanent partner, and operated mainly in the Auckland region. It was growth-oriented and wanted to expand the number of permanent service providers.

Participant #3 Marketing manager at a concrete precast components' manufacturer.
(Company est. 1975. 100-150 employees; permanent partners; member of PrefabNZ, Precast association, and two other associations).
The participant (25 years of experience) had a bachelor degree in commerce. He had been a marketing manager for the concrete precast company for some years and was a member of the company's 3-person management board. The company designed and manufactured concrete precast panels which it delivered on-site. The company worked closely with several permanent (long-term) partners for designing panels and for assembling panels into residential and non-residential buildings. The company started producing lightweight precast panels in 2003 and adopted and designed several innovative solutions. The company had between 100-150 employees and operated in the greater Auckland region.

Participant #4: Owner of insulation manufacturer, distributor & installation company.
(Company est. 2000. 20 employees, six franchisees, international manufacturing company. NZGBC and others).
The participant had a bachelor degree in commerce, had been active in several sales positions in the industry. He bought the company in 2000. Since then he transformed the company into a franchise organization and imported and manufactured several types of insulation material for residential and non-residential buildings. He worked from a main outlet in Auckland and outlets (franchisees) in six major New Zealand cities. The company had approximately 20 direct staff (for management, import, production, sales, and installation) and approximately 50 indirect staff in the franchise outlets (for sales and installation).

Participant #5: Architect & Project Manager for designing and delivering prefabricated buildings.
(Company est. 1998. two employees and approximately five staff with permanent "collective partners". PrefabNZ).
The participant was a professional architect with 30 years of experience in Africa and Europe. His company included architectural design, engineering, construction and project management of containerized prefabricated buildings for residential and non-residential purposes. These buildings were used for aid-relief in the Pacific Islands and for off-the-grid holiday homes in New Zealand. He worked with a collective network of engineers, contractors, and with product manufacturers. These manufacturers were often suppliers who contributed with innovative solutions.

Figure 34: Overview of interview participants and company profiles

Section summary-conclusion:

1. *The research conducted five exploratory interviews with representatives from entrepreneurial or innovative companies. It was posited that those representatives had adequate experience in managing innovative suppliers.*

4.2 Preparing the Analysis of the Exploratory interviews

The Figure in the corresponding Appendix shows results from a world cloud analysis[70] of the interview transcripts. This enabled a first analysis on the frequencies of non-common words (nouns, verbs, adjectives, and adverbs). The clouds showed that participants #1 and #2 discussed the research topic in more general terms, whereas participants #3 and to a larger degree #4 and #5 discussed the research topic with examples from their company contexts. Interview #1 (with the owner of a construction consultancy company) was also used to validate insights gathered from earlier desk research and industry observations on more

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[70] Created on the website www.tagul.com, accessed 4th of February 2016.

general trends that were related to the research topic. This first interview enabled the researcher to validate the interview topics and offered first empirical insights on the research topic. The interviews #2 to #5 offered richer insights in procurement practices for this research as is discussed in the following Sections.

The research had prepared topics with indicative questions and some power-point slides with the classification model. (See Table 18 in §2.10). However, in several instances this was not necessary and when prompted, participants discussed their experiences in procurement of innovations. Due to the structure of the interviews, respondents did not discuss all aspects from the classification model. Instead the interviews individually "fragmentary" (Huberman & Miles, 1989: 57) but combined more coherently revealed procurement activities that participants thought relevant. Based on conceptual model II, the following Table shows main or pattern codes (variable constructs) and themes used for (cross-)analysing the interviews.

Table 40: Coding frame for the exploratory interviews

Company-related aspects (§4.3)	Company size and virtual size Experience and position (role) of participant Company strategy related to the research topic
Innovation-related aspects (§4.4)	Product versus process innovations Radical versus incremental innovations Idea versus develop phases for innovations
Procurement and Supplier-related aspects (§4.5)	Intensity of relations Foreign versus domestic suppliers New versus current suppliers Small versus large suppliers Procurement steps: Specify; Search & Select; Negotiate-contract; Manage-relations
Performance aspects (§4.6)	Success related to company objectives Success on specific procurement or innovation activities

The following Sections analyse in detail the interview findings for each code type over the five companies. The topics that participants brought forward were often inter-related and therefore readers may experience some redundancy while studying the Sections. Section §4.7 summarises interview findings.

Section summary-conclusion:
2. *Word clouds from the five interview transcripts showed that participants #1 and #2 discussed the research topic in more general terms, whereas participants #3, and to a larger degree #4 and #5 discussed the research topic with examples from their company context.*

3. *The clouds showed the variety of discussed topics, probably also caused by the process of the interviews. This suggested that the interviews taken separately would probably*

not cover the research topic adequately; however when combined the interviews would give a more coherent perspective.

4. *Respondents could relate their experience to the classification model (Table 18), but did not discuss each aspect of this model.*

4.3 Discussing coding Results on Company-related Aspects

This Section discusses the coding results from the interviews on company-related aspects, notably aspects of (1) company size, (2) experience, (3) position of the participants, and (4) company and customers strategies.

4.3.1 Company Size and Virtual Size

The companies were selected on the basis of their sizes. Three companies were micro companies, one company was small, and one company was medium-sized. (cf. §2.6.1). The companies worked with several permanent partners. Participant #3 indicated that his company and an independent key supplier were "virtually one organization" (line 45; lines 335-340). Company #3 and its key supplier were both relatively large to New Zealand standards, but small compared to the main competitor. Participant #4 stated that his franchise organization "generates volume" (line 78) which was high enough for an international material supplier to partner with this SME company. Similarly, participant #5 used suppliers to co-develop innovations (e.g. lines 215-233).

This implied that these companies used partnering as a procurement or innovation strategy to overcome their liabilities of smallness. Similar open innovation strategies of SMEs are more often found, e.g. by Van der Vrande *et al.* (2009) and by Spithoven *et al.* (2013), but mostly related to high-tech industries.

Due to its small size, participant #5 (lines 68-70) experienced limitations in the credibility to his customers or regulators: "and again, clearly, you need to have a 1000 people in a whole-wide organization to come up with smart ideas. If you are an individual architect clearly you must be an idiot, it is desperately sad". At least this statement shows that in buyer-seller relations, a small supplier did not always gain a favourable position with its customers. (More on company size in §4.5.4).

4.3.2 Professional Experience

The participants had university degrees, and all had 10+ years of experience either in management, marketing-sales and/or in the construction industry. This was more than the initial threshold levels that the research had assumed. (§3.6.2.2). This high level of experience could be in line with educational background and experience of PrefabNZ or NZGBC members. However, these education levels could differ with those of other companies in the wider industry (§2.6.2). Due to the educational levels, these case companies could be more innovative which could confirm conclusions from e.g. Ozorhon (2010: 11). Similarly, the educational levels and experience would yield better procurement performances which could confirm general findings from Adams (2004), Paik (2009) and Park & Krishnan (2001).

4.3.3 Position of Procurement & Roles

The owners of companies #2, #4 and #5 played an important role both in day-to-day and in strategic procurement and innovation activities and were responsible for procurement and for managing relations with their key suppliers. Company #3 employed a procurement officer who should ensure that materials and deliveries were "on time and on the right price" (line 335), which was a more traditional view on procurement (Van Weele, 2010: 69). However, that procurement officer was not responsible for *strategic procurement* aspects such as technology scouting, supplier selection or designing and managing partnerships with key suppliers (lines 336-345). Participant #3 did not discuss the roles of the general director and the executive team, but this marketing director was at least aware of, or was involved in the company's procurement and innovation strategy.

Small business or entrepreneurial literature in general (Burns, 2001; Oakey, 2012: 26) stipulated the importance of the role of the owner. Similarly, this importance of the owner was confirmed by Ellegaard (2006: 273) on buying strategies in micro-companies, by Hagelaar *et al.* (2015) on key commodity procurement, and by Ozmen *et al.* (2014) on non-product related procurement. That participants would not perceive such activities as 'procurement activities' is also in line with Fisher (1970).

4.3.4 Company and Customer Strategies

Section §2.8 discussed literature on three company strategies and three customer strategies; Section §2.7 discussed literature on entrepreneurial orientation. This Subsection discusses these aspects with the five case companies.

GROWTH STRATEGY: Company #1 appeared a steady-going consultancy business. The other four companies had been or were growth-oriented. Company #2 was a new venture that was growth-oriented (lines 170, 285, 320) and sought business opportunities via suppliers with innovative building equipment or products (lines 210-230), and via partnering with subcontractors (lines 285-295). It mentioned that its growth was limited due to a lack of suitable subcontractors or staff. Company #3 was a manufacturer and pursued a long-term objective of being an innovative leader in precast lightweight concrete construction in his geographical market (greater Auckland). Company #4 displayed a similar behaviour. This participant #4 bought the company in 2000. After extensive market research (line 287) with an analysis of material prices (line 290) in 2009, the owner/participant saw opportunities to partner with an international material supplier and started a nation-wide franchise organisation. Participant #5 appeared committed to the company-objectives of developing and building aid-relief buildings. For 2-3 years he had dedicated considerable time and effort in convincing suppliers, regulators, and clients on the concept and necessary innovations. He was goal-driven: "People think I am absolutely eccentric and a complete idiot, but I've got to send a container!" (line 245). He seemed capable in building trust with regulators and in convincing suppliers of fitness-for-use of existing materials in a new application (e.g. roofing material used as flooring material, line 406). This contrasted with findings that New Zealand companies were often not considered as innovative or growth-oriented. (See §2.8.2).

DOMINANT CUSTOMER STRATEGY: Participant #3 mentioned: "we [constantly] look for development and things" (line 204). The company preferred reliability (line 346) and quality over lowest price from its suppliers: "we used a small supplier, not necessarily the best prices but as long as the quality was there" (line 16). It scanned the supplier market for new opportunities and innovations. This supplier strategy therefore matched with the product leadership strategy of Treacy & Wiersma (1995). Company #4 and its international material supplier cooperated to create and meet varying demands of franchisees and customers. This matched most with customer intimacy. Company #5 wanted supplier innovations that were simple and cost-effective, and could be installed and maintained with simple means and low skills. This matched with operational excellence. Finally, company #2 mostly matched with a product leadership strategy (Treacy & Wiersma, 1995).

ENTREPRENEURIAL ORIENTATION: The supplier strategies of company #3 has similarities with its customer strategies; this company could be seen as both opportunity-driven and

market-driven (Zortea-Johnson *et al.*, 2012). Participant #3 stated "the company wants to treat customers identical to suppliers" (lines 270-274). The material supplier of company #4 provided 80% of his procurement spend (line 507). The owner had a commercial background in sales (line 120) and stated: "As far as I am concerned my supplier [...] is just as important as my customers: they are equally important to us" (line 278). Companies #3 to #5 knew their suppliers and customer markets equally well, and they allowed or gave their suppliers a prominent role in innovations. This supplier prominence was in line with Koebel (2008) and Mlecnik (2013) that the construction industry was "supplier dominated" (Pavitt, 1984). In the above New Zealand study, Zortea-Johnsen *et al.* (2012: 157) indicated that more entrepreneurial companies (i.e. companies with a higher entrepreneurial orientation) were more likely to develop "market-driving innovations" (i.e. disruptive or radical innovations). Findings from the interviews showed that companies #3 to #5 gave their key suppliers a dominant role in realising such innovations. Cheng & Huizingh (2014) stated that an entrepreneurial orientation was "the best basis for open innovation", better than a market-orientation in which companies would focus on current customers. In conclusion: findings and literature both indicated an entrepreneurial orientation towards suppliers which (so far) had not been found in SME procurement literature. Findings suggested a positive relation between entrepreneurial orientation towards customers and towards suppliers, and also between entrepreneurial orientation and the role of innovative suppliers.

LONG-TERM: Findings in part showed a long-term perspective to suppliers. Company #3 started to develop lightweight panels in the early 2000's and still developed and improved its products (lines 161-164). In line with a long-term customer perspective, participant #3 favoured long-term and intensive relations with its key supplier: "you need give and take" (line 73). This key material supplier operated on facilities next to the premises of company #3 (line 35-45), which gave several benefits. Similarly, company #4 started his cooperation with his key supplier and franchisees in 2009. A long-term orientation on supplier relations in micro-firms was confirmed by Ellegaard (2008, 2009), in SMEs by Cambra-Fierro (2008), and in SMEs for critical goods and services by Paik (2011: 14). Tsai (2009) found that SMEs favoured long relations in open innovation. The micro-company #5 however reported it switched suppliers when necessary. (See also §4.5.3).

Section summary-conclusion:
5. *Companies from the sample varied from micro, to small, and medium-sized. Companies #3, #4 and #5 worked closely with a small number of permanent partners to overcome*

liabilities of smallness. In part the smaller companies worked with (international) suppliers that were much bigger.

6. *Participants had 10+ years of experience and had relevant university degrees. Indirectly. Literature showed a positive relation between relevant education levels and innovation or procurement performance.*

7. *Owners conducted strategic and in part also operational procurement activities and innovation activities with key suppliers. This was in line with findings from literature.*

8. *In contrast to average companies in the New Zealand construction industry, companies #2 to #5 were or had been growth-oriented with long-term objectives. Company #1 appeared to focus on business-continuity.*

9. *Companies #3 to #5 appeared to have similar entrepreneurial orientations to customers versus suppliers. They appreciated their suppliers and customers equally well, and they allowed or gave their suppliers a prominent role on innovations.*

10. *In line with SME procurement literature, companies #3 and #4 preferred long-term relations with their innovative key suppliers. For company #1 this was irrelevant; company #2 was probably too young to have developed such a preference.*

4.4 Discussing coding Results on Innovation-related Aspects

This Section presents results from coding the interviews on innovation aspects, notably on (1) product versus process innovations, (2) radical versus incremental innovations, and (3) innovation process phases.

4.4.1 Product versus process Innovations

Most innovations appeared to relate to supplier product innovations, although companies #3, #4 and #5 each also procured at least one innovative service from their suppliers. Such supplier product innovations could be sold as or transformed into product innovation for customers. Alternatively, such supplier product innovations could be adopted as or transformed into process innovations by offering a service to customers with those innovative products. For example, company #4 imported and then sold innovative products to its customers and to its franchise partners. Company #2 imported innovative products (lines 210-230) and used specialised contractors to provide innovative services (lines 285-295) with such innovative products.

Companies innovated with multiple parties. Company #3 collaborated on product innovations both with suppliers and customers. It also used government grants and universities. Company #4 collaborated on innovations with his key suppliers, architects, and franchise-partners. Company #5 mostly collaborated with suppliers and regulators (line 213-

233) for realising innovations. It involved suppliers in at least five product innovations[71] on specific functional aspects of a prefabricated container as an aid-relief building. The company struggled with obtaining regulatory (BRANZ) consent (lines 459-474) and took great effort to obtain such approval (lines 415-425). The participant was distrustful of green ranking systems (line 100-115). He used his professional experience in supplier discussions and for simple product testing (lines 240-245). He based his designs on a lifecycle approach with minimal installation or maintenance skills and with a focus on low total costs and low maintenance during the container life (e.g. lines 75-80). He remarked that lifecycle-thinking could be a good driver for construction innovations (line 110). For example Ozorhon *et al.* (2010) and Manley (2009) would agree. Finally, participant #5 indicated that the New Zealand construction industry was relatively slow in adopting lifecycle approaches. Extant literature (e.g. §2.3.5, §2.10) confirmed the use of multiple innovation partners to (co) develop product innovations.

Most of the respondents reported product innovations with their suppliers. Literature was however inconclusive whether companies would develop product versus process innovations with suppliers. Pries & Janszen (1995) and later Pries & Doree (2005; see §2.4), found that suppliers were an important source for construction innovations. However, Reichstein *et al.* (2008) found that suppliers were an important source for process innovations in construction (but were less important for product innovations). Reichstein *et al.* (ibid, 2008: 617) concluded that especially small construction companies relied on suppliers for such process innovations. It must be noted that companies #3 and #4 were manufacturers and that company #5 designed container units. Research by Inauen Schenker (2011) on open innovation found that manufacturing companies obtained product innovations with suppliers.

4.4.2 Radical versus incremental Innovations

The basis distinction between radical and incremental innovations relates to the extent of changes in linkages and in concepts. (§2.2.3). This varying level or innovativeness in industry practice is often called "newness" and potentially was an important variable because of the differing levels of risks and resources (Wheelwright & Clark, 1992; Pullen, 2010: 14). Related

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[71] Innovative concrete-less foundation system; new use of sprayed waterproof coating membrane on exterior parts of container, that can be repaired by applying new coating with a paint brush; insulated wall system; wall cladding; insulated roofing system; integrated flooring system with a prolonged life; modular stair system; integrated non-pollutive sewage system.

to open innovation, for example Ahn *et al.* (2015) suggested that SMEs preferred incremental innovations. Within the context of the New Zealand construction industry Page & Curtis (2013) and Fairweather (2009) said similarly. However, others such as Baumol (2002) concluded that technical breakthroughs were the "specific province of small firms" (cited in Hardie, 2011: 264).

Participant #1 generally confirmed (lines 255-258) the earlier assumption of this research (§2.2.3.2) that material suppliers, and not main or subcontractors introduced innovations into the industry. Companies #2 to #5 were engaged or had been engaged in both incremental and radical innovations[72]. The market introduction of the lightweight precast concrete by company #3 in the early 2000's was a radical product innovation. Participant #3 noted that the technology on lightweight panels was then available (lines 154-156) in Europe and in Asia. However, he additionally mentioned that his company was the only company that invested time and money to develop this innovation for the New Zealand market and with specific New Zealand raw material. Similarly, this participant considered that his company's recent product development on panels with higher insulation values (lines 170-175) also was a radical development for the New Zealand market.

Company #3 also developed more incremental innovations based on current technology or on earlier radical innovations: "it's an ongoing process" (line 162). Internal resistance could be an inhibitor for innovations. (Koebel, 2008). Participant #3 discussed an example with applying rubber molds to obtain surface textures in concrete slabs (lines 298-308) which helped to enter new markets segments. The use of molds was adopted after a suggestion from a supplier. However, the production department of company #3 initially opposed the use of such molds as these would complicate production, but later acknowledged advantages. Using a rubber mold to produce profiled panels seemed an incremental step, but the participant mentioned the large impact on the customer side. This participant also discussed the adoption of 3D-printing (lines 290-295) for modelling the panels as a process innovation, so that own production staff, suppliers and (prospective) customers obtained a better idea on what the finished panels would look like.

Company #4 procured innovative insulation material from an international material supplier. The company used this supplier to create New Zealand market demand. The international supplier offered advice (lines 441-444) to prospective customers of company

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[72] See §3.2.3 for the intersubjective perception of this innovation type.

#4 and to related stakeholders such as architects. Additionally, company #4 and his franchisees then installed the material for such customers. Company #4 hence established a business innovation (c.f. OECD 2005: 51) in partnering with the international material supplier and in establishing a franchise organization. Participant #4 said his major competitors worked more traditional. This approach was a more radical innovation and considered interests of all stakeholders. He commented on this success: "because I have read a lot and done some research and I can see" (line 118). The current focus in this company #4 seemed on product innovations. These were incremental by nature as company #4 competed in a "commoditized market" (line 74) with other material suppliers (line 84). Some minor innovations (improvements) could be called open source innovations (Huizingh, 2011) as company #4 shared technical company knowledge with stakeholders (customers, construction companies, architects) to drive the demand for the insulation products (lines 445-449; lines 460-470).

The following Table shows a selection of the innovations as discussed with the participants.

Table 41: Classification of part of the innovations discussed with the five companies (C#1 to C#5)

Innovation Type	Linkage Change	Concept Change	Examples from the participants' companies	Supplier role (Mlecnik, 2013)
Incre-mental	L	L	C#2: More efficient industrial cleaning devices or imported overseas materials. C#3: New Malaysian raw material supplier for precast company. Although this 2nd tier material-supplier switch needed high trust & material testing, it did not change relationships/linkages and brought no changes in functionality.	"can include all parties in the value chain"
Modular	L	H	C#3: Used profiled molds in precast lightweight concrete slabs. More esthetical for customers, and easier to apply than with on-site concrete casting. C#3: 3D printing for modelling. C#5: new use of waterproof coating membrane developed with supplier.	"new entrants or from parties that have control over module"
Architec-tural	H	L	C#3: redesigned supply lines by relocating a key material supplier on company #3 premises. C#4: Supplied glass-wool to licence partners and clients with international manufacturer who created demand in the market. (Business model innovation).	"general and specialty contractors"
System	H	H	C#1: innovations that needed to interface with other (sub)systems are harder to implement (lines 202-210). C#3: Highly-insulated pre-cast concrete slabs – used e.g. special plastic pellets. Needed alignment with construction company, architect, BRANZ consent, and new material / component suppliers. (Made extra insulation layer obsolete)	"suppliers that do not have a vested interest."
Radical (*see also footnote #68 below)	Very H	Very H	C#3: Development and introduction of lightweight precast panels in 2000. (The participant classified this as radical). C#5: Aid-relief container as the new use of this finished product needed new thinking, application of new technology (e.g.	"from outside and existing industry" companies used in-house and

Innovation Type	Linkage Change	Concept Change	Examples from the participants' companies	Supplier role (Mlecnik, 2013)
			foundation, flooring) and new relations between funding and consent authorities, and with aid-relief organisations. It could be argued that this container was a systems innovation, however the existing container had gained a new functional application by using five innovations in which suppliers played a role. The container had the potential to change the industry.	external research

The classification is based on Slaughter (2000, see §2.2.3.1) and distinguishes one type of incremental and four types of radical construction innovations[73]. The descriptions of the participants provided insights into the relation between the innovation types and suppliers which generally confirmed the Slaughter model. (Mlecnik, 2013: 87)

4.4.3 Innovation Process during the Idea, Develop or Business Phase

The five interviews did not discuss the classification model of §2.10.3 in detail. Companies #3 and #5 interacted with suppliers during the develop phase and the ongoing business phase[74]. Trading company #2 was too young for a profound comparison. It probably did not use innovative suppliers during the idea phase as it did not transform supplier innovations. Instead, it added value by applying the innovation in a service offering, of by selling the innovation. Data of company #4 gave no indications on use of suppliers during the innovation phases. The company had signed an agreement after the idea phase and then used the international key supplier for creating demand. Considering the performance, the scarce resources and the small size of company #5, it had to be effective (Spithoven *et al.*, 2013) and efficient (Laursen & Salter, 2006). The data indicated that company #5 used the same suppliers for the develop and for the business phase (e.g. lines 285-290). Company #5 operated with permanent partners during the business phase (information from company website). On the other hand, the intensity of its supplier relations could vary. (See also §4.5.1 and §4.5.3).

Lasagni (2012) suggested that SMEs used suppliers for generating ideas in early phases of open innovation processes, but were probably less open during the develop phase and then used less suppliers. This was not found in the company interviews. Findings from company

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[73] Somewhat confusingly, literature uses two notions for *radical innovations*. One is a radical innovation as generally opposed to an incremental innovation. Others distinguished several types of non-incremental innovations. In their view, a radical innovation is a particular non-incremental innovation with a disruptive or discontinuous nature that makes current solutions obsolete. Hence the Table at the following page shows four *types* of non-incremental innovations, only one of them being radical according to the definition of Slaughter (1998). (For a discussion, see §2.2.3).

[74] See §2.10.3.2 for business phase.

#4 could however confirm Hemert *et al.* (2013) who found that collaboration with innovative suppliers was more important during the develop phase versus the idea phase. The Slaughter model (§4.4.2) stated that supplier involvement for radical innovations started earlier than for incremental innovations. This was not discussed during the interviews.

> **NOTE:**
> The quantitative part of the empirical research (Chapter 5 – 8) did not further investigate the business phase, and instead focussed on the idea and develop phase.

Section summary-conclusion:

11. *Companies mostly procured supplier product innovations, which they then sold as or transformed into product innovations or as process innovations for their customers. Some literature stated that such companies would procure process innovations, other that such companies would procure product innovations from their suppliers.*
12. *Companies cooperated alone with suppliers, but also incorporated customers, partners, or regulators for developing supplier innovations. This was also found in literature.*
13. *Companies #2 to #5 were both involved in incremental innovations and in radical innovations. This was contrary to findings from literature and perhaps also to general sentiments or opinions that New Zealand construction companies were mainly involved with incremental innovations.*
14. *Companies #2 to #5 indicated that their suppliers played a dominant role in most innovations. This was in line with literature.*
15. *When findings on companies #2 to #5 were compared with the Slaughter model, this suggested that suppliers had different roles in incremental innovations versus radical innovations, and hence were managed differently. Participants however did not discuss such differences during the interviews.*
16. *The idea, develop, and business innovation phases were identified with the companies. Literature produced conflicting views, and interview findings only partly showed use of different suppliers during the separate phases.*

4.5 Discussing coding Results on Procurement & Supplier-related Aspects

This Section presents the results from coding the interviews on procurement and supplier-related aspects, notably (1) the intensity of supplier relations, (2) foreign versus domestic suppliers, (3) new versus current suppliers, (4) small versus large suppliers, and (5) the four procurement steps (specify-needs, find-select, negotiate-contract, manage suppliers).

4.5.1 Intensity of Supplier Relations

In this research, the notion of *relation intensity* (Wynstra, 1998) was the amount of effort and commitment (in time, money resources and risks) that buying companies and suppliers exerted in achieving innovation objectives (See §2.9.4). As mentioned in §4.3, the intensity of supplier relations in companies #2 to #5 varied. Interview findings (notably from companies #3 and #4) indicated that intensity in supplier relationships could positively affect company success.

For companies #2 to #5, the relation intensity matched the perceived risks or opportunities, which could be either financial or non-financial. For example company #5 had close relations with its key suppliers to reduce innovation risks; company #4 had close relations with the international material supplier to pursue opportunities; company #3 cooperated on logistics (planning & transport) and on problem solving. The intensity of such relations could be long-term (companies #3 and #4). However this could also be temporarily or project-based (company #5), and could additionally vary with radical or incremental innovations as participant #5 indicated. (See also §4.3.4).

Furthermore, the supplier intensity appeared to relate to the experience the companies had with their suppliers, and to the amount of trust[75] companies had in their suppliers. As discussed in §4.3.1, company #3 had a close relation with his concrete supplier "virtually one organization" (line 46). It had built trust, and this again had enabled both companies to benefit from the relation. This trust was noticeable in the manner how company #3 allowed this key supplier to switch a raw material supplier in Malaysia (lines 140-146). Participant #3 (line 51) was aware that this type of intensive and long-lasting cooperation was quite rare in the New Zealand construction industry. He stated that the relationship had gradually grown as "it just happened" (line 55). The formation of this relationship could be called adaptive (Dess *et al.*, 1997), and could be in line (§3.4) with the effectuation theory (Sarasvathy, 2001) or entrepreneurship theory (Shane & Venkataram, 2000). (See §3.4).

Lee *et al.* (2010) and Urbina-Criado (2012) suggested that large SMEs had more intense relations for inbound open innovation than small SMEs. Contrarily, Spithoven *et al.* (2013) found that SMEs were more effective and could benefit more from relations in open innovations than large companies. Moreover, Tsai (2009) distinguished between *partners* for long-term value creation and *suppliers* for providing technical solutions or process innovations. (The key suppliers of companies #3 and #4 could be classified as partners).

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[75] See definition in §2.9.5.

Skiffington *et al.* (2013: 130) stated that New Zealand printing SMEs were able to remotely manage Asian suppliers and develop long-term relations by using short-term contracts. Ahn *et al.* (2015) additionally saw a positive relationship between intensity in relations and performance. This was confirmed for companies #3 and #4. Laursen & Salter (2006) however cautioned and described an optimum between the two variables with an inverted U shape. (Compare §4.3.2 on education levels).

Comparing size aspects, the relatively large company #3 showed similar intensity in supplier relations as the small company #4. The micro company #5 seemed to be pragmatic with the intensity of relations – probably because of the resource constraints within this company.

4.5.2 Foreign versus domestic Suppliers

Findings indicated that companies #2 to #5 exhibited varying preferences for foreign versus domestic innovative suppliers.

Company #2 actively searched and selected overseas companies for innovative products and systems. It used the Internet to identify foreign innovations that were not available on the New Zealand market. The interview did not reveal insights on criteria for supplier or product assessments.

Participant #3 was outspoken over foreign suppliers: "the problem with sourcing internationally is that you do not know what sort of quality you get" (lines 128-129). Most of the specialist raw material of company #3 came from Europe (line 567). This company sourced from Europe when there was no local alternative (line 228). In another example, the company did not proactively select a specific European material (line 218), but it used European materials when these were imported via New Zealand distributors. Overall, company #3 preferred a local source it could trust. At the same time, it allowed its local key material supplier to source in Malaysia, "from a quality manufacturer offshore" (line 134). In similar words, it described the 2nd tier supplier in Malaysia as "a reputable company". Industry knowledge and relations for foreign sourcing was essential as the interview excerpt below shows. (Lines 141-153. A=interviewer; P=interview participant).

A: So, you source this product locally here in New Zealand - but at the same time your company allows its key suppliers to switch supplier and source clinker material in Malaysia...
P: But they source from a reputable company.
A: OK. That is the difference. You know they are reputable.
P: It is a large cement manufacturer based in I think in Malaysia.
A: OK. How then do you determine whether it is a reputable company, whether you can trust that company? Is that just industry knowledge?
P: Oh yes, definitely.
A: That is past experience or information from a competitor etc.
P: It is not a very big industry.
A: Everyone knows each other I guess.
P: Yes.

Figure 33: Foreign versus local supplier (Excerpt from transcript company #3, lines 141-153)

Company #4 purposely partnered with a major international material supplier to meet its company objectives. However, company #4 also preferred a local raw material supplier for its recycled sheep's wool insulation. In this, it would rather not use an overseas supplier although they were available (lines 162-165). This local preference seemed related to the eco-product branding and marketing purposes (line 174).

Participant #5 did not explicitly distinguish between foreign versus domestic suppliers although he mentioned that some of his innovative suppliers either worked internationally or imported existing innovative products into New Zealand. He used suppliers for product applications that were new to the New Zealand market or new for their functional applications. Considering this company had to collaborate with suppliers and used intense relationships (cf. §4.5.1), it could be argued that company #5 preferred domestic suppliers with an international background both during the idea and the develop phase.

Participant #2 commented on the adoption drivers of the New Zealand construction industry compared to other industries (lines 95-125). He gave as an example how multinationals started production subsidiaries in other countries. Such local subsidiaries would then often use the multinational's existing supply base. In this way, the supply base also exported innovations to those countries which would stimulate the adoption of innovations. Participant #2 stated that New Zealand lacked such international (manufacturing) companies with local production facilities, and therefore New Zealand could also lack a network of international supply companies bringing innovations into the local industry. Likewise, participant #2 stated that only a limited number of New Zealand companies had overseas production facilities and therefore did not benefit from interacting with overseas supply networks[76].

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[76] Participant #2 felt this could explain low adoption of foreign construction innovations in New Zealand.

Extant literature was unclear on whether SMEs would prefer foreign or domestic suppliers. Agndal (2006) stated that (Danish) SMEs were more reactive than pro-active in international sourcing. Contrarily Overby & Servais (2005) concluded that SMEs (up to 500 staff) in Denmark were "highly import intensive". In a related study two years later, Knudsen & Servais (2007) found that Danish SMEs considered building strong ties and trust as important. Scully & Fawcett (1994) also found that US SMEs (up till 500 staff) conduct international sourcing, although they found that large companies had higher levels of international sourcing. In a New Zealand case study, Canham & Hamilton (2013) found that both strategies can be successful for SMEs. However, the SME procurement literature did not discuss foreign versus domestic sourcing for innovations. From an open innovation perspective, Dahlander & Gann (2010) found that SMEs prefer simple open innovation transactions as they are limited in resources and have limited control over supplier networks.

Generally however, inbound innovation literature implied that looking for new innovations (sourcing) can be done both domestically and internationally. Although technology and globalisation have made foreign sourcing easier, sourcing from a foreign supplier still has higher risk levels due to logistical distances, culture, currency fluctuations (Johnson *et al.*, 2013: 148). From a survey of 3,540 Danish manufacturing SMEs, Esbjerg *et al.* (2012) suggested that most Danish SMEs use a closed innovation approach; a minority of Danish SMEs used a wide range of information sources (e.g. the Internet, trade fairs or shows, trade organisations, procurement, or licensing R&D results, cooperate with lead users). This could also apply to the situation in New Zealand especially with the long (thin) supply lines from overseas. Findings confirmed the varying preferences from literature.

4.5.3 New versus Current Suppliers

Participant #3 stated it was loyal to its innovative (and non-innovative) suppliers: "we don't change [suppliers] a lot" (line 320). The participant stated it needed to switch when material quality or reliability became in-adequate and when the supplier's efforts to correct this were too low (lines 485-520). As discussed earlier, the exception with this company #3 was the key cement supplier: company #3 allowed this supplier to switch its Malaysian 2nd tier raw material supplier for a cheaper source. All new material would be tested though, and this new 2nd tier supplier was considered "a reputable company" (lines 140-146).

It could be assumed that company #3 would also benefit from this cheaper source of raw material. Nevertheless, the company stated that costs were less important (line 24). It would not always switch when potential suppliers were soliciting for sales. However it had switched chemical additive suppliers (line 248) "a couple of times". The participant thought that European companies would switch their suppliers or their customers quicker (line 568).

Company #2 was too young to discuss switching suppliers. Participant #4 did not discuss switching existing suppliers for new suppliers. Participant #5 indicated it worked closely together with suppliers on a project base, but at the same time would switch when his suppliers were unable to give warranties or to develop innovations.

These findings indicated that the case companies were loyal to their innovative suppliers. This was in line with literature on SME procurement (e.g. Ellegaard, 2009, Mosselman & Kemp, 2005; Marchesnay & Julie, 2007; Hagelaar *et al.*, 2014; cf. §2.9.1). However, that SME procurement literature did not discuss whether SMEs would switch suppliers when developing innovations. Findings confirmed the varying preferences in literature. Lasagni (2012) suggested that SMEs would prefer a new supplier when they wanted to reduce costs or accelerate innovations processes. In this context, Johnsen *et al.* (2011) suggested that SMEs would use new suppliers for radical innovations and current suppliers for current innovations.

4.5.4 Small versus large Suppliers

The effect of small versus large suppliers was notably discussed with participant #3. The participant stated with several examples that small suppliers were more loyal and tried to correct mistakes. "Because small suppliers look after you more. They have all your business." (line 18). "[They will] not necessarily have the best price but as long the quality was there" (lines 14-16). The participant mentioned a small supplier that "gives us the service you would not believe (line 386). Several small suppliers of company #3 had grown in size with the company itself. Sometimes relationships were still good, sometimes they deteriorated. Participant #3 stated that one of its large suppliers tended to use legal measures for limiting liability (lines 510-520). It also mentioned that when a small supplier grew in size, the personal relation with this large supplier was then still important for keeping performance on a satisfactory level (lines 525-535): "the guy has coffee with us twice a week". This supplier also sold to competitors but "they tend to look after us".

As discussed earlier, company #4 had explicitly selected a large international supplier for his insulation material (line 76). Company #5 used large international suppliers to get access to technology and proven material but used small suppliers for contracting services.

Some literature suggested that SMEs preferred small suppliers over large suppliers for better collaboration (e.g. Morrissey & Pittaway, 2006) because of the "adversarial practice" of large suppliers. New Zealand SMEs depend on suppliers for construction innovations (Pries & Janszen, 1995; Pavitt, 1980). In the New Zealand context, overseas innovations would probably come from (large) wholesale-distribution companies, or from local branches of large multinationals.

4.5.5 Procurement steps (specify; find-select; negotiate-contract; manage-relations)

The participants recognised the four procurement steps from the model. (Cf. §2.4.2; §2.10.3). In this Chapter so far, participants mentioned several examples of practices related to these steps. Within the context of the companies, such practices were logical. The following Table presents examples on procurement practices for each of the four procurement steps.

Table 42: Examples of practices in the four procurement steps taken from the interviews[77]

Specify-needs	C#1: Client and main contractor focus on lowest costs (lines 75-79; line 215); should focus more on lifecycle costs as a driver for innovations (lines 97-110) C#3 Quality and reliability are more important than costs (lines 24; 345-350) C#5 Need products that have high quality, low cost, easy to install and to maintain (lines 245-260)
Find-select suppliers	C#1: Select main and subcontractors on lowest costs (lines 72-80). Most domestic suppliers are monopoly suppliers and not interested in innovation and hence innovative companies need overseas suppliers, but these are riskier and can bring BRANZ consent issues. (lines 120-130) C#2 Costs are important, but relationships for selecting suppliers are also important (lines 173-175) Use the Internet to find overseas products or suppliers (lines 252-268) C#3 Overseas supplier when necessary, but prefer local suppliers as they are less risky (lines 128-140) Switch suppliers when necessary. Industry knowledge to select the right (international) supplier is important (line 148) Do not yet use BIM but hire specialists or extra staff to quickly respond to tenders (line 450) C#5 Because of liability risks, suppliers are hesitant for new applications of existing products (line 410, 520)
Negotiate-contract	C#1 Negotiate on lowest price, and then also demand a discount (lines 215-250) Protect innovations with patents (lines 280-295) C#3 Negotiate on price with innovative supplier (lines 227)

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[77] C#1 means company #1; etc.

	Use emails and brief contracts instead of long formal contracts (line 385; lines 505-510) Long-term relations bring benefits (line 340) C#4 Logistics and distribution contract with international supplier (line 455) C#5 Supplier needs to give warrants for fitness of use on parts they provide, otherwise switch suppliers (lines 525-545) Need suppliers for innovations (line 714)
Manage supplier relations	C#1: Adverse relation and mistrust between suppliers and buying organisations (specifically sub and main contractors) (lines 58-63). Need a normal relation between sub and main contractor to stimulate innovations (Lines 64-65). C#2 Suppliers (subcontractors) unable to deliver due to lack of skills (lines 286-296) C#3 Use a trading account with a material supplier for easy call-offs (lines 190) Large suppliers are more likely to use legal measures (lines 488-518); small suppliers are more loyal (lines 15-20). C#4 Collaboration with international manufacturing supplier to create demand for innovative product (line 263).

The Table shows the variety in practices which also were logical within the company contexts. These partially and indirectly confirmed the selected 4x9 procurement practices of the four procurement steps (§2.11.2).

Section summary-conclusion:
17. *Findings indicated that intensity of supplier relations in companies #2 to #5 varied and could depend on their company size (resources available), phase of the innovation process, supplier risks & opportunities, trust, and past experiences.*
18. *Findings suggested a positive relation between supplier relation intensity and performance.*
19. *The case companies appeared to have varying preferences for foreign versus domestic suppliers. Findings fragmentary indicated that having foreign or domestic suppliers could affect procurement activities, and procurement or innovation performance. Literature suggested that both strategies could have advantages and disadvantages*
20. *Company #3 indicated it was loyal to existing suppliers but would switch for financial, quality or reliability reasons. Company #5 closely collaborated with suppliers but would switch when suppliers proved unable to develop innovations or give warranties. Literature suggested that SMEs would be loyal to their suppliers, unless they wanted to reduce costs or accelerate innovations. Hence two participants confirmed the literature on this aspect.*
21. *The interview data and the literature revealed a mixed preference on supplier size. Companies either preferred small (local) suppliers as these were more loyal and provided better services. However they preferred large multinational suppliers or their local representatives or distribution companies to get access to overseas innovations.*
22. *The companies applied procurement practices that were logical within their contexts. The interview structure did not allow for an exhaustive enquiry to procurement practices, nor for exploring in-depth relations between such practices in specific company contexts.*
23. *Findings partially and indirectly validated the selected 4x9 procurement practices.*

4.6 Discussing coding Results on Performance-Aspects

The participants discussed performance objectives (drivers) both on a general company level and on the level of specific procurement or innovation activities. (Cf. §2.12).

Participant #1 mentioned the general ability for subcontractors to generate new contracts with their main contractors, often with a sharp focus on low costs and less on innovations (lines 72-80; 220-231). The young company #2 was growth-oriented and its objectives were to introduce new innovations and use more subcontractors to realize growth. The objectives of company #3 seemed a strategy of steady improvements and innovations to remain a product leader in the pre-cast industry. Company #4 was built with a long-term perspective on a business innovation with a major international supplier and with franchisees which enabled this company to become number two or three in the market (lines 260-262). Finally, company #5 earned its primary income from off-the-grid homes and seemed altruistic in its objective to develop aid-relief containers. He pursued an innovation and business-development strategy.

According to participant #1, New Zealand material suppliers had a monopoly position, were not innovative and enjoyed good profits (lines 119-123). This was in line with Koebel (2008). Participants #2 to #5 explicitly referred to environmental benefits of their innovations.

On a more specific level, the case companies described performance in terms of successful supplier management and supplier innovations.

Section summary-conclusion:
24. *In line with extant literature, the case companies appeared to define their company objectives and performance differently. On a more specific level, companies could relate company performance to successful supplier management and supplier innovations.*
25. *Performance seemed to depend on several variables. However, the interviews did not discuss a direct relationship of activities, context, and performance.*

4.7 Chapter Summary

This Chapter aimed to answer the following empirical research question:

(RQ4) To what extent did exploratory interviews in five New Zealand companies on how they managed innovative suppliers in construction supply chains increase the understanding of the research domain, and confirm the variables and conceptual model II from Chapter 2?

Interview findings were classified with conceptual model II and related to extant literature. The following Table summarised the constructs of variables & practices from the 24 Section summary-conclusions of this Chapter.

Table 43: Summary table from exploratory interviews per variable construct

Company-related aspects	Company size did not seem to matter on innovative behaviour with suppliers: both small and large companies could partner for strategic reasons. Participants had 10+ years of relevant experience. Owners conducted operational and strategic procurement and innovation activities with (key) innovative suppliers. Three companies (3/5) seemed growth-oriented with long-term objectives. They also exhibited similar levels of entrepreneurial orientations towards customers and suppliers. They preferred long-term relations with key innovative suppliers and gave these suppliers a prominent innovation role.
Innovation-related aspects	Companies mostly procured product innovations. They used suppliers alone or in combination with customers, partners or regulators. Companies were involved in incremental and in radical innovations with their suppliers. Findings confirmed the different phases of idea and development. Findings could not confirm whether suppliers had different roles with the different innovation types.
Procurement and supplier-related aspects	Intensity of supplier relations varied, probably with company size (resources), phase of the innovation process, supplier risks & opportunities, trust, and past experiences. Findings indicated a positive relation of intensity with performance. Companies showed varying preferences for foreign versus domestic suppliers; Companies were loyal to existing suppliers, provided they could further innovations or reduce costs. Companies either preferred small suppliers for their loyalty or large suppliers to get access to overseas innovative products. Depending on the context, companies used a variety of procurement practices.
Performance aspects	Companies seemed to have different company objectives and performance. Performance seemed to depend on several variables, was related to successful supplier management and supplier innovations, and to benefits for the environment.

The interviews generally validated conceptual model II. Conclusions from the interviews are discussed in §9.2.

Chapter 5 discusses descriptive statistics from Survey I.

Chapter 5

Survey I:

Getting a Feel for the Data

*The art of data analysis usually lies in finding
the most useful and appropriate comparisons to make.
J. MacInnes (2016: 254).*

Chapter 5

Survey I: Getting a Feel for the Data

This Chapter discusses descriptive and some inferential statistics on independent company variables (§5.1), mediating procurement management variables (§5.2), and dependent procurement performance variables (§5.3). (See below). It ends with a summary (§5.4).
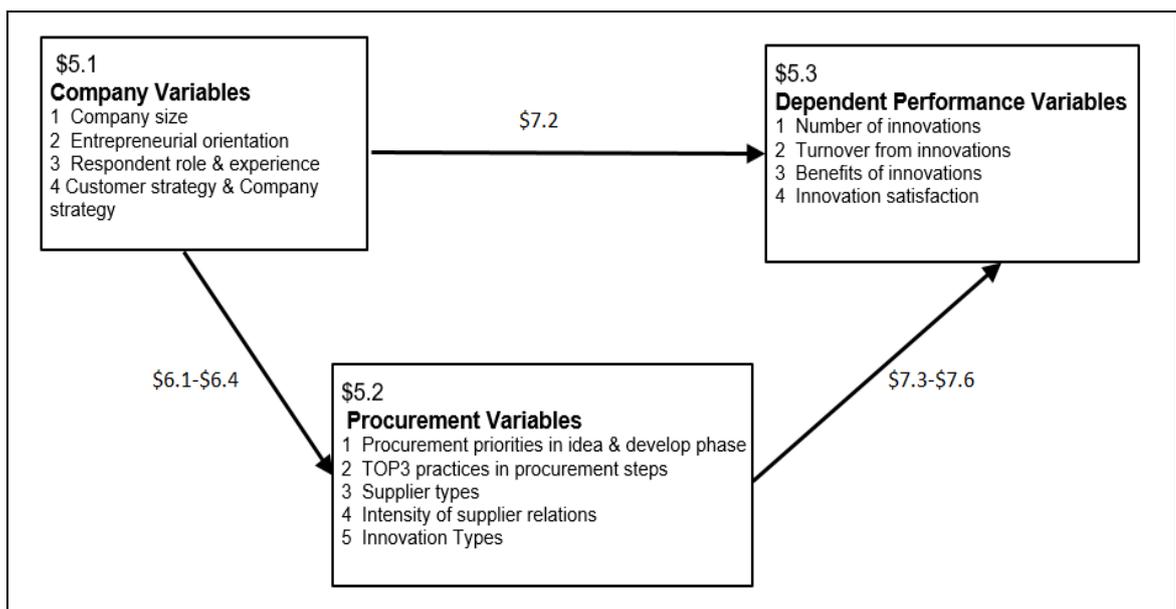
Figure 34: Conceptual model II with independent company variables (Copy §2.13; §3.5)

The Chapter forms the basis for the inferential Chapters 6, 7 and 8. It aimed to answer the following empirical research question with five sub-questions.

(RQ5) What variables & practices did respondents report, what was the profile of the case companies, and to what extent did these companies represent the target-population?

a. *What were company variables of New Zealand companies that managed innovative suppliers in construction supply chains?*

b. *What were procurement management variables & practices of New Zealand companies that managed innovative suppliers in construction supply chains?*

c. What were procurement performance variables of New Zealand companies that managed innovative suppliers in construction supply chains?

d. What was the profile of the survey respondents and case companies?

e. To what extent did respondents and the case companies represent the target-population? (See the high-level Hypotheses H1, H2, H3 in the following three sections).

NOTE:
Any statistical significance did not necessarily relate to significance in managerial practice. For once, the research could not analyse all possible (complex) statistical relations due to limitations in sample size, homogeneity or variety of the sample, and limitations in the survey and hence data structure. Moreover the research had to apply broad conceptual models, ignoring effects from mediating or multiple variables. And finally, the response N=112 rendered it useless to calculate size effects (Sullivan & Feinn, 2012: 217). (See also Chapter 6).

Section summary-conclusion:

1. Chapter 5 discusses descriptive and some inferential statistics on the three main types of variables from conceptual model II.

5.1 Descriptives on Independent Company Variables

This Section[78] discusses the independent company variables from Conceptual Model II. The objective of this Section was to increase the understanding of companies in New Zealand construction supply chains that managed innovative suppliers. It discusses the following high=level hypothesis which relates survey findings to the companies in the target-population (§3.1.3).

H1: The company variable data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

5.1.1 Company Size (Q21)

The distribution of the company size in the sample is shown in the Table and pie chart below. (Based on N=112). The average company size in New Zealand construction supply chains is quite small: approximately 87% of all companies have <10 staff (see §2.6.1; MBIE, 2013a: 14, 48). As mentioned earlier, this survey *non-randomly* targeted both large and SMEs. According to Survey I, 27% of respondents worked in companies with <10 staff.

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[78] In Chapter 5 – 7, the Sub-section titles include the survey question numbers.

Consequently, the distribution of company size in the dataset was not representative for the overall distribution of companies in New Zealand construction supply chains. However, due to lack of comparable company size data on companies *managing innovative suppliers*, it remained unclear to what extent the data were representative for the target-population.

Company size in classes

		Frequency	Percent
Valid	employees: 0 - 4	18	16,1
	employees: 5 - 9	12	10,7
	employees: 10 - 19	10	8,9
	employees: 20 - 99	24	21,4
	employees: 100-249	10	8,9
	employees: 250-499	10	8,9
	employees: above 499	25	22,3
	Total	109	97,3
Missing	System	3	2,7
Total		112	100,0
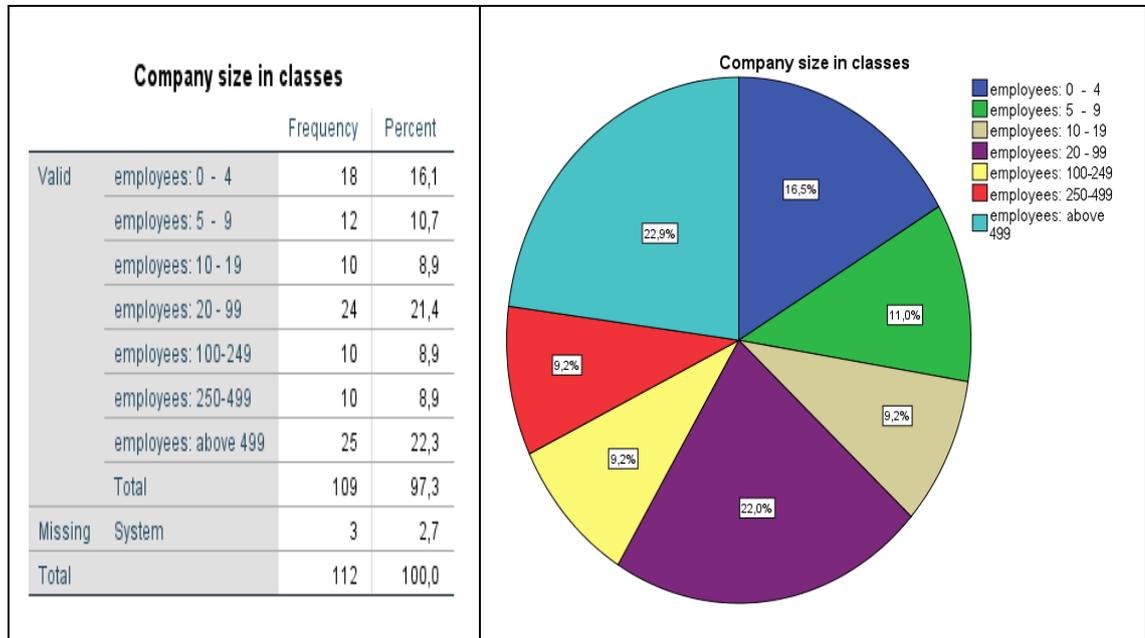
Figure 35: *Left* company size in seven classes. *Right* pie chart with respondent percentages

Section summary-conclusion:

2. *The sample contained a relatively large percentage of large companies. The company size distribution was not representative for the total construction industry. Based on company size data, it remained unclear to what extent the data were representative for the target-population.*

NOTE:
1. The research used a Dutch version of SPSS version 23. Therefore the SPSS tables show decimals numbers with a decimal comma instead of a decimal point.
2. The research for this Section à priori posited (§3.1.3; §3.6.4)) that focal companies need NOT exhibit innovative or entrepreneurial traits when they managed innovative suppliers.
3. Findings from Survey I however indicated (see §5.2.5, §5.3.1) that the case companies were innovative relative to the New Zealand population.

5.1.2 Entrepreneurial Orientation to innovative Customers & Suppliers (Q7)

The construct of entrepreneurial orientation in Survey I was based on Lumpkin & Dess (1996) amended with a trust variable (§2.7.1; §2.95).

The construct consisted of the 2x5 paired-variables as shown in the following Table. The means and standard deviations within the five variable-pairs showed that companies were

similarly (3/5) entrepreneurial[79] towards their innovative customers and towards their innovative suppliers. Respondents gave highest priorities to trust, and lowest priorities to aggressiveness in customer or in supplier markets.

As the data were non-normally distributed, a Wilcoxon signed-ranks test was used to explore significance[80]. (Table 46 below). Significant differences within variable-pairs was confirmed for innovating activities with innovative customers versus activities with innovative suppliers. Similarly, this was confirmed for trust with innovative customers versus with innovative suppliers.

Table 44: Descriptive statistics five entrepreneurial orientation variable-pairs (not recoded)[81]

Descriptive Statistics

	N	Mean	Std. Deviation	Variance
Innovating activities with Innovative Customers	110	2,03	,943	,889
Innovating activities with Innovative Suppliers	108	1,83	,779	,607
Risk taking towards Innovative Customers	107	2,55	1,021	1,042
Risk taking towards Innovative Suppliers	106	2,36	,917	,842
Opportunities with Innovative Customers	107	1,97	1,014	1,028
Opportunities with Innovative Suppliers	107	1,99	,783	,613
Aggressiveness in Customer Markets	108	2,90	1,215	1,476
Aggressiveness in Supplier Markets	108	2,96	1,110	1,232
Trust with innovative Customers	108	1,50	,791	,626
Trust with innovative Suppliers	109	1,35	,516	,266
Valid N (listwise)	105			

Table 45: Significance levels entrepreneurial orientation innovative customers versus suppliers

Test Statistics[a]

	Innovating activities with Innovative Suppliers - Innovating activities with Innovative Customers	Risk taking towards Innovative Suppliers - Risk taking towards Innovative Customers	Opportunities with Innovative Suppliers - Opportunities with Innovative Customers	Aggressiveness in Supplier Markets - Aggressiveness in Customer Markets	Trust with innovative Suppliers - Trust with innovative Customers
Z	-1,996[b]	-1,771[b]	-,152[c]	-,819[c]	-2,170[b]
Asymp. Sig. (2-tailed)	,046	,077	,880	,413	,030

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.
c. Based on negative ranks.

 The research then used bivariate correlations to further analyse differences and similarities of entrepreneurial orientation within the customer variable pair and within the suppliers

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[79] Notations as 3/5 mean that 3 out of 5 instances were entrepreneurial. Similar for 2/3, 4/5 3/5, etc.
[80] Assuming normality, a Paired Samples t-test gave similar results.
[81] Scale: 1 very important, 2 important, 3 moderately important, 4 not important, or 5 not important at all.

variable pair. The below two Tables revealed significant Spearman correlations (indicated in
yellow) at the p≤.01 and *p*≤.05 levels.

The Table below on the *customer* variable pairs indicates that especially innovating activities
correlated moderately (Cramer & Howitt, 2004: 39) with three other customer
entrepreneurial orientation variables. Aggressiveness in customer markets only weakly
correlated with one other customer variable. *Except for the aggressiveness variable, it could
be concluded that respondents who mentioned an entrepreneurial orientation on one
customer variable, also had moderate orientation on the other customer variables.*

Table 46: Spearman correlations for the five *customer* variables

		Innovating activities with Innovative Customers	Risk taking towards Innovative Customers	Opportunities with Innovative Customers	Aggressiveness in Customer Markets	Trust with innovative Customers
Correlations						
Innovating activities with Innovative Customers	Correlation Coefficient	1,000	,319**	,647**	-,040	,376**
	Sig. (2-tailed)	.	,001	,000	,681	,000
	N	110	107	107	108	108
Risk taking towards Innovative Customers	Correlation Coefficient	,319**	1,000	,085	,216*	,062
	Sig. (2-tailed)	,001	.	,386	,026	,523
	N	107	107	106	106	107
Opportunities with Innovative Customers	Correlation Coefficient	,647**	,085	1,000	-,103	,520**
	Sig. (2-tailed)	,000	,386	.	,290	,000
	N	107	106	107	107	107
Aggressiveness in Customer Markets	Correlation Coefficient	-,040	,216*	-,103	1,000	,032
	Sig. (2-tailed)	,681	,026	,290	.	,744
	N	108	106	107	108	107
Trust with innovative Customers	Correlation Coefficient	,376**	,062	,520**	,032	1,000
	Sig. (2-tailed)	,000	,523	,000	,744	.
	N	108	107	107	107	108

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

The Table below on the *supplier* variable pairs indicates that especially innovating activities
correlated moderately (though somewhat less strongly) with three other supplier variables.
(Cramer & Howitt, ibid)

Aggressiveness in supplier markets did not significantly correlate with another supplier
variable. Aggressiveness also scored lowest of all ten variables (Table 46). Consequently
when entrepreneurial, companies would not probably be aggressive towards supplier
markets. The two Tables suggest that aggressiveness would not fit with entrepreneurial
orientation. Nevertheless to a limited degree aggressiveness could fit with risk-taking with
innovative customers*.*

Except again for aggressiveness, it could be concluded that respondents who had an entrepreneurial orientation on one supplier variable, had weak-to-moderate orientation on the other supplier variables.

The two Tables also demonstrated the internal validity of the entrepreneurial orientation for the customer and for supplier variables.

Table 47: Spearman correlations for the five *supplier* variables

		Innovating activities with Innovative Suppliers	Risk taking towards Innovative Suppliers	Opportunities with Innovative Suppliers	Aggressiveness in Supplier Markets	Trust with innovative Suppliers
Correlations						
Innovating activities with Innovative Suppliers	Correlation Coefficient	1,000	,210*	,584**	-,072	,397**
	Sig. (2-tailed)	.	,031	,000	,461	,000
	N	108	106	107	108	108
Risk taking towards Innovative Suppliers	Correlation Coefficient	,210*	1,000	,283**	,136	,208*
	Sig. (2-tailed)	,031	.	,003	,164	,033
	N	106	106	106	106	106
Opportunities with Innovative Suppliers	Correlation Coefficient	,584**	,283**	1,000	,057	,441**
	Sig. (2-tailed)	,000	,003	.	,556	,000
	N	107	106	107	107	107
Aggressiveness in Supplier Markets	Correlation Coefficient	-,072	,136	,057	1,000	-,057
	Sig. (2-tailed)	,461	,164	,556	.	,559
	N	108	106	107	108	108
Trust with innovative Suppliers	Correlation Coefficient	,397**	,208*	,441**	-,057	1,000
	Sig. (2-tailed)	,000	,033	,000	,559	.
	N	108	106	107	108	109

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

A Principal Component Analysis (PCA) could help to further analyse reliability and internal validity of the entrepreneurial constructs for innovative customers and for innovative suppliers. A simple PCA explained a relatively high percentage of variances[82] on the two individual variable pairs and on the combined variable pair. A cautious conclusion from the PCA was that the variable pairs separately and combined were internally consistent.

Additionally, a factor analysis (Table below) confirmed that three components together loaded to an acceptable degree (*N*=105; KMO .611; total variance explained 71.9%; Field, 2009). A factor analysis forcing two components would combine risk-taking and aggressiveness. However, it would not produce a clear distinction as it would see risk-taking also loading on the other variables. Hence a minimum of a three-component factor analysis was preferred. Component 1 loaded on the variables pairs opportunities, innovating and

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[82] The PCA was conducted on the five customer variables with a varimax. This resulted in KMO=.639. For two components this explained 70.2% of variance. A similar PCA on the five supplier variables with a varimax resulted in KMO=.683, with $p \le .001$. For two components, this explained 64.8% of variance. A PCA with both the five supplier and the five customer variables gave a KMO=.611. Four components explained 77.4% of variances.

trust. This component 1 could collectively be termed cooperation. Component 2 loaded on the variable-pair aggressive behaviour, and component 3 loaded on the variable-pair risk-taking. (See the rotated rescaled component in the following Table). These findings would indicate that companies that behaved entrepreneurial in one or more variables towards suppliers or towards customers need not behave entrepreneurial towards suppliers or towards customers on other variables It could be concluded that such companies would not have an 'overall entrepreneurial profile'. Hence, they would not be recognised straightforward as being entrepreneurial. This was opposed to the unidimensional view of e.g. Covin & Slevin (1989) and Wiklund & Shepard (2003), but was in line with findings on a multidimensional approach by Gupta et al. (2014) and Schueler et al. (2018)[83].

Table 48: Rotated component matrix from a factor analysis showing three components

Rotated Component Matrix[a]

	Raw Component			Rescaled Component		
	1	2	3	1	2	3
Opportunities with Innovative Customers	,898			,885		
Innovating activities with Innovative Customers	,763			,807		
Trust with innovative Customers	,594			,744		
Innovating activities with Innovative Suppliers	,525			,676		
Opportunities with Innovative Suppliers	,449			,572		
Trust with innovative Suppliers	,245			,470		
Aggressiveness in Supplier Markets		1,033			,925	
Aggressiveness in Customer Markets		1,108	,247		,917	,204
Risk taking towards Innovative Customers			,936			,918
Risk taking towards Innovative Suppliers			,733			,803

Extraction Method: Principal Component Analysis.
Rotation Method: Quartimax with Kaiser Normalization.
a. Rotation converged in 4 iterations.

Finally, Cronbach's α tests[84] indicated that the internal consistency for the entrepreneurial orientation variables on innovative customers and for entrepreneurial orientation variables on innovative suppliers were both acceptable. The PCA had already shown that two aggressiveness variables could be negatively correlated with the other variables. When

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[83] For a discussion, see Franz (2018:22-25).

[84] Testing for internal consistency with Cronbach α gave the following results. Cronbach α=.610 for the construct with five customer variables, which was above α=.60 and was acceptable according to Malhotra & Birks (2000: 307). Nevertheless, Cramer & Howitt (2004: 79) would recommend a value of α >.750. Deleting the variable on aggressiveness to customer markets increased α to α=.727.
For the construct with the five suppliers variables, Cronbach α was lower: α=.521. Again deleting aggressiveness to supplier markets increased it to α=.668.
The combination of both constructs (without the aggressiveness variables) gave an α=.642.

these two variables were omitted, a combination of both constructs produced an acceptable α=.642 (Malhotra & Birks (2000: 307). This also confirmed that both entrepreneurial orientation constructs were consistent, i.e. could measure entrepreneurial orientation towards innovative customers as well as towards innovative suppliers. This confirmed that the variable pairs could be used to assess entrepreneurial orientations towards customers and towards suppliers

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NOTES:
1. The factor analysis was conducted with *N*=105 as sample size. For example Adams (2005: 112) and De Waal (2011: 103) conducted factor analyses with similar samples sizes. However, the sample size in this research was smaller than the minimum *N*=300 as e.g. recommended by Field (2009: 647), and most of the variables were not approximately normally distributed. Therefore factor analysis results should be treated with caution.
2. Initially, variables from the survey as discussed in this Subsection had been designed with a 5–point Likert-type scale. To increase validity for further testing in the remaining part of Chapters 5, 6 and 7, these scales were dichotomous into two classes: high entrepreneurial orientation (1=very important) and low entrepreneurial orientation (3=moderately important, 4=not important, or 5=not important at all). To decrease the risk of outliers, the middle group of "2=important" was not used in the recoded version[85].

Section summary-conclusion:

3. *Entrepreneurial orientation to innovative customers and innovative suppliers were similar on 3/5 variables. Entrepreneurial orientation (2/5) to innovative suppliers were significantly more important for trust and innovating activities, than to innovative customers.*
4. *Trust with innovative customers or suppliers was seen as most important, then innovating activities, and then opportunities with innovative customers or innovative suppliers. Risk-taking and especially aggressiveness towards innovative customers or innovative suppliers were seen as least important.*
5. *Aggressiveness correlated weakest with the other variables; innovating activities highest.*
6. *Except for aggressiveness, respondents who reported entrepreneurial orientation on one variable towards customers (or likewise to suppliers), could also have moderate orientation for the other variables towards customers (or likewise to suppliers).*
7. *A correlation analysis confirmed consistency for the customer variable pairs and the supplier variable pairs. A cluster analysis and a Cronbach α analysis confirmed that the two variable pairs separately and combined were internally consistent. (Again, omitting the aggressiveness variable increased consistency). Therefore, the variable pairs could be used to assess entrepreneurial orientations towards innovative customers, and likewise towards innovative suppliers.*
8. *A factor analysis confirmed the internal consistency of the 2x5 entrepreneurial orientation variables towards customers and towards suppliers. It distinguished a collaboration*

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[85] Recoding gave high skewness & kurtosis levels. Hence next Subsections used non-parametric tests.

component (opportunities, trust, and innovation), an aggressiveness component, and a risk-taking component. (Note that the sample size was too small for a reliable result).

9. *Companies that were entrepreneurial towards innovative customers or suppliers on some of the entrepreneurial variables would not necessarily exhibit such behaviour on other entrepreneurial variables. Consequently they would not be easily recognised as being entrepreneurial. (This was also found with the correlation analysis). These findings were contrary to the uni-dimensional view of Covin & Slevin (1989) and Wiklund & Shepard (2003). However they were in line with findings on a multi-dimensional approach by Gupta et al. (2014 and Schueler et al. (2018). (See Franz, 2018: 22-25).*

10. *Findings were also in line with those of Chapter 4. (§4.3.4).*

11. *The research did not have access to comparable data on the larger New Zealand population. The relatively high means on entrepreneurial orientation variables however showed that findings were representative for the target-population.*

12. *The research was unable to find comprehensive studies on applying the entrepreneurial orientation construct on innovative suppliers. Results should be interpreted with care, but controlling for entrepreneurial orientation variables seemed a promising avenue.*

5.1.3 Company Turnover Types and Company Strategies (Q25-27)

Respondents worked in company types that deployed three distinct company strategies[86]. (See §2.8.1; see the following Table). The most frequent company turnover (60%) came from either contractor services or specialist services. Respondents in the residual category Others / Not relevant (11%) mostly worked for (large) public or semi-public organisations in procurement or facilities management.

Table 49: Distribution of "most important" company turnover types (listwise *n*=97)

	Wholesale / distribution	Manufacturing products	Providing Services	Other / Not relevant	Totals
Most important (n)	9	19	58	11	97
Percentages	9%	20%	60%	11%	100%

Companies displayed different company strategies. When asked on the company strategy towards customers or suppliers, respondents respectively reported entrepreneurial strategy (50%), business continuity or lifestyle strategy (38%), and survival strategy (12%) as "most important". (§2.8.2). As expected and purposely targeted, this percentage of entrepreneurial approach was considerably higher than the average company in New Zealand construction supply chains. (See literature in §2.8.2). The entrepreneurial strategy correlated negative with lifestyle strategy (*Rho*=-.582, *p*<.01) and survival strategy (*Rho*=-.480; *p*<.01); lifestyle again related negative to survival (*Rho*=-.374, *p*<.01).

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[86] Based on data in SurveyMonkey.

Section summary-conclusion:

13. *The surveyed companies were mostly (60%) service providers, and reported entrepreneurial strategies (50%).*
14. *Survey data on the company strategy indicated that the dataset was not representative for the New Zealand population. Based on literature, the dataset instead suggested it was representative for the target-population that managed innovative suppliers*

5.1.4 Respondent Experience Levels and Roles (Q28-29)

Respondents had different experience levels and could fulfil different roles (*N*=112; See bar charts below). The left bar chart shows relatively high experience levels[87] (means) in the management & strategy role, and somewhat lower experience levels in commercial (i.e. sales or procurement), operations and innovation roles. The level of overseas experience had a similar lower range. Only 4% of respondents indicated low levels of management experience, whereas 23% to 29% of respondents indicated low levels of experience in one or more other (functional) areas.

The right bar chart indicates that respondents in part reported multiple roles. (Counts). Overall 43 respondents (38%; out of *N*=112) had a role as director or owner. Considering the earlier company size distribution (§5.1.1), at least 22% of these directors / owners ran companies with five staff or more. Respondents from companies with <100 staff generally reported a somewhat lower level of experience, and more frequently had a role of director or owner (68%).
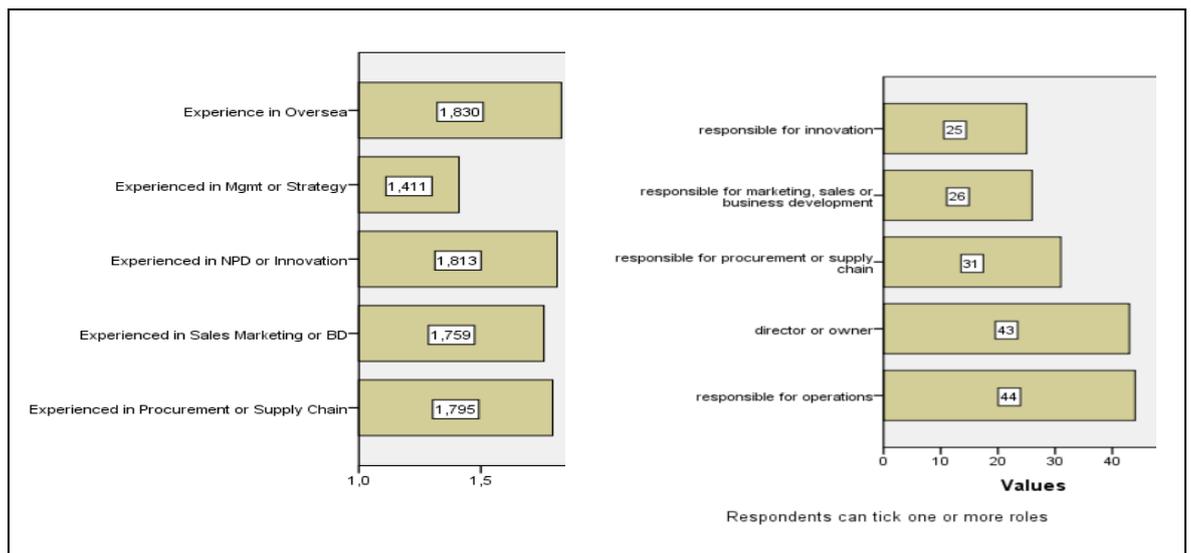
Figure 36: Respondents' functional experience (means; left). Roles (counts; right)

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[87] A reversed 3-point Likert-scale: 1=high, 2=medium, 3=low experience level.

Literature (see §2.6.2) suggested a positive relationship between experience levels and performance. Hence this research analysed high versus low levels of experience[88]. (See also §5.6). Contrary to general findings on low experience levels in the New Zealand construction industry (MBIE, 2013, see §2.6.2), the following Table suggested that most respondents (N=58) had high experience levels in management & strategy; fewer (N_{avg}=34) respondents had high experience levels in other areas.

Table 50: Descriptives on experience levels (N=112)

		Count	Column N %
Experienced in Procurement or Supply Chain	no data	8	7,1%
	high	32	28,6%
	medium	47	42,0%
	low	25	22,3%
Experienced in Sales Marketing or BD	no data	10	8,9%
	high	32	28,6%
	medium	45	40,2%
	low	25	22,3%
Experienced in NPD or Innovation	no data	7	6,3%
	high	33	29,5%
	medium	46	41,1%
	low	26	23,2%
Experienced in Mgmt or Strategy	no data	7	6,3%
	high	58	51,8%
	medium	41	36,6%
	low	6	5,4%
Experience in Oversea	no data	7	6,3%
	high	37	33,0%
	medium	36	32,1%
	low	32	28,6%

The procurement experience level was significantly lower than the management & strategy experience level. The procurement experience did not significantly differ with the other three experience types. (See below).

Table 51: Significance with management experience versus the other four experience types

Test Statistics[a]

	Experienced in Sales Marketing or BD - Experienced in Procurement or Supply Chain	Experienced in NPD or Innovation - Experienced in Procurement or Supply Chain	Experienced in Mgmt or Strategy - Experienced in Procurement or Supply Chain	Experience in Oversea - Experienced in Procurement or Supply Chain
Z	-,373[b]	-,246[c]	-4,269[b]	-,267[c]
Asymp. Sig. (2-tailed)	,709	,806	,000	,790

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.
c. Based on negative ranks.

---

[88] The experience data were distributed such that parametric test could be used. Likert: 1 high, 2 medium, 3 low.

The data (see Table below) showed positive and weak-to-moderate correlations (Cramer & Howitt, 2004: 39) between procurement experience and the other experience types. The data generally showed somewhat higher correlations among the other four experience types. This could imply that respondents who would be specialised in procurement (i.e. were procurement professionals) would be somewhat less skilled in other experience types. And alternatively, that respondents with one or more of the other experience types had broader experiences.

Table 52: Correlations between the five experience types (*N*=112)[89]

			Experienced in Procurement or Supply Chain	Experienced in Sales Marketing or BD	Experienced in NPD or Innovation	Experienced in Mgmt or Strategy	Experience in Oversea
Spearman's rho	Experienced in Procurement or Supply Chain	Correlation Coefficient	1,000	,272**	,386**	,353**	,275**
		Sig. (2-tailed)	.	,004	,000	,000	,003
		N	112	112	112	112	112
	Experienced in Sales Marketing or BD	Correlation Coefficient	,272**	1,000	,476**	,516**	,303**
		Sig. (2-tailed)	,004	.	,000	,000	,001
		N	112	112	112	112	112
	Experienced in NPD or Innovation	Correlation Coefficient	,386**	,476**	1,000	,340**	,442**
		Sig. (2-tailed)	,000	,000	.	,000	,000
		N	112	112	112	112	112
	Experienced in Mgmt or Strategy	Correlation Coefficient	,353**	,516**	,340**	1,000	,404**
		Sig. (2-tailed)	,000	,000	,000	.	,000
		N	112	112	112	112	112
	Experience in Oversea	Correlation Coefficient	,275**	,303**	,442**	,404**	1,000
		Sig. (2-tailed)	,003	,001	,000	,000	.
		N	112	112	112	112	112

**. Correlation is significant at the 0.01 level (2-tailed).

Finally, overseas experience was quite common for New Zealand professionals, either because of a long stay abroad or because the professional was a migrant. Overseas experience correlated weakly-moderately (Cramer & Howitt, 2004: 39) with other experience types. From the data, it remained unclear whether this effect was causal.

Section summary-conclusion:

15. *Respondents had significantly higher levels of management experience compared to the other experience types. Respondents could take multiple roles.*
16. *The data revealed weak-to-moderate positive correlations between procurement experience and the other experience types. The data generally revealed somewhat stronger (yet moderate) correlation levels among other experience types.*
17. *This indicated that respondents had broad levels of experience and knowledge of different roles. Although correlations with procurement experience were somewhat weaker, the broader experience base and multiple roles could be beneficial for successfully managing innovative suppliers. This would be in line with extant research.*

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[89] Data were non-normal with the Kolmogorov-Smirnov and Shapiro-Wilk tests, but Q-Q plots suggested normality.

18. *Findings indicated that the dataset was representative for the target-population. (Note that reported experience levels were intersubjective and could contain respondent-bias).*

5.1.5 Company Age (Q24)

The bar chart below gives the company age distribution (*M*=34 years; *N*=96). An independent-samples *t*-test and a non-normal correlation test (Spearman *Rho*=.712*, p≤*.01) found that younger organisations (≤40 years) were significantly smaller (≤100 staff); older organisations (>60 years) were significant larger (>250 staff)[90]. An OECD report (Andrews *et al.*; 2015: 210) found that 36% of New Zealand companies were older than 10 years. It also stated that younger companies were more dynamic, innovative and created more jobs. However 61% of the companies from Survey I were older than 10 years.
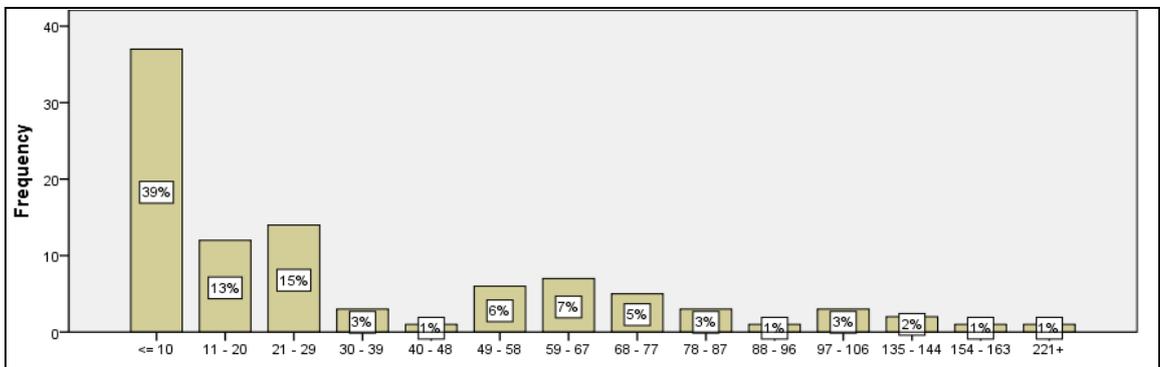
Figure 37: Company age: 39% of companies ≤10 years old (*N*=96; *M*=34 years; *SD*=39)

This average age changed when controlled for small company size (<99 staff; *N*=64). The mean age then dropped to *M*=15.6 years, and 40% of surveyed companies were 10 years or older. Based on findings of Andrews *et al.* (ibid) this could imply that the small company population could be more innovative than the average population in the New Zealand construction supply chain. (§5.3.1 & §7.2 analysed whether this was causal).

Section summary-conclusion:

19. *A comparison with OECD data indicated the dataset contained a relatively high percentage of companies ≥10 years old. The small companies were younger than the large companies.*
20. *The relative high company age in Survey I indicated that respondents worked in more traditional companies that probably were less innovative or entrepreneurial. Hence from this perspective the dataset was probably not representative for the target population.*

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[90] This independent variable was only used for descriptive purposes.

5.1.6 Customer Strategy - Value Proposition (Q26)

Survey I applied the customer value proposition strategy model (§2.8.2; Treacy & Wiersema, 1997). This model implied that companies that rank high on product leadership but also on customer intimacy would be more innovative towards customers. Companies that ranked high on operational excellence would be more engaged in operational efficiency with process or perhaps incremental innovations. When asked on customer strategies[91], most respondents (49%) reported that product leadership was their "most important" strategy; 36% of respondents reported customer intimacy, and only 15% of respondents reported that operational excellence was "most important". Statistics are shown in the Table below. A Wilcoxon signed-rank test revealed that differences were statistically-significant among the three propositions.

Table 53: Descriptives on customer value proposition (*n*=87)

Statistics		Customer strategy is product leadership	Customer strategy is customer intimacy	Customer strategy is operational excellence
N	Valid	93	96	91
	Missing	19	16	21
Mean		1,70	1,88	2,32
Std. Deviation		,791	,771	,773
Skewness		,596	,220	-,624
Std. Error of Skewness		,250	,246	,253
Kurtosis		-1,148	-1,279	-1,052
Std. Error of Kurtosis		,495	,488	,500

Considering that construction supply chain companies in New Zealand generally focussed on lowest costs and efficiencies, (e.g. Hinton, 2013; §2.8.3) the surveyed population was non-representative in this respect, and hence representative for the target-population.

The following Table shows moderate negative Spearman correlations (*p*≤.01 level) between the three customer value propositions. (Cramer & Howitt, 2004: 39). The product leadership strategy was moderately negative correlated to the two other strategies (Spearman *Rho*=-.553 and -.451 respectively, with *p*<.01). Similarly, the customer intimacy strategy was moderately negative correlated with operational excellence (Spearman *Rho*=-.434, with *p*<.01). In line with the Treacy & Wiersema model, this suggested that the case companies with different customer strategies could exhibit different behaviour. Chapter 6-8 explored

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[91] Based on a 3-point Likert-type scale in SurveyMonkey (1 most important; 2 important; 3 least important). Data were non-normal.

in more detail to what extent this would lead to differences in procurement practices and performance.

Table 54: Spearman correlations (negative) between the three customer value propositions

Correlations

		Customer strategy is product leadership	Customer strategy is customer intimacy	Customer strategy is operational excellence
Customer strategy is product leadership	Correlation Coefficient	1,000	-,553**	-,451**
	Sig. (2-tailed)	.	,000	,000
	N	93	91	87
Customer strategy is customer intimacy	Correlation Coefficient	-,553**	1,000	-,434**
	Sig. (2-tailed)	,000	.	,000
	N	91	96	89
Customer strategy is operational excellence	Correlation Coefficient	-,451**	-,434**	1,000
	Sig. (2-tailed)	,000	,000	.
	N	87	89	91

**. Correlation is significant at the 0.01 level (2-tailed).

Section summary-conclusion:

21. *Analysis of the customer strategy found significantly large percentages of product leadership (49%) and customer intimacy (36%), and a lower number of respondents with operational excellence (15%). In line with literature, this indicated that the target-population differed from the overall population of companies in New Zealand construction supply chains which would be more cost-driven and hence focussed on operational excellence.*

22. *The research did not have access to comparable customer strategy data on the larger New Zealand population*

5.1.7 Conclusions from Descriptives of Independent Company Variables

This Section analysed descriptive and some inferential statistics on the independent company variables. The research hypothesis for this Section is:

H1: The company variable data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

The Table in §5.4 summarises the 22 Section Summary-conclusions of this Section. The surveyed respondents appeared to come from a broad background with regards to company size, company age, company's turnover types, customer strategies, their professional experiences, and roles. These companies could have characteristics that were different from the larger New Zealand construction industry as discussed in §2.1. They could exhibit different company and customer strategies, and could exhibit different levels of

entrepreneurial orientation. Findings suggested that the variables selected from §2.6.3, §2.7.1, and §2.8.4 were relevant to survey respondents.

These findings indicated that Survey I succeeded in finding and analysing the target-population of companies that managed innovative suppliers. Also, results further defined the target-population. Inferential findings on entrepreneurial orientation, company strategy, and customer strategy were discussed in Chapters 6-7.

The H1 hypothesis was confirmed: the company data were representative for the target-group of companies that managed innovative suppliers.

5.2 Descriptives on Mediating Procurement Management Variables

The objective of this Section was to increase the understanding on procurement management variables of companies in New Zealand construction supply chains that managed innovative suppliers. It discusses descriptive and some inferential statistics on six groups of mediating procurement management variables. (See conceptual model II at the beginning of this Chapter). Hence this Section also forms a basis for inferential statistics in the following two Chapters. It discusses the following hypothesis as it relates findings to the companies of the target-population (§3.1.3).

H2: The procurement management data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

5.2.1 Priorities in four Procurement Steps in Idea & Develop Phase (Q1-2)

In line with the classification model of §2.10.3, the below Figure (bar chart) gives mean values on priorities of the four procurement steps in the idea and the develop phase[92]. Significance was tested via a paired-samples *t*-test. The bar graph revealed that respondents overall (*n*=103) ranked the *specify-needs* step during the idea phase (*M*=2.1) and during the develop phase (*M*=2.2) significantly as "most important"[93]. In both phases, the *negotiate-contract* step was most often found "least important" (*M*=0.7; *M*=1.0). This was somewhat contrary to common business practice that would state that the 3rd step of negotiate-contract is critical. (No source). Contrariwise, it was more in line with early supplier involvement for specifying needs, e.g. Johnsen (2014: 167-168) and the concept of early procurement involvement by Van Weele (2010: 53). In both phases, respondents also

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[92] See §2.4.2 for the four procurement steps. See §2.10.2 for idea and develop phase of innovations.
[93] A 4-point Likert-scale: 1 most important, 2 important, 3 not so important, 4 least important.

attached relatively-little priority to the 4th procurement step of manage-relations with innovative suppliers. Note that in several instances the standard deviations were relatively high, indicating the variety of priorities that respondents gave to these steps.
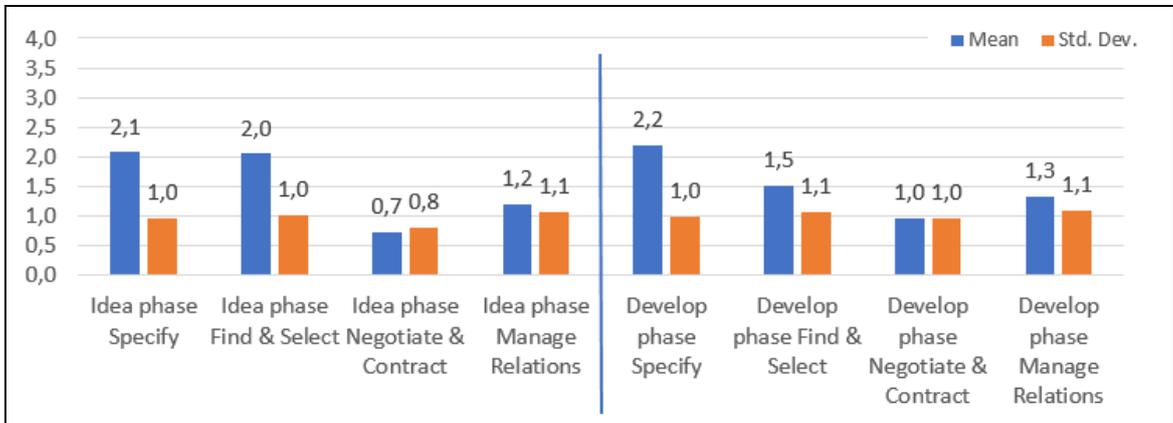
Figure 38: Procurement steps in idea & develop phase (mean; standard deviation; scale 0-4; *N*=103)

It could be argued that in the total population (*N*=112) the distributions in priorities of the four procurement steps were fairly equally distributed among survey respondents. Some respondents would favour prioritising on specifications, others on finding-selecting suppliers, others on negotiation-contracting, or on manage-relations. The above bar chart however shows that respondents made different decisions in their priorities. For the idea phase, the means of the specify-needs step and the find-select step appeared to be significantly different from the negotiate-contract step (*p*≤.001), and from the manage-relations step (*p*≤.001). The means between the four procurement steps during the develop phase were also significantly different. Moreover, the negotiate-contract step during the develop phase was ranked statistically higher (*M*=1.0) than during the idea phase (*M*=.7, *p*≤.013).

Section summary-conclusions:

23. *Respondents displayed different priorities of the procurement steps in the idea and develop phases. The first two procurement steps were significantly seen as most important during both phases. Standard deviations were relatively low.*

24. *Respondents considered the negotiate-contract step as least important in both phases, although they considered this step significantly more important during the develop phase. Overall, this indicated that respondents thought negotiation-contracting would give limited benefits.*

25. *The similarly low priorities of the manage-relations steps suggested that respondents in the dataset spent relatively less time on managing relations and were purpose-driven. Literature generally suggested that managing relations could lead to higher procurement performance.*

26. *Especially for the negotiate-contract and the manage-relations steps, the high standard deviations suggested that individual respondents varied in their priorities.*

27. *The research did not have access to comparable procurement step priority data on the larger New Zealand population. The data gave no indication on whether the target-population differed from the larger New Zealand population.*

5.2.2 Procurement TOP 3 Practices in four Procurement Steps (Q3-6)

Section §2.11.2 presented overviews of procurement practices per procurement process step. In Survey I, respondents (*N*=112) could select three out of nine practices ("Rank your TOP 3 of most important procurement practices"). Hence respondents indicated their own three practices for each of the four procurement steps. (SP=specify-needs; FS=find-select; NC=negotiate-contract; MR=manage-relations. (See §2.11.2; §3.6.4.3). Table 25 in the corresponding Appendix[94] shows the 4x9=36 practices in descending order. Jointly, the *N*=112 respondents selected 1326 practices for the four procurement steps[95]. The practice most-selected by *n*=71 respondents (5.5%; i.e. *n/N* %) was "our supplier negotiations focus on opportunities". The practice least-selected by *n*=3 respondents (0.22%, i.e. *n/N* %) was "relations are adversarial and innovative suppliers are managed rigorously"[96].

A post-hoc analysis of the 36 practices indicated, that 8 to 10 practices were probably phrased negatively or neutral; 26 or 28 practices were phased more positively. This latter category scored higher, which could have caused some bias. (See also the Table in the corresponding Appendix).

The cumulative percentage column from the Table indicated the fragmented selection of practices. (Grosfeld-Nir *et al.*, 2007: 2318). A number of practises were preferred over other practices. However, the corresponding Figure below shows an almost linear decrease in relative frequencies over the practices. And does not indicate a dominant TOP 3 with strong preferences. (A dominant TOP 3 of a limited set of "best-practices" with critically higher frequencies would have resulted in a more reversed hockey-stick pattern commonly associated with Pareto curves).

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[94] The data on procurement practices had to be analysed in Excel.

[95] That is: 3x4x112=1344. In 18 instances respondents did not select a TOP 3 best-practice. Consequently, 1344–1326=18.

[96] This least-selected practice often prevails in construction procurement. In hindsight this practice was probably too negatively phrased in the questionnaire whereas the other practices were phrased neutral or positive.
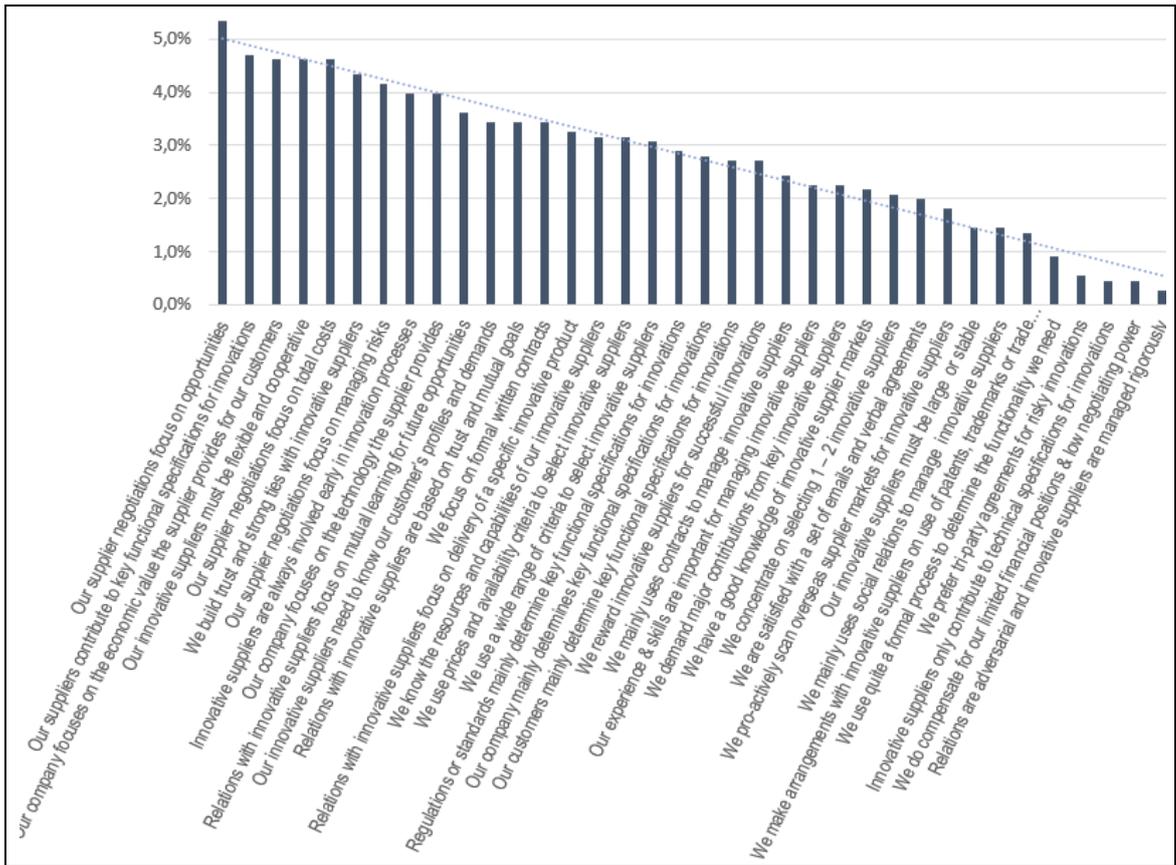
Figure 39: Relative use of practices gave a uniform Pareto diagram (Grosfeld-Nir *et al.*, 2007)

Focussing on the most-used practices per procurement step. Overall, respondents selected their TOP 3 of each of the four procurement steps 57.4 times (*M*=57.4; see right in the Figure below). Means per procurement steps differed slightly when compared to the total *N*=1,326. The negotiate-contract practices had the highest mean (*M*=63.3); the find-select practices had the lowest mean (*M*=51.7).
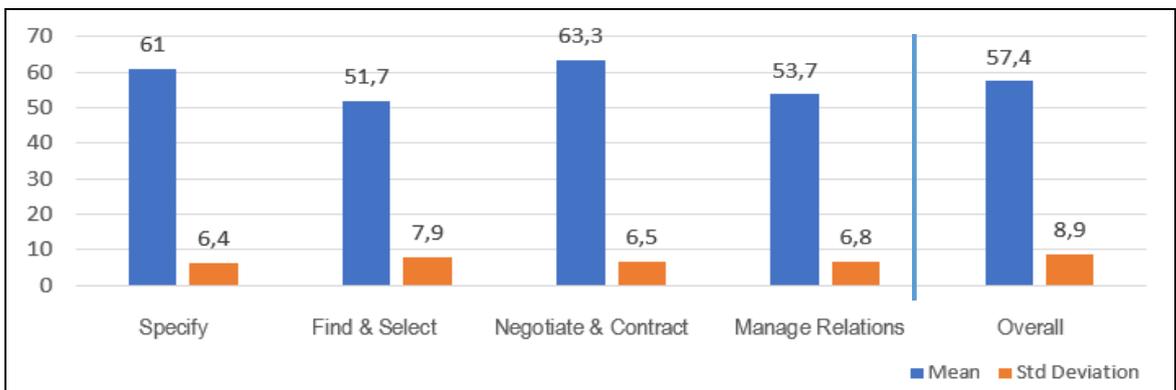
Figure 40: Procurement step TOP 3: mean counts and standard deviations. (Right: overall scores)

Nevertheless, combined the TOP 3 for each of the four procurement steps (3x4=12) practices accounted for 52% of all practices[97]. This would indicate, that respondents showed some preferences but overall ranked practices fairly consistent. (Table below for TOP 3). As discussed above, this would not meet the Pareto principle.

Table 55: Rankings of TOP 3 of procurement practices in procurement step (SP, FS, NC, MR)*[98]*

Procurement Practices	n	n/Tot %	Pr Step Rk	Adams
Our company focuses on the economic value the supplier provides for our customers	66	5,0%	SP 1	
Our suppliers contribute to key functional specifications for innovations	65	4,9%	SP 2	
Our company focuses on the technology the supplier provides	52	3,9%	SP 3	
Our innovative suppliers must be flexible and cooperative	64	4,8%	FS 1	
We use a wide range of criteria to select innovative suppliers	46	3,5%	FS 2	6.08
We use prices and availability criteria to select innovative suppliers	45	3,4%	FS 3	3.05
Our supplier negotiations focus on opportunities	71	5,4%	NC 1	6.00
Our supplier negotiations focus on total costs	64	4,8%	NC 2	5.65
Our supplier negotiations focus on managing risks	55	4,1%	NC 3	
We build trust and strong ties with innovative suppliers	63	4,8%	MR 1	5.82
Innovative suppliers are always involved early in innovation processes	51	3,8%	MR 2	5.10
Relations with innovative suppliers are based on trust and mutual goals	47	3,5%	MR 3	
		52,0%		

For a comparison: Adams (2004: 129) analysed practices on bill-of-material procurement in North American manufacturing SMEs (*N*=185; 1–500 staff)[99]. His rankings on similar (*not always* identical) practices are shown right in the above Table. Those rankings showed similarities in perceived importance which suggested some external validity of the ranking in practices.

Most of the 3x4 practices in this Table were phrased positively and differed from cost-focused, short-term perspectives or adversarial relations as commonly observed in construction supply chains in and outside New Zealand (see e.g. Hinton, 2013; see e.g. §2.1.2; §2.3.4).

Additionally, the remarks[100] of respondents (*n*=46) to the list of procurement practices showed the complexity of procurement practice with innovative suppliers. (See Appendix §5.2). As one respondent wrote, his/her company struggled to "balance [supplier?]

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[97] These 3x4 practices were considered "best-practices" and were analysed in more detail in Chapter 8.
[98] SP=specify-needs; FS=find-select; NC=negotiate-contract; MR=manage-relation. The right column partially shows similar relative rankings from Adams (2004: 129).
[99] Adams used a 7-point Likert-type scale: 1=strongly disagree … to … 7=strongly agree.
[100] Respondents from large companies added more remarks than respondents from small companies.

innovations against our clients' economic values in the short term". Respondents wanted to manage supplier relationships "so that the doors are open, and the supplier understands my needs and can contribute". Another respondent noted "we certainly demand a lot from our suppliers". Yet another was more cautious and added that "innovations must be well-supported and not locked-in by one vendor". Preferred suppliers needed a good reputation and need not "by definition be large or stable companies so it [is] difficult to find-select the right supplier". Relations should benefit both parties. Finally, one respondent noted that "early involvement and early cost estimation are important as innovations are usually aimed at better value – more performance without too much extra costs and risk".

Overall, respondents did not make remarks on adversarial, short-term, or cost-focussed measures; instead the remarks again showed a more collaborative and exploratory behaviour towards suppliers.

Section summary-conclusion:

28. *Respondents selected their TOP 3 out of nine procurement practices in each of the procurement steps. (They choose from 4x9 practices and added remarks on other practices).*
29. *Contrary to common perceptions on adversarial and cost-focussed relations in the construction industry, the ranking of procurement practices and the related respondents' remarks showed a more nuanced and cooperative representation of procurement practices with innovative suppliers.*
30. *The average TOP 3 of procurement practices (3x4=12) in the four steps accounted of 53% of all practices, which suggested that respondents had slight preferences. However, a visual Pareto analysis on all 4x9 variables showed a uniform diagram. Therefore respondents did not show strong preferences.*
31. *A part of the ranking was in line with extant research which could indicate external validity.*
32. *The research did not have further access to comparable procurement practice data on the larger New Zealand population. Findings however suggested that the dataset was representative for the target-population.*
33. *The frequency count of the practices was in nominal data with multiple response options which gave no opportunities for advanced statistics. This limited possibilities in Chapters 6-7 to analyse rankings in more detail. Chapter 8 analyses a set of best-practices in more detail.*

5.2.3 Three Basic Supplier Types (Q11-13)

Based on the literature review from §2.9, this Subsection discusses three basic supplier types: foreign versus domestic, new versus current, and small versus large suppliers. The context was working with suppliers on either radical versus incremental innovations. Literature was inconclusive (Appendices §2.3.6) to what extent large or SME companies had preferences with these supplier types. Generally, companies would prefer domestic and current suppliers, unless they would see an opportunity or needed to switch to another

supplier type. (Appendices §2.3.6). This was also found (§4.5) in the five exploratory interviews.

In general, products from abroad must adhere to New Zealand building code standards and regulations, which effectively can act as a barrier for importing innovative products. (§2.9.3). As one respondent remarked: "incremental innovations are easier close to home, radical innovations need to be proven overseas". (Appendix §5.2.3).

The Table below shows means and standard deviations. A Wilcoxon signed-rank test revealed significant differences within the 2ⁿᵈ supplier pair: new versus current suppliers. Respondents would slightly prefer *new* suppliers more for (somewhat) radical innovations than for (somewhat) incremental innovations. This would be in line with Lasagni (2012), Johnsen *et al.* (2011) and Schiele (2010). (See §2.9.1).

Table 56: Descriptives on the three supplier types[101]

Descriptive Statistics			
	N	Mean	Std. Deviation
We prefer domestic (1) or foreign (5) suppliers for (somewhat) incremental innovations	112	2.53	.759
We prefer domestic (1) or foreign (5) suppliers for (somewhat) radical innovations	112	2.64	.826
We prefer new (1) or current (5) suppliers for (somewhat) incremental innovations	112	3.34	.623
We prefer new (1) or current (5) suppliers for (somewhat) radical innovations	112	3.21	.716
We prefer small (1) or large (5) suppliers for (somewhat) incremental innovations	112	3.05	.517
We prefer small (1) or large (5) suppliers for (somewhat) radical innovations	112	3.04	.591
Valid N (listwise)	112		

Furthermore, a non-parametric (Spearman) correlation test was applied. (Table below). As expected, the three variable-pairs[102] (in yellow) showed moderate paired-correlations: Spearman *Rho* was .507, .338, & .501 respectively with *p*=.01 (Cramer & Howitt, 2004: 39).

Two significant but weak negative correlations (in green) were found (*Rho*=-.228; *Rho*=-.205 *p*=.05) between foreign suppliers versus new suppliers for (somewhat) incremental and for (somewhat) radical innovations. It seemed that when respondents favoured *foreign* suppliers, they would prefer *current* foreign suppliers over *new* foreign suppliers. As one

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[101] Likert-scales: (Pair 1) Foreign versus domestic: 1 only domestic, 2 mainly domestic, 3 both domestic and overseas, 4 mainly overseas, 5 only overseas suppliers. (Pair 2) New or current: 1 only new, 2 mainly new, 3 both new & current, 4 mainly current, 5 only current suppliers. (Pair 3): Small or large: 1 only small, 2 mainly small, 3 both large & small, 4 mainly large 5 only large suppliers. (Data were non-normal).

[102] Each of the 3 variable-pairs contrasted (somewhat) incremental versus (somewhat) radical innovations.

respondent remarked: "Overseas suppliers are frequently in front of New Zealand suppliers on innovation in process and technical ability". Hence respondents could feel the need to procure innovations from overseas. This suggested they would do so with *current* foreign suppliers. This was logical from a risk & trust perspective. (Johnsen, 2014: 112).

Finally, one significant but weak correlation (Spearman *Rho*=.216, *p*=.05 level) was found in that respondents preferred *small* foreign suppliers over large domestic suppliers for *radical* innovations (in purple). Additionally, several respondents remarked that size was not the important factor for supplier selection. (Instead they mentioned agility, reliability, and performance). Other correlations with supplier size were not significant.

Table 57: Correlations between and within the three supplier type variables

			We prefer foreign or domestic suppliers for (somewhat) incremental innovations	We prefer foreign or domestic suppliers for (somewhat) radical innovations	We prefer new or current suppliers for (somewhat) incremental innovations	We prefer new or current suppliers for (somewhat) radical innovations	We prefer small or large suppliers for (somewhat) incremental innovations	We prefer small or large suppliers for (somewhat) radical innovations
Spearman's rho	We prefer foreign or domestic suppliers for (somewhat) incremental innovations	Correlation Coefficient	1,000	,507**	-,228*	-,118	,102	-,015
		Sig. (2-tailed)	.	,000	,015	,214	,285	,876
		N	112	112	112	112	112	112
	We prefer foreign or domestic suppliers for (somewhat) radical innovations	Correlation Coefficient	,507**	1,000	-,157	-,205*	,077	,216*
		Sig. (2-tailed)	,000	.	,098	,030	,419	,022
		N	112	112	112	112	112	112
	We prefer new or current suppliers for (somewhat) incremental innovations	Correlation Coefficient	-,228*	-,157	1,000	,338**	-,125	-,088
		Sig. (2-tailed)	,015	,098	.	,000	,189	,356
		N	112	112	112	112	112	112
	We prefer new or current suppliers for (somewhat) radical innovations	Correlation Coefficient	-,118	-,205*	,338**	1,000	-,123	,022
		Sig. (2-tailed)	,214	,030	,000	.	,196	,818
		N	112	112	112	112	112	112
	We prefer small or large suppliers for (somewhat) incremental innovations	Correlation Coefficient	,102	,077	-,125	-,123	1,000	,501**
		Sig. (2-tailed)	,285	,419	,189	,196	.	,000
		N	112	112	112	112	112	112
	We prefer small or large suppliers for (somewhat) radical innovations	Correlation Coefficient	-,015	,216*	-,088	,022	,501**	1,000
		Sig. (2-tailed)	,876	,022	,356	,818	,000	.
		N	112	112	112	112	112	112

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Section summary-conclusion:

34. *The two supplier types foreign versus domestic suppliers, and small versus large suppliers had similar preferences with respondents with regards to (somewhat) incremental versus (somewhat) radical innovations.*
35. *Respondents however could significantly favour new suppliers with (somewhat) radical innovations more than new suppliers with (somewhat) incremental innovations. Respondents then significantly preferred small foreign suppliers over large domestic suppliers for radical innovations. (Correlations were weak).*

36. *Bivariate Spearman correlations within the three pairs of supplier-type indicated moderate correlations for (somewhat) radical innovations versus (somewhat) incremental innovations. This would mean that respondents who preferred such supplier types for (somewhat) radical innovations, would to a moderate extent also use such supplier types for (somewhat) incremental innovations. (And vice versa).*

37. *Bivariate Spearman correlations between the three supplier-type pairs only indicated weak correlations.*

38. *The research did not have access to comparable supplier type data on the larger New Zealand population. The data gave no direct indication on whether the target-population differed from the New Zealand population. However, the amount of respondent remarks and the fact that respondents rated their preferences for incremental and radical innovations generally similar, suggested a more innovative sample of Survey I.*

5.2.4 Intensity of Relations with different innovative Suppliers (Q8)

The intensity of the relations[103] with innovative suppliers (§2.9.4) varied with the supplier turnover type (i.e. the offering by the supplier). A Wilcoxon signed-rank test revealed significant differences in the intensity of relations between the three types of suppliers. (See the combined Table below).

The high level of intensity of relations with service providers was understandable as managing supplier services and discussing innovations generally would require intense communications, especially when this related to process innovations (see also next Subsection). The low level of intensity with wholesalers or distributors was also understandable as these would often deliver commodities (off-the-shelf) products.

One respondent mentioned a relation between supplier intensity and business outcome; another respondent mentioned they did not value innovative suppliers over non-innovative suppliers. (See appendix §5.2.4).

Table 58: Intensity of relations with three sorts of suppliers

Descriptive Statistics				
	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Intensity of relationships with suppliers providing services	112	3,17	,069	,734
Intensity of relationships with suppliers manufacturing products	112	2,88	,081	,857
Intensity of relationships with suppliers in wholesale or distribution	112	2,34	,087	,916
Valid N (listwise)	112			

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[103] A 4-point Likert-type scale: 1 never used; 2 low intensity; 3 medium intensity; 4 high intensity.

Test Statistics^a

	Intensity of relationships with suppliers manufacturing products - Intensity of relationships with suppliers providing services	Intensity of relationships with suppliers in wholesale or distribution - Intensity of relationships with suppliers providing services	Intensity of relationships with suppliers in wholesale or distribution - Intensity of relationships with suppliers manufacturing products
Z	-2,632^b	-6,547^b	-4,942^b
Asymp. Sig. (2-tailed)	,008	,000	,000

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.

Section summary-conclusion:

39. *Relations with service providers were significantly more intense than those with manufacturers. Relations with wholesalers had the lowest intensity. Correlations were weak-to-moderate.*

40. *The research did not have access to comparable supplier type data in New Zealand. However, the relatively high mean values on the intensity of relations suggested that the dataset was representative for the target-population.*

5.2.5 Two Basic Innovation Types (Q9-10)

In line with the basic innovation typology of §2.10, this Subsection discusses statistics on product versus process innovations, and on radical versus incremental innovations. These two innovation types are developed with innovative suppliers and for/with innovative customers.

The combined frequency Table below on developing product versus process innovations with innovative suppliers versus innovative customers show preferences for middle positions, with only a slightly higher tendency for product innovations[104]. Respondents developed both types of innovations with upstream and downstream partners in the supply chain. (With innovative customers: *M*=3.04, *SD*=.793; with innovative suppliers: *M*=3.14, *SD*=.613).

A Wilcoxon signed-rank test found that rankings with innovative customers versus suppliers were not significantly different[105]. A correlation analysis produced a moderate Spearman correlation (*Rho*=.573 at with *p*≤.01; two-tailed). This would indicate that respondents who developed product versus process innovations for/with innovative customers would to a

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[104] A 5-point Likert-scale: 1 only process innovations, 2 mainly, 3 both, 4 mainly, 5 only product innovations.
[105] Data were non-normally distributed.

moderate degree do similarly with innovative suppliers. One respondent remarked they needed both types of innovations. Another remarked that innovations were required where materials or systems from different suppliers come together.

Table 59: Preferences product versus process innovations to customers or suppliers (*n*=112)

We develop product or process innovations /with our innovative customers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	only process innovations	4	3,6	3,6	3,6
	mainly process innovations	16	14,3	14,3	17,9
	both process and product innovations	69	61,6	61,6	79,5
	mainly product innovations	18	16,1	16,1	95,5
	only product innovations	5	4,5	4,5	100,0
	Total	112	100,0	100,0	

We develop product or process innovations with our innovative suppliers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	only process innovations	1	,9	,9	,9
	mainly process innovations	8	7,1	7,1	8,0
	both process and product innovations	80	71,4	71,4	79,5
	mainly product innovations	20	17,9	17,9	97,3
	only product innovations	3	2,7	2,7	100,0
	Total	112	100,0	100,0	

The combined frequency Table below on developing radical versus incremental innovations with innovative suppliers versus for/with innovative customers was slightly skewed to incremental innovations[106]. These preferences for incremental innovations were in line with extant literature (§2.10.1), and such incremental innovations are perceived as less risky. The kurtosis was lower than in the above Tables on product versus process innovations, suggesting a broader variety in ranking. Development of innovations with suppliers versus customers was similar distributed. (Innovative customers: *M*=3.33, *SD*=.894; Innovative suppliers: *M*=3.21; *SD*=.874). A Wilcoxon signed-rank test found that rankings with innovative customers versus innovative suppliers were not significantly different[107].

Again, a correlation analysis produced a moderate Spearman correlation (*Rho*=.616 at the *p*≤.01; two-tailed). This would indicate that respondents who developed radical versus incremental innovations for/with innovative customers would do similarly with innovative suppliers.

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[106] A 5-point Likert-scale: 1 only radical, 2 mainly radical, 3 neutral, 4 mainly, 5 only incremental innovations.
[107] The data were non-normally distributed.

One respondent remarked they had incremental processes, but sometimes radical products. Another respondent related the radical / incremental dichotomy to skills and knowledge levels of suppliers or customers. According to this respondent, "there are different approaches for different suppliers, and there are different approaches for different customers".

Table 60: Preferences radical versus incremental innovations to suppliers and customers (*n*=93)

We develop radical or incremental innovations for/with our innovative customers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	only radical	1	,9	,9	,9
	mainly radical	21	18,8	18,8	19,6
	neutral (both radical and incremental)	38	33,9	33,9	53,6
	mainly incremental	44	39,3	39,3	92,9
	only incremental	8	7,1	7,1	100,0
	Total	112	100,0	100,0	

We develop radical or incremental innovations with our innovative suppliers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	mainly radical	28	25,0	25,0	25,0
	neutral (both radical and incremental)	37	33,0	33,0	58,0
	mainly incremental	42	37,5	37,5	95,5
	only incremental	5	4,5	4,5	100,0
	Total	112	100,0	100,0	

Section summary-conclusion:

41. *Preferences for product or process innovations with innovative suppliers or innovative customers did not significantly differ. Respondents developed somewhat more product innovations than process innovations, both with/for innovative customers and innovative suppliers. This was in line with interview findings (§4.4.1).*

42. *Correlations were moderate, hence respondents who developed process of product innovations for/with innovative customers also could do with innovative suppliers.*

43. *Preferences for radical versus incremental innovations with innovative suppliers versus innovative customers did not statistically differ. This would imply that the innovation risk profiles towards innovative customers and innovative suppliers were fairly similar. Respondents had a slight preference for incremental innovations. Respondents who developed radical or incremental innovations for/with innovative customers would do similarly with innovative suppliers.*

44. *The research had no access to comparable data on the larger New Zealand population. The data gave no direct indication on whether preferences for product or process innovations differed from the larger New Zealand population. Preferences for radical innovations was higher than New Zealand averages.*

5.2.6 Entrepreneurial Orientation towards Suppliers (Q7)

This Subsection expands on §5.1.2 and discusses correlations of entrepreneurial orientation (§2.7) from the procurement perspective. The Table below shows significant weak-to-moderate correlations of supplier variables versus other customer variables. (Cramer & Howitt[108], 2004: 39. In <mark>yellow</mark>).

An analysis of customer variables versus *different* supplier variables (and *vice versa*) produced several weak (*Rho* <.30) to moderate (*Rho* <.80) correlations. (Cramer & Howitt, 2002: 39). Consequently, innovating with innovative customers had weak correlations with opportunities, risk-taking and aggressiveness with suppliers. Likewise, innovating with innovative suppliers had weak-to-moderate correlations with opportunities and trust with customers. Risk-taking with suppliers had weak correlations with aggressiveness with customers. Opportunities with customers had weak correlations with aggressiveness and trust with suppliers. Opportunities with suppliers had weak correlations with trust for customers. (Note that aggressiveness in supplier markets correlated negatively in two instances). This would confirm that respondents showed a similar entrepreneurial orientation towards customers, and towards suppliers (§5.1.2). This could also imply that case companies could have multiple entrepreneurial profiles towards customers, and also to suppliers. Due to the often-weak correlations, such profiles would not be easily recognised. This is in line with a meta-analysis by Schillo (2011:23).

The Table also shows correlations *within* the five variable-pairs in <mark>green</mark>. All within variable-pairs correlations were moderate: risk-taking (*Rho*=.607), aggressiveness (*Rho*=.716), trust (*Rho*=.655), although the following two were somewhat weaker: innovation (*Rho*=.486) and opportunities (*Rho*=.450) (Cramer & Howitt, 2004: 39). This showed that the entrepreneurial orientation towards customers within variable-pairs was similar to the entrepreneurial orientation towards suppliers. Consequentially, case companies could exhibit similar entrepreneurial orientation to suppliers and suppliers on specific variable pairs.

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[108] Note that e.g. Knoke *et al.* (2002: 150) would be less cautious and would call correlations with Rho between 0.51 and 0.75 moderate-to-strong.

Table 61: Spearman correlations on supplier vs customer variables (sign=green, yellow; *N*=102)

Correlations		Innovating activities with Innovative Customers	Innovating activities with Innovative Suppliers	Risk taking towards Innovative Customers	Risk taking towards Innovative Suppliers	Opportunities with Innovative Customers	Opportunities with Innovative Suppliers	Aggressiveness in Customer Markets	Aggressiveness in Supplier Markets	Trust with innovative Customers	Trust with innovative Suppliers
Innovating activities with Innovative Customers	sign	1,000	,486**	,319**	,076	,647**	,301**	-,040	-,236*	,376**	,223*
	p	.	,000	,001	,440	,000	,002	,681	,014	,000	,020
Innovating activities with Innovative Suppliers	sign	,486**	1,000	,096	,210*	,431**	,584**	,008	-,072	,341**	,397**
	p	,000	.	,327	,031	,000	,000	,938	,461	,000	,000
Risk taking towards Innovative Customers	sign	,319**	,096	1,000	,607**	,085	,085	,216*	,055	,062	,053
	p	,001	,327	.	,000	,386	,384	,026	,573	,523	,587
Risk taking towards Innovative Suppliers	sign	,076	,210*	,607**	1,000	,039	,283**	,270**	,136	,052	,208*
	p	,440	,031	,000	.	,690	,003	,005	,164	,596	,033
Opportunities with Innovative Customers	sign	,647**	,431**	,085	,039	1,000	,450**	-,103	-,195*	,520**	,284**
	p	,000	,000	,386	,690	.	,000	,290	,044	,000	,003
Opportunities with Innovative Suppliers	sign	,301**	,584**	,085	,283**	,450**	1,000	,050	,057	,326**	,441**
	p	,002	,000	,384	,003	,000	.	,606	,556	,001	,000
Aggressiveness in Customer Markets	sign	-,040	,008	,216*	,270**	-,103	,050	1,000	,716**	,032	-,017
	p	,681	,938	,026	,005	,290	,606	.	,000	,744	,863
Aggressiveness in Supplier Markets	sign	-,236*	-,072	,055	,136	-,195*	,057	,716**	1,000	-,099	-,057
	p	,014	,461	,573	,164	,044	,556	,000	.	,312	,559
Trust with innovative Customers	sign	,376**	,341**	,062	,052	,520**	,326**	,032	-,099	1,000	,655**
	p	,000	,000	,523	,596	,000	,001	,744	,312	.	,000
Trust with innovative Suppliers	sign	,223*	,397**	,053	,208*	,284**	,441**	-,017	-,057	,655**	1,000
	p	,020	,000	,587	,033	,003	,000	,863	,559	,000	.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Finally, the following Table suggests that the entrepreneurial orientation towards suppliers differed significantly among the five supplier variables. Combined with the conclusion from the correlation analyses, and in line with §5.1.2, *this would again imply that the companies did not have 'one overall entrepreneurial profile' towards their innovative suppliers and hence such individual activities towards innovative suppliers could not always be recognised as being straightforward entrepreneurial*. This is in line with a meta-analysis by Schillo (2011:23).

Table 62: Significance levels entrepreneurial orientation supplier variable-pairs

Test Statistics[a]										
	Risk taking towards Innovative Suppliers - Innovating activities with Innovative Suppliers	Opportunities with Innovative Suppliers - Innovating activities with Innovative Suppliers	Aggressiveness in Supplier Markets - Innovating activities with Innovative Suppliers	Trust with innovative Suppliers - Innovating activities with Innovative Suppliers	Opportunities with Innovative Suppliers - Risk taking towards Innovative Suppliers	Aggressiveness in Supplier Markets - Risk taking towards Innovative Suppliers	Trust with innovative Suppliers - Risk taking towards Innovative Suppliers	Aggressiveness in Supplier Markets - Opportunities with Innovative Suppliers	Trust with innovative Suppliers - Opportunities with Innovative Suppliers	Trust with innovative Suppliers - Aggressiveness in Supplier Markets
Z	-4,581[b]	-2,412[b]	-6,632[b]	-5,575[c]	-3,483[c]	-4,017[b]	-7,260[c]	-6,097[b]	-6,935[c]	-8,051[c]
Asymp. Sig. (2-tailed)	,000	,016	,000	,000	,000	,000	,000	,000	,000	,000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. Based on positive ranks.

Section summary-conclusion:

45. *The analysis on entrepreneurial orientation showed a weak-to-moderate correlation between different supplier and customer variables. This suggested that companies with entrepreneurial profiles towards innovative customers also had entrepreneurial profiles towards innovative suppliers. This could also imply that case companies could have multiple entrepreneurial profiles towards customers, and also to suppliers.*

46. *The analysis produced several significant and moderate correlations within variable-pairs on entrepreneurial orientation. The analysis suggested weak-to-moderate correlations between several supplier and customer variables. This would confirm that companies could exhibit similar entrepreneurial orientation to suppliers and suppliers.*

47. *Respondents prioritised the entrepreneurial orientation variable-pairs towards suppliers significantly different in all 10/10 instances. This would confirm that companies did not have one 'overall entrepreneurial profile' towards their innovative suppliers, and hence that activities towards innovative suppliers would not be recognised straightforward as being entrepreneurial. This was in line with recent literature (e.g. Schillo, 2011).*

48. *The relatively high scores on entrepreneurial orientation suggested that the sample was representative for the target-population.*

NOTE:
Inferential statistics with entrepreneurial orientations are discussed in §6.2 and §7.2.

5.2.7 Conclusions from Descriptives of Mediating Procurement Variables
This Section analysed descriptive and some inferential statistics on the mediating procurement variables. The research hypothesis for this Section is:

H2: The procurement management data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

The Table in §5.4 summarises the 27 Section Summary-conclusions of this Section. The surveyed respondents reported procurement management practices that at least in part differed from general procurement practises in construction supply chains. One reason could be that managing innovative suppliers suited a different purpose than managing suppliers to obtain lowest costs or to obtain on-time delivery.

Findings therefore indicated that the survey for a large part succeeded in reaching the intended target-population of companies that managed innovative suppliers. Also, findings further defined the target-population.

The H2 hypothesis was largely confirmed: the procurement management data were representative for the target-group of companies that managed innovative suppliers.

5.3 Descriptives on Dependent Procurement Performance Variables

This Section gives descriptive and inferential statistics on dependent procurement performance variables as reported by the survey respondents. (See model II §5.1). Hence this Section also forms a basis for the inferential statistics in the next two Chapters.

The research defined the two variables: estimated numbers of innovations, and estimated percentage of turnover as output-performance variables. The research defined innovation-satisfaction variables and innovation-benefit variables as process-performance variables; these acted as proxies for the output variables. (See also §2.12).

The objective of this Section was to increase the understanding on performance results from companies in New Zealand construction supply chains that managed innovative suppliers. It discusses the following hypothesis as it relates findings to the companies of the target-population (§3.1.3).

H3: The procurement performance data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains

5.3.1 Number of Innovations & related Turnover (Q14-15)

Based on §2.12.3, this Subsection discusses estimated innovation numbers developed with all suppliers over the last three years, and the related turnover percentage[109]. The mean value on number of innovations developed was *M*=7.98, with *SD*=13,39 *(N* valid=74). This standard deviation implied a large variety of innovations in companies. The research was unable to find comparable OECD or New Zealand statistics on such innovation numbers with suppliers.

Nevertheless, the reported innovation numbers seemed high, also considering §2.2. (Inter-subjectivity on self-reporting is discussed in §2.2.2, and §3.2.3). The below chart gives frequencies of estimated innovation numbers with all suppliers over the last three years. One company reported 100 supplier innovations; this could be an outlier. Two companies reported 50 supplier innovations over the same 3-year period; ten companies reported zero innovations.
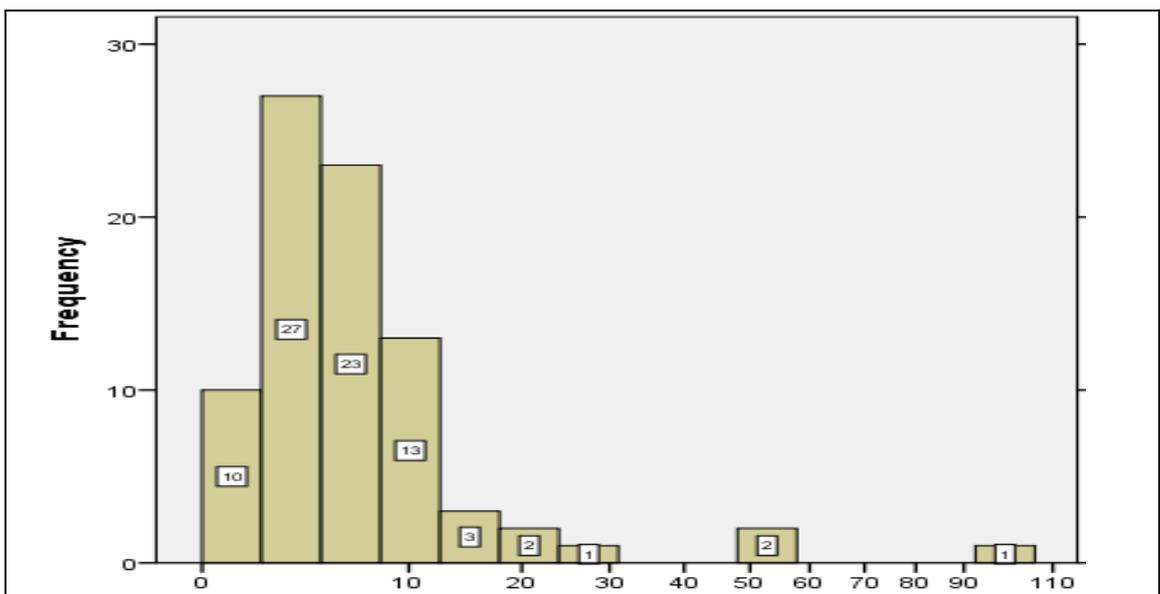
Figure 41: Estimated innovation numbers with all suppliers over last three years (*N*=82)

The following Figure gives details on estimated percentage of turnover from these innovations developed over the last three years with all suppliers. The mean value on turnover percentage from innovations was *M*=15.70, with *SD*=19.57 *(N* valid=74). This standard deviation again implied a large variety of innovation turnover among companies. One company (1.4%) reported 100% turnover; another 13 (17.6%) companies reported 0% turnover with supplier innovations.

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[109] Data on these performance results were scale but had high kurtosis and skewness values.

Comparable data from New Zealand statistics (NZ stats, 2013) showed that almost 50% of construction companies did not invest in innovations. The general perspective is (see e.g. Fairweather, 2009) that the New Zealand construction industry lags in reported innovation rates. Additionally, New Zealand businesses generally score relatively low in several OECD innovation rankings. The proportion of turnover found in this research is however comparable to general innovation rankings of top tier OECD countries (RIO.JRC, 2017). This proportion can therefore be considered high when related to the average New Zealand construction companies.

NOTE:
Survey I did not target innovative companies *per se*, but companies that managed innovative suppliers. (See also NOTE in §5.1). The supplier innovation numbers reported in Survey I however indicated that such companies were innovative.
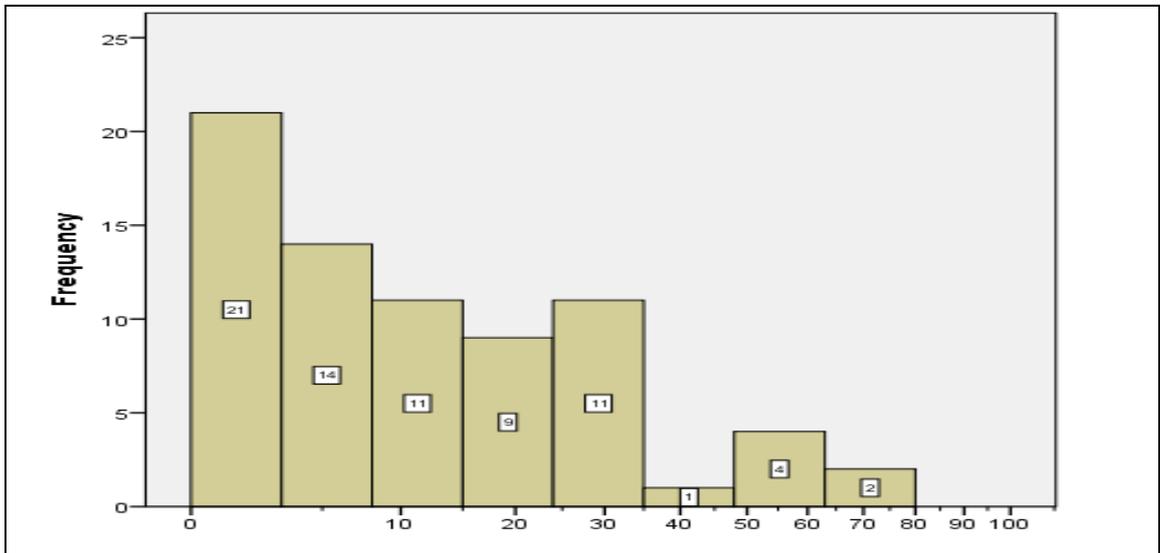
Figure 42: Turnover percentage from innovations developed w all suppliers last three years (*N*=74)

Section summary-conclusion:

49. *The companies showed a large variety of estimated innovation numbers with suppliers and related percentage of turnover. On average, respondents reported 8 innovations with all suppliers over the past three years, with a SD=13. Respondents reported an average percentage of turnover from these innovations of 16%, with a large SD=20. (Data were non-normal).*

50. *The research did not have access to comparable data on the larger New Zealand population However, the data on the innovation numbers and the turnover percentage and with all suppliers over the last three years suggested that the dataset was representative for the target-population.*

5.3.2 Benefits from Innovations (Q17-20)

In line with §2.12.3, the following Table shows four variable-pairs on perceived innovation benefits with supplier interaction[110]. It appeared that respondents valued innovations with supplier interaction higher than innovations without supplier interactions. Kibbeling (2010) found similar results among Dutch companies.

Table 63: Descriptives and significance levels on innovation-benefits.

Descriptive Statistics

	N	Mean	Std. Deviation
Innovations with supplier interaction are beneficial for our company	112	2,25	,865
Innovations with supplier interaction are beneficial for the natural environment	112	2,60	,905
Innovations without supplier interaction are beneficial for our company	112	2,92	,902
Innovations without supplier interaction are beneficial for the natural environment	112	3,04	,995
Valid N (listwise)	112		

Test Statistics[a]

	Innovations with supplier interaction are beneficial for the natural environment - Innovations with supplier interaction are beneficial for our company	Innovations without supplier interaction are beneficial for our company - Innovations with supplier interaction are beneficial for our company	Innovations without supplier interaction are beneficial for the natural environment - Innovations with supplier interaction are beneficial for our company	Innovations without supplier interaction are beneficial for our company - Innovations with supplier interaction are beneficial for the natural environment	Innovations without supplier interaction are beneficial for the natural environment - Innovations with supplier interaction are beneficial for the natural environment	Innovations without supplier interaction are beneficial for the natural environment - Innovations without supplier interaction are beneficial for our company
Z	-4,289[b]	-5,480[b]	-6,129[b]	-2,926[b]	-4,608[b]	-1,601[b]
Asymp. Sig. (2-tailed)	,000	,000	,000	,003	,000	,109

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

A series of Wilcoxon signed-rank tests indicated that differences were statistically-significant in 5/6 instances. Interacting with innovative suppliers equalled better results. The data suggested it was more "frequently to sometimes" beneficial for the company to interact with innovative suppliers, than without innovative suppliers. It was also more "frequently to sometimes" beneficial for the natural environment to interact with innovative suppliers, than without innovative suppliers. From the data it could be theorized, that if the primary company goal were to be beneficial for the natural environment (as for example in a social enterprise), interacting with suppliers would still yield higher benefits for the company than not interacting with innovative suppliers.

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[110] A 5-point Likert-type scale: 1 always beneficial, 2 frequently, 3 sometimes, 4 occasionally, 5 never.

Generally, most companies use internal and external sources for innovations and ideas. New Zealand stats (2013) mentioned that overall, 11% of construction companies only used *internal* sources for ideas or information for innovations[111]. Based on this survey, cooperating (also) with suppliers as an external source would be beneficial in the construction industry.

The Spearman correlation of the variable-pair for benefits on interacting *with* suppliers was moderate (Spearman *Rho*=.620; Cohen, 1992), as was the Spearman correlation on benefits *without* supplier interaction (Spearman *Rho*=.668). This would imply that higher company benefits could also equal higher environmental benefits. This was in line with for example a seminal article in the HB-Review by Nidumolu, Prahalad & Rangaswami (2009), but would differ from common practice in the New Zealand construction industry. *Hence companies that focused on obtaining higher company benefits, would also benefit the natural environment to a larger extent.*

Section summary-conclusion:

51. *Innovations with and without supplier interactions were significantly seen as more beneficial to the company, than to the natural environment.*
52. *Innovations with supplier interactions were significantly seen as more beneficial to the company and to the natural environment, than innovations without supplier interactions.*
53. *Even if the primary goal were to be beneficial for the natural environment, supplier interactions would still equal more benefits to the company than innovations without supplier interactions. Correlations were moderate, which also suggested that higher (or lower) company innovation-benefits equalled higher (or lower) environmental innovation-benefits. This was in line with some generic innovation literature and seemed to differ from common business practice in New Zealand construction supply chains.*
54. *The research did not have access to comparable innovation-benefit data on the larger New Zealand population. Findings however suggested that the dataset was representative for the target-population.*

5.3.3 Satisfaction Rates on Procurement, Sales, and Innovation (Q30)

Based on §2.12.3, the following Table gives perceived satisfaction rates on innovation activities through the value chain with innovative customers versus suppliers[112]. The survey question measured perceived satisfaction on procurement with suppliers, innovation with suppliers, internal innovation, marketing-sales with customers, and on innovation with

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[111] The New Zealand industry average of companies only using internal sources is 8% (NZ Stats, 2013).
[112] A 5-point Likert-type scale: 1 very unsatisfied; 2 unsatisfied; 3 neutral; 4 satisfied; 5 very satisfied. Data were non-normally distributed.

customers. Considering the means and standard deviations, on average, respondents only reported "neutral-to-satisfied" (M_{avg}=3.42) with these activities.

Table 64: Descriptives on innovation-satisfaction rates (*N*=102, listwise)

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Satisfaction with procurement with innovative suppliers	104	1	5	3,40	,830
Satisfaction with innovation with innovative suppliers	103	2	5	3,44	,800
Satisfaction with marketing&sales with innovative customers	104	1	5	3,30	,774
Satisfaction with innovation with innovative customers	103	1	5	3,44	,882
Satisfaction with internal innovation activities	105	1	5	3,52	,856
Valid N (listwise)	102				

These satisfaction rates were statistically similar in 9/10 variable-pairs. (See below).

Table 65: Significance levels innovation-satisfaction rates *(N* listwise=102)

Test Statistics[a]										
	Satisfaction with innovation with innovative suppliers - Satisfaction with procurement with innovative suppliers	Satisfaction with marketing&sales with innovative customers - Satisfaction with procurement with innovative suppliers	Satisfaction with innovation with innovative customers - Satisfaction with procurement with innovative suppliers	Satisfaction with internal innovation activities - Satisfaction with procurement with innovative suppliers	Satisfaction with marketing&sales with innovative customers - Satisfaction with innovation with innovative suppliers	Satisfaction with innovation with innovative customers - Satisfaction with innovation with innovative suppliers	Satisfaction with internal innovation activities - Satisfaction with innovation with innovative suppliers	Satisfaction with innovation with innovative customers - Satisfaction with marketing&sales with innovative customers	Satisfaction with internal innovation activities - Satisfaction with marketing&sales with innovative customers	Satisfaction with internal innovation activities - Satisfaction with innovation with innovative customers
Z	-,642[b]	-1,283[c]	-,277[b]	-1,276[b]	-1,712[c]	-,140[c]	-,612[b]	-1,433[b]	-2,107[b]	-,838[b]
Asymp. Sig. (2-tailed)	,521	,200	,782	,202	,087	,889	,541	,152	,035	,402

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.
c. Based on positive ranks.

An analysis on the five variables revealed several weak-to-moderate Spearman correlations (Cramer & Howitt, 2004: 39) where Spearman *Rho* varied from .275 to .645 at the *p*≤.05 significance level. Correlation between satisfaction on procurement activities and innovating activities with suppliers was higher (*Rho*=.645), than the corresponding correlation between satisfaction on marketing-sales activities and innovation activities with customers (*Rho*=.322). *This suggested that procurement and innovating activities with innovative suppliers were better aligned than marketing-sales and innovating activities with innovative customers.*

Table 66: Correlations on innovation-satisfaction types

Correlations		Satisfaction with procurement with innovative suppliers	Satisfaction with innovation with innovative suppliers	Satisfaction with internal innovation activities	Satisfaction with marketing&sales with innovative customers	Satisfaction with innovation with innovative customers
Satisfaction with procurement with innovative suppliers	Correlation Coefficient	1,000	,645**	,285**	,249*	,482**
	Sig. (2-tailed)	.	,000	,003	,011	,000
	N	104	103	104	103	103
Satisfaction with innovation with innovative suppliers	Correlation Coefficient	,645**	1,000	,310**	,381**	,450**
	Sig. (2-tailed)	,000	.	,001	,000	,000
	N	103	103	103	103	102
Satisfaction with internal innovation activities	Correlation Coefficient	,285**	,310**	1,000	,261**	,298**
	Sig. (2-tailed)	,003	,001	.	,008	,002
	N	104	103	105	104	103
Satisfaction with marketing&sales with innovative customers	Correlation Coefficient	,249*	,381**	,261**	1,000	,322**
	Sig. (2-tailed)	,011	,000	,008	.	,001
	N	103	103	104	104	102
Satisfaction with innovation with innovative customers	Correlation Coefficient	,482**	,450**	,298**	,322**	1,000
	Sig. (2-tailed)	,000	,000	,002	,001	.
	N	103	102	103	102	103

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Section summary-conclusion:

55. *On average, respondents were neutral-to-satisfied (M=3.42; Max=5) on their innovations with procurement, suppliers, internally, marketing-sales, and customers. These five types of satisfaction rates overall did not statistically differ (9/10) and showed weak-to-moderate correlations.*

56. *Correlations of innovation-satisfaction on procurement and on innovating activities with innovative suppliers were somewhat higher than correlations on marketing-sales and on innovating activities with innovative customers. This suggested that the procurement activities with innovative suppliers were better aligned than marketing & sales activities with innovative customers.*

57. *The research did not have access to comparable innovation-satisfaction data on the larger New Zealand population. Findings indirectly suggested that the dataset was representative for the target-population.*

5.3.4 Conclusions from Descriptives on Procurement Performance

This Section analysed descriptive and some inferential statistics on dependent procurement performance variables. The research hypothesis for this Section is:

H3: The procurement performance data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

The Table in §5.4 summarises the 9 Summary-conclusions of this Section. Although numbers varied, respondents on average reported *M*=8 supplier-innovations over the past three years, with related average turnover-percentages of almost *M*=16%. Interacting with innovative suppliers was beneficial to the company and the natural environment. Respondents were equally satisfied with innovating with suppliers and customers. Data on procurement performance overall suggested that the dataset was representative for the target-population.

The H3 hypothesis was confirmed: the procurement performance data were representative for the target-group of companies that managed innovative suppliers.

5.4 Chapter Summary

This Chapter aimed to increase the understanding in the descriptive variables of the target-population. The Chapter was designed broadly to capture the variety of variables within companies that managed innovative suppliers in New Zealand construction supply chains. It aimed to answer the following empirical research question and supporting high-level hypotheses.

(RQ5) What variables & practices did respondents report, what was the profile of the case companies, how did these companies represent the target-population?
a) *What were company variables of New Zealand companies that managed innovative suppliers in construction supply chain?*

b) *What were procurement management variables & practices of New Zealand companies that managed innovative suppliers in construction supply chain?*

c) *What were procurement performance variables of New Zealand companies that managed innovative suppliers in construction supply chains?*

d) *What was the profile of the survey respondents and case companies?*

e) *To what extent did the respondents represent the target-population? (H1, H2, H3).*

H1: The company data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

H2: The procurement management data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

H3: The procurement performance data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains construction supply chains.

The following summary Table[113] describes the profile of the survey respondents as it summarises the 57 Section summary-conclusions of this Chapter 5.

Table 67: Summary on the descriptive statistics from Survey I

Company variables		
§§	Variable	Conclusions from the data
5.1.1	Company size distribution	The sample had a relatively large proportion of large companies when compared to New Zealand construction industry data. Not representative for the New Zealand construction industry. Unclear whether representative for the target-population.
5.1.2	Entre-preneurial orientation towards suppliers or customers	The construct was internally consistent and could be applied to assess entrepreneurial orientation towards innovative customers, but more interestingly also towards innovative suppliers. Entrepreneurial orientation towards innovative customers and suppliers did not significantly differ for 3/5 variable-pairs. Repondents considered innovating activities and trust with as most important, and statistically more important with suppliers than with customers. They considered aggressiveness towards supplier or customer markets as least important. Moreover, correlations within the variable-pairs were moderate. This implied that companies that were entrepreneurial towards customers would to a reasonable extent also be entrepreneurial towards suppliers. Companies that were entrepreneurial on some variables towards customers or towards suppliers would not necessarily exhibit such behaviour on other entrepreneurial variables. This would imply that companies could have multiple entrepreneurial profiles towards customers or towards suppliers. The research distinguished a cooperation, aggression and risk-taking profile. Due to moderate or weak correlations, such profiles would not be easily recognised. Findings were in line with interview data from Chapter 4. Findings were contrary to the uni-dimensional view of Covin & Slevin (1989) and Wiklund & Shepard (2003). However they were in line with findings on a multidimenional approach by Gupta *et al.* (2014) and Schueler *et al.* (2018). (See Schillo, 2011: 23; Franz, 2018: 22-25). Findings suggested (indirectly) that they were representative for the target-population[114].
5.1.3	Company type Company strategy	The most frequent company type (60%) provided either contractor or specialist services; 20% of respondents worked in manufacturing. (Another worked 20% in wholesale or not relevant). Most respondents (50%) reported an entrepreneurial strategy as most important; 38% a lifestyle strategy; 12% a survival strategy. Findings suggested that they were representative for the target-population.
5.1.4	Experience levels & roles	Respondents probably reported higher experience levels than in average construction industry (MBIE, see §2.6.2). Respondents reported significantly higher experience levels in management & strategy than in other functional areas. Respondents could have different roles. Correlations between the five experience types were generally moderate; correlation of procurement experience with the other experience types was somewhat weaker. The broad experience base and multiple roles could be helpful in managing innovative suppliers. Findings were in line with interview data from Chapter 4. Results suggested that the dataset was representative for the target-population.
5.1.5	Company age	The sampled population was older than the average New Zealand company. The SMEs in the sample however had an age similar to the average New Zealand company. According to literature these smaller and younger companies could be more innovative. However it remained unclear whether the age distribution was representative for the target-population.
5.1.6	Customer value proposition	Most respondents (49%) reported that product leadership was their most important customer strategy. Similarly, 36% of respondents reported customer intimacy, and 15% that operational excellence was most important. This was in line with interview findings from Chapter 4 and not in line with the cost-concious strategy in New Zealand constuction. Findings were probably representative for the target-population.

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[113] This Table summarises findings from §5.1.7, §5.2.7, and §5.3.4
[114] and probably not for the New Zealand construction industry. (Like elsewhere in this Table).

Procurement variables		
§§	Variable	Conclusions from the data
5.2.1	Idea and develop phase	The specify-needs and the find-select step in both phases were significantly considered most important with relatively low standard deviations. This was fairly in line with early supplier involvement with e.g. Johnsen *et al.* (2014: 167-168) and Van Weele (2010: 53). The negotiate-contract and the manage-relations steps were therefore seen as less important. Respondents had relatively high standard devations in these last two procurement steps. Moreover, the negotiate-contract step was considered significantly more important in the develop phase than in the idea phase. The low ranking of the manage-relation step could indicate that espondents were purpose-driven. Unclear whether findings were representative for the target-population.
5.2.2	TOP 3 procurement practices	Overall, respondents did not show strong preferences on procurement practices in the four procurement steps. However, the TOP 3 of (12) practices accounted for 53% of all (36) practices. (See Table 57). Contrary to common perceptions on adversarial and cost-focussed relations in the construction industry (Hinton, 2013; see §2.1.2, §2.3.4), the ranking of procurement practices and the related respondents' remarks showed a more nuanced and cooperative representation of procurement practices with innovative suppliers. Findings were partially in line with Adams (2004: 129). Rankings suggested that findings were representative for the target-population.
5.2.3	Supplier types	Overall respondents had similar preferences for the supplier types small versus large, and for foreign versus domestic with (somewhat) incremental and (somewhat) radical innovation. Respondents slightly but statistically-significant favoured somewhat more new suppliers with (somewhat) radical innovations than new suppliers with (somewhat) incremental innovations. Respondents also significantly preferred small foreign suppliers over large domestic suppliers for radical innovations. This could be in line with literature (Lasagni, 2012, Johnsen ea (2011) and Schiele (2010), see §2.9.1). The data found moderate correlations within the three supplier types for radical and incremental innovations. This would mean that respondents who preferred such supplier types for (somewhat) radical innovations, would to a moderate extent also use such supplier types for (somewhat) incremental innovations. (And vice versa). The data only found weak correlations between the three supplier types. Rankings indirectly suggested that findings were representative for the target-population.
5.2.4	Supplier relations	Overall, respondents had the highest relation intensities with service providers, then with manufacturers and then with distributors. These differences were statistically-significant and correlations were weak-to-moderate. This could be explained by the fact that procuring services generally need more interaction than procuring products. Findings could be in line with interview findings from Chapter 4. The relatively high intensity of relations only indirectly suggested that the dataset was representative for the target-population.
5.2.5	Innovation types	Respondent showed similar preferences of product versus process innovations, and of radical versus incremental innovations towards innovative suppliers and towards innovative customers. Respondents generally preferred incremental innovations. However the relatively higher preferences for radical innovations indirectly suggested that the sample was represetive for the target-population.
5.2.6	Entrepreneurial orientation towards suppliers	Findings confirmed conclusions from §5.1.2. Companies with entrepreneurial profiles towards innovative customers also had enterpreneurial profiles towards innovative suppliers. Companies did not have one unique entrepreneurial profile. (This was in line with Schillo, 2011) and others. Findings on the entrepreneurial orientation were indirectly in line with interview data from Chapter 4. The relatively high scores would (indirectly) suggest that the dataset was representative for the target-population.
Performance Variables		
§§	Variable	Conclusions from the data
5.3.1	Number of innovations and related turnover	The companies showed a large variety of estimated innovation numbers with supplier and related percentage of turnover. On average they reported 8 innovations from all suppliers over the past three years, with a large SD=13. (Data were non-normal). They reported on average 16% turnover from these innovations with a large SD=20.

		Findings on innovation numbers would be in line with findings from the interiews in Chapter 4. The relatively high scores (cf. NZStats, 2013) would (indirectly) suggest that the dataset was representative for the target-population.
5.3.2	Benefits for company and natural environ-ment	Respondents reported innovations with and without supplier interactions significantly as more beneficial to the company, than to the natural environment. Innovations with supplier interactions were significantly seen as both more beneficial to the company and to the natural environment, than innovations without supplier interactions. Even if the primary goal were to be beneficial for the natural environment, supplier interactions still equalled more benefits to the company, than innovations without supplier interactions. Correlations were moderate, which also suggested that higher company innovation-benefits equalled higher environmental innovation-benefits. The finding that innovations with suppliers were valued higher, was in line with Kibbeling (2010). Findings indirectly suggested that the dataset was representative for the target-population.
5.3.3	Satisfaction rates	Innovation-satisfaction rates with procurement, suppliers, internally, marketing-sales and with customers were similar, and rated neutral-to-satisfied. Procurement versus innovating activities with suppliers correlated higher than marketing-sales versus innovating with customers. This could suggest that respondents thought that procurement with innovative suppliers was better aligned than marketing & sales with innovative customers. Open innovation literature gave some support of this finding, escpecially that SMEs conducted more open innovation with suppliers than with customers. (§2.3.6). Findings indirectly suggested that the dataset was representative for the target-population.

Findings showed, that Survey I succeeded in reaching the intended target-population of companies that managed innovative suppliers. The above Table describes the three main variable types of Survey I. It used literature from Chapter 2 and generally complemented findings from Chapter 4.

Hypotheses H1 and H3 were confirmed. H2 was largely confirmed. Hence the company data, the procurement management data, and the procurement performance data were representative for the target-group of companies that managed innovative suppliers.

The next two Chapters discuss inferential statistics of company variables on mediating procurement variables (Chapter 6), and inferential statistics of company and procurement management variables on procurement performance (Chapter 7). Section §9.3 discusses conclusions on Chapter 5.

Chapter 6

Survey I:

Company Variables on Procurement Management

Chapter 6

Survey I: Company Variables on Procurement Management

This Chapter discusses (causal or correlation) relations between 17 company variables and 24 procurement management variables. (See the Conceptual Model II below; copy §2.13, §3.5). Hence the following Sections §6.1 to §6.4 analyse possible effects of four independent company variables on six mediating procurement management variables. The Chapter ends with a summary and conclusions (§6.5).
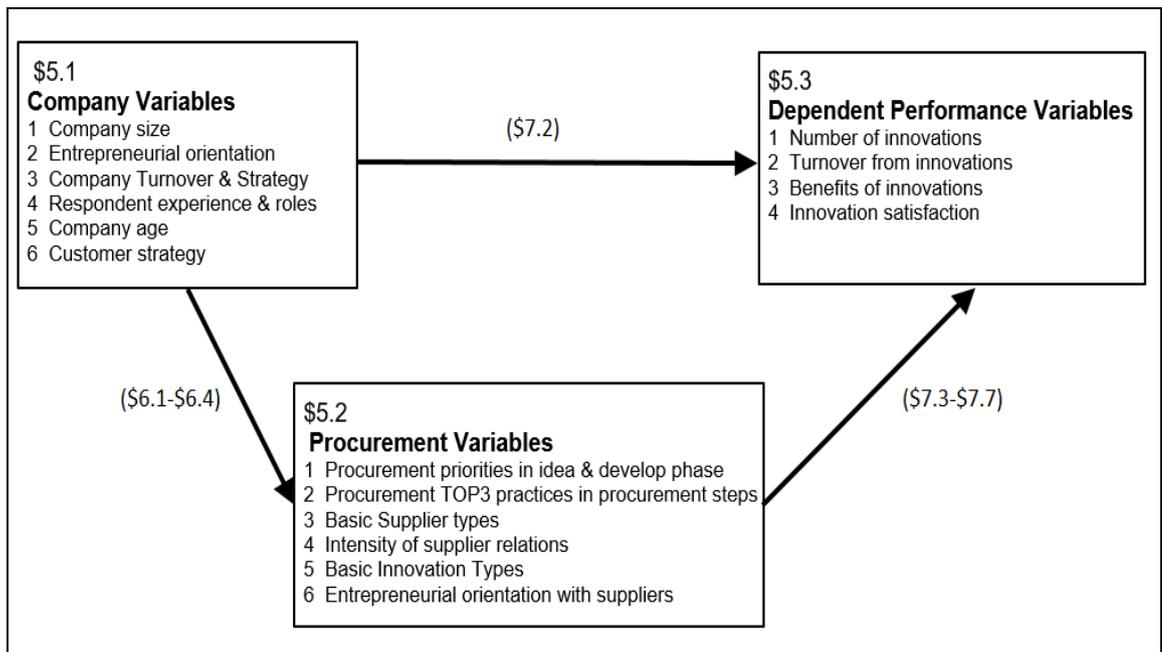
Figure 43: Conceptual Model II explores procurement variables controlled for company variables

This Chapter aimed to answer the following empirical research question and hypothesis.

(RQ6) What relations existed between company variables and procurement management variables & practices in New Zealand companies that managed innovative suppliers in construction supply chains?

H4: Differences in company variables had significant effects on procurement management variables.

Each Section of this Chapter discusses a part of the following sub-hypotheses:

H4a: Differences in company size had significant effects on procurement management practices. (§6.1)

H4b: Differences in entrepreneurial orientation towards innovative suppliers had significant effects on procurement management practices. (§6.2)

H4c: Differences in experience levels had significant effects on procurement management practices. (§6.3)

H4d: Differences in strategy types had significant effects on procurement management practices. (§6.4)

NOTES:

1. In this Chapter 6, the variables company age and company turnover type were not used.
2. This Chapter used uncoded and recoded variables as this strategy should help to detect more significant results. The uncoded variables had somewhat larger sample sizes, which should help in finding significant results. The recoded variables focused on extreme (high versus low) values. Such extremes should also help to find significant results. Tests were therefore conducted twice.
3. This Chapter aimed to suggest whether relations *could* be causal or correlational. (See also §3.2.4; §3.5). Any statistical significance did not necessarily relate to significance in managerial practice. For once, the research could not analyse all possible (complex) statistical relations due to limitations in sample size, homogeneity or variety of the sample, and limitations in the survey and hence data structure. Moreover the research had to apply broad conceptual models, ignoring effects from mediating or multiple variables.
4. The research analysed statistically-significant relationships relative to the total number of relations between coded and/or uncoded independent and dependent variables. In case one such significance occurred one out of 20 relations, this instance was indicated as e.g. 1/20 instances; two such instances as 2/20, etc.
5. Instances are summarised in Section Chapters and/or in the Chapter Summary. An overview of analysed significant and non-significant relations is provided in a table in §6.5.
6. The research made limited use of relative or calculated effects sizes as the sample size was too small and most of the data were non-normal. (Sullivan & Feinn, 2012: 217; Lavery, 2015: 28). Moreover, calculating effect sizes in all instances would go well beyond the purpose of this broadly-designed quantitative research. Where relevant, it analysed correlations. (See also §5.1; §10.3).
7. Section §6.1 notably also used literature in Appendices §2.3.3 & §2.3.6. From Section §6.2 onwards, the comparison with literature was mainly based on the main text of Chapter 2.
8. From Section §6.2, detailed Figures & Tables can be found in corresponding Appendices.

Section summary-conclusion:

1. *Chapter 6 analysed statistically significance of procurement variables & practices controlled for company variables. In several instances it additionally analysed correlations. It did not analyse other effect sizes as most of the data was non-normal.*

6.1 Effects of Company Size on Procurement Management Variables

This Section (with seven Subsections) discusses possible (causal or correlation) effects of company size. The survey data had N=112 respondents (Chapter 5). As discussed in §2.3.3, §2.3.6, §2.5 and §2.6.1, literature was inconclusive, but a body of research suggested that SMEs could have different procurement behaviour than large companies. This was supported by entrepreneurship research. (For example Storey, 1986; Torrès & Julien, 2005; see §2.5) However, Adams (2004: 131, 147) for example noticed no significant differences related to SME size, but noticed some differences with annual sales on the formalisation of procurement practices. Other procurement research, e.g. Paik (2009a, 2009b, 2009c, 2011) or Ellegaard (2006, 2008, 2009) clearly noted differences related to size. Therefore the hypothesis for this Section is:

H4a: Differences in company size had significant effects on procurement management variables.

In line with e.g. conclusions of Morrissey & Knight (2011: 1152) it was posited that companies with a 'medium' size, i.e. between SMEs and large companies would show a mixed behaviour. This research therefore omitted n=10 companies with 100 to 249 staff from the company size analyses. Hence for this Section the analysed dataset contained n=99 respondents (See §5.1.1). To avoid low values in individual cells and consequently to increase the validity of the findings in this Section, the six remaining company size classes were dichotomously recoded into *small* companies (SMEs) with 0-99 staff (n=64) and *large* companies with >250 staff (n=35)[115]. (See Table below).

Table 68: Distribution company size without the group of 100-249 staff (n=10)

ComSize Small (< 99) vs Large (> 249)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 99 fte	64	57,1	64,6	64,6
	more than 249 fte	35	31,3	35,4	100,0
	Total	99	88,4	100,0	
Missing	System	13	11,6		
Total		112	100,0		

The Section continues with analysing and discussing the effects of company size on six mediating procurement management variables.

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[115] Note that this classification is in line with the SME classification discussed in §2.6.1.1.

6.1.1 Company Size & Procurement Priorities in Idea & Develop Phase (Q21, Q1-2)

Chapter 5 (§5.2.1) revealed that companies attached different priorities in the four procurement steps during the idea phase of an innovation and during the develop phase. The research hence tested effects of company size with the relative priorities of the four procurement steps in the two phases. Descriptives are shown below.

Table 69: Procurement step priorities idea & develop phase controlled for company size (*N*=95)[116]

Group Statistics					
	ComSize Small (< 99) vs Large (> 249)	N	Mean	Std. Deviation	Std. Error Mean
Ranking in Idea phase Specify	less than 99 fte	61	1,77	,883	,113
	more than 249 fte	34	2,21	1,095	,188
Ranking in Idea phase Find or Select	less than 99 fte	60	1,95	,946	,122
	more than 249 fte	35	2,03	1,150	,194
Ranking in Idea phase Negotiate or Contract	less than 99 fte	62	3,29	,797	,101
	more than 249 fte	34	3,26	,790	,136
Ranking in Idea phase Manage Relations	less than 99 fte	63	2,92	1,052	,133
	more than 249 fte	35	2,46	1,039	,176
Ranking in Develop phase Specify	less than 99 fte	62	1,71	,982	,125
	more than 249 fte	34	2,00	1,015	,174
Ranking in Develop phase Find or Select	less than 99 fte	62	2,44	1,034	,131
	more than 249 fte	34	2,62	1,129	,194
Ranking in Develop phase Negotiate or Contract	less than 99 fte	61	3,26	,854	,109
	more than 249 fte	34	2,65	1,070	,183
Ranking in Develop phase Manage Relations	less than 99 fte	61	2,61	1,053	,135
	more than 249 fte	34	2,74	1,163	,199

The Table suggests that small versus large companies differed in their prioritisation of procurement steps in the two phases. The dependent variable data appeared to behave non-normal[117] in several instances. Therefore, a Kruskal-Wallis test was applied (Table below). This revealed that small (<99 staff) versus large (>250 staff) companies only in 2/8 instances had significant differences in the priorities of the procurement steps. These were during the idea phase for manage-relations (*p=.032*), and during the develop phase for negotiate-contract (*p=.005*). Comparing the above means and the results from the Kruskal-Wallis test indicated that SMEs put a statistically-significant *lower* priority on these two procurement steps than large companies. Differences were not significant for the other six instances.

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[116] A 4-point Likert-scale: 1 most important; 2 important; 3 not so important; 4 least important.
[117] Q-Q plots seemed fairly normal although especially box plots showed non-normality. Tests of normality (Shapiro-Wilk and especially Kolmogorov-Smirnov) all gave *p*<.01 hence non-normality. Therefore, non-parametric tests were preferred.

Table 70: Procurement step priorities idea & develop phase controlled for company size

	Test Statistics[a,b]							
	Ranking in Idea phase Specify	Ranking in Idea phase Find or Select	Ranking in Idea phase Negotiate or Contract	Ranking in Idea phase Manage Relations	Ranking in Develop phase Specify	Ranking in Develop phase Find or Select	Ranking in Develop phase Negotiate or Contract	Ranking in Develop phase Manage Relations
Chi-Square	3,583	,002	,042	4,584	2,578	,615	7,832	,373
df	1	1	1	1	1	1	1	1
Asymp. Sig.	,058	,964	,838	,032	,108	,433	,005	,541

a. Kruskal Wallis Test

b. Grouping Variable: ComSize Small (< 99) vs Large (> 249)

These two differences could be explained on the limited resources SMEs had for managing relations where there was not yet a specific innovation, and on the smaller negotiation powers these SMEs had for the develop phase. The corresponding standard deviations were comparable to deviations of the other procurement steps. Although the differences of these 2/8 procurement steps[118] were statistically-significant, the descriptive Table at the beginning of this Subsection also indicated that respondents gave these activities relatively low priorities (importance).

Section summary-conclusion:

2. *Based on the survey data, both small and large companies saw specify-needs and find-select suppliers in both phases as most important. (See also §5.2.1).*

3. *Small versus large companies showed 2/8 significant differences in the prioritisation of their 2x4 procurement steps during the idea phase and the develop phase. SMEs placed a significantly lower priority on manage-relations in the idea phase, and also on negotiate-contract during the develop phase. The limited resources and negotiation power of SMEs could explain these differences.*

4. *Literature was inconclusive and yet gave more context. Skiffington et al. (2013) found that New Zealand SMEs (1-99 staff) preferred longer relations with suppliers. De Wilde & Slee (2006) found benefits for SMEs (1-250 staff) for early involvement in project-based procurement, i.e. involvement in the idea phase. Dills & Prough (1989) found that US small travel agencies ranked close supplier relations and contracts lower than larger companies. Hemert et al. (2013) found that collaboration for supplier innovations would be more important in later phases of innovation projects. However, Heger et al. (2014) found that SMEs would use the first phases for data collection, but not for decision-making. Lasagni (2012) found that companies would use suppliers in the innovation idea phase for generating ideas, but probably would use internal resources for development.*

5. *Although results in 2/8 instances were statistical different, there was not enough evidence to confirm the hypothesis. Hence small and large companies had fairly similar priorities in*

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[118] In Chapters 6 and 7 therefore, this research used notations similar to "2/8", or "2/8 instances".

the procurement steps when engaging with innovative suppliers in the idea and the develop phase. Findings were also unable to confirm or reject the inconclusive findings from extant literature.

6.1.2 Company Size & Procurement Practices (Q21, Q3-6)

As discussed in §3.6.4.2 and §5.2.2, the structure of the dataset provided counts (constants) per variable for the four procurement steps: specify-needs, find-select, negotiate-contract and manage-relations. Consequently in this Chapter the dataset did *not* allow for significance tests on nine practices from each of the four procurement steps in small versus large companies[119]. Instead it used SurveyMonkey data to assess differences and similarities[120]. It applied a cut-off ≥10% and practices above this cut-off percentage were labelled as "potentially-relevant". This cut-off percentage could be considered somewhat arbitrary but tried to balance between Type I and Type II errors (Saunders *et al.*, 2009: 602).

The exploratory interviews (Chapter 4) and the literature review in Chapter 2 (see also the beginning of §6.1) suggested different procurement behaviour. In the survey, respondents could select their TOP 3 out of 9 practices for each of the four procurement steps.

The aggregated TOP 3 of procurement practices in the specify-needs step was analysed on differences in company size. (As an example, see the vertical blue arrow in the below stacked bar charts; manual assessments with cut-off ≥10%. The differences were not (0/9) above the 10% cut-off. Also the preferences for the TOP 3 was similar with small versus large companies).

The aggregated TOP 3 of procurement practices in the find-select step seemed to differ with company size. (See the Figure below with the stacked bar charts). However differences were not (0/9) above the 10% cut-off. Therefore, the TOP 3 preferences were fairly similar for small versus large companies.

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[119] This is also true for procurement practices in §6.2.2, §6.3.2, and §6.4.2. For inferential analyses on procurement (management) best-practices, see Chapter 8.
[120] The gross SurveyMonkey sample size was larger (*N*=101) than the SPSS sample size (*N*=99) as it included two more partial respondents. The blue arrow gives an example of the comparison. (In this case delta=1%).
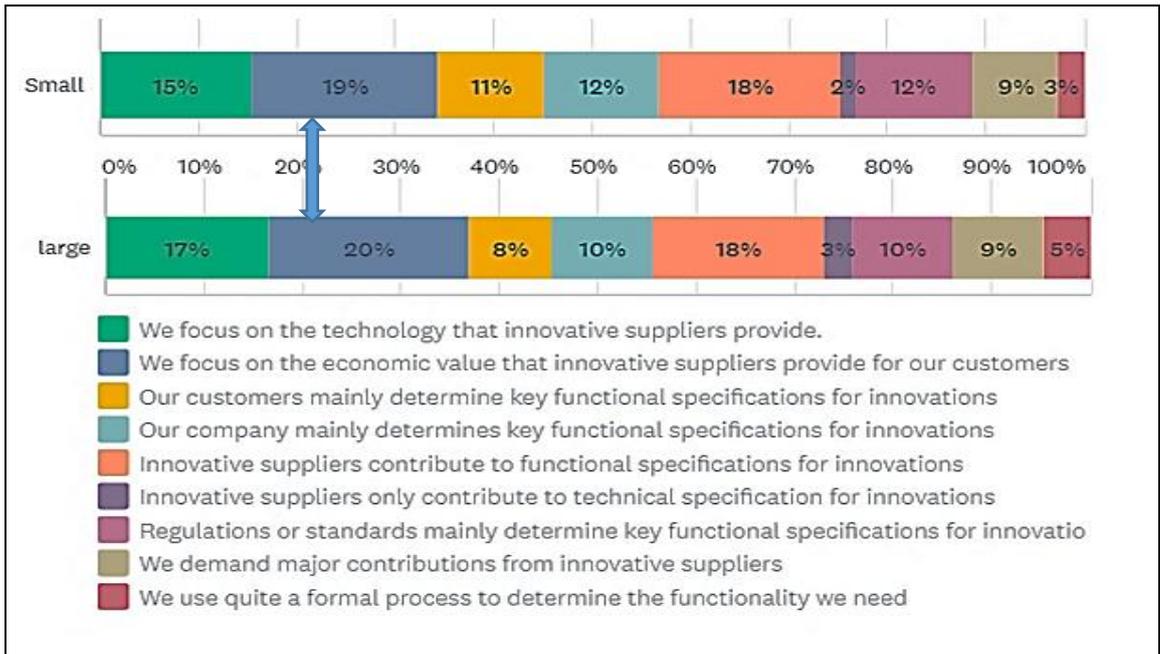
Figure 44: Specify-needs practices & small versus large companies (N_{small}=65; N_{large}=36)
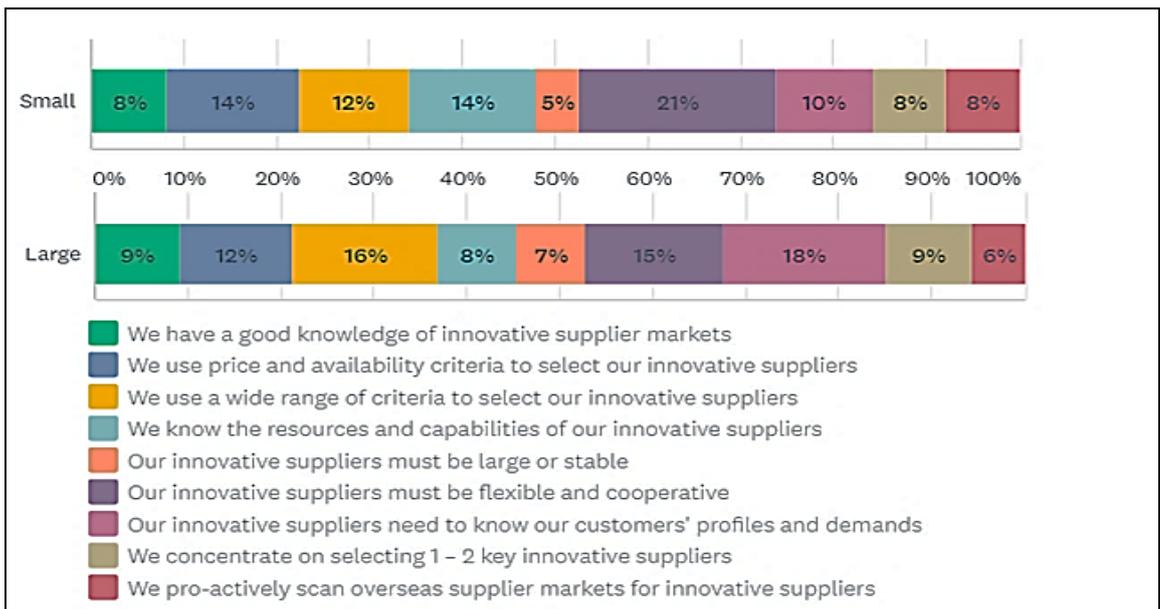
Figure 45: Find-select practises & small versus large companies; N_{small}=65; N_{large}=36)

When the aggregated TOP 3 on negotiate-contract step was analysed on company size some differences appeared. Again, these were not (0/9) above the 10% cut-off. (See below stacked bar charts). The TOP 3 preferences only seemed to differ slightly with company size.

Figure 46: Negotiate-contract practises & small versus large companies (N_{small}=65; N_{large}=36)

Finally, when the aggregated TOP 3 in the manage-relations step was analysed on company size, some possibly-relevant differences appeared. Again, these were mostly not above the 10% cut-off. Except for using contracts (1/9), the TOP 3 preferences were fairly similar for small versus large companies. (See below stacked bar charts).
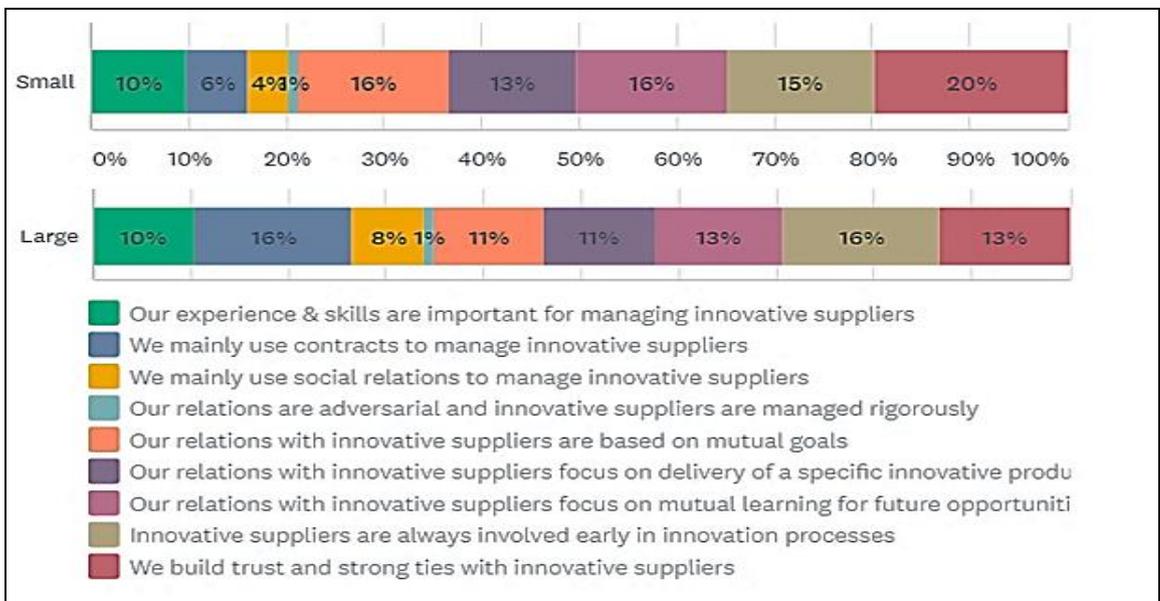
Figure 47: Manage-relations practises & small versus large companies (N_{small}=65; N_{large}=36)

Section summary-conclusion:

6. *Due to the data structure, the 4x9=36 procurement practices in the four procurement steps were not tested on statistical significance levels.*

7. *Instead findings of "possibly-relevant differences" were manually based on cut-off points ≥10%. In 35/36 (97%) instances, large and SMEs showed similar preferences on procurement practises.*

8. *Small and large companies overall showed similar practices. The one exception was that large companies more often used contracts and social relations to manage innovative suppliers. This finding was in line with literature (see §2.11.2).*

9. *Section §2.11.2 and Appendices §2.3.3 and §2.2.6 suggested differences on many procurement practices when controlled for company size. For example Jong & Vermeulen (2006: 595) found "major differences" in innovation practices between SMEs (<100 staff) and large organisations.*

10. *This analysis found several small differences (between 5% and 10%) in procurement practices with innovative suppliers. However, unlike extant literature, this analysis was unable to find major possibly-relevant differences meeting the ≥10% cut-off.*

6.1.3 Company Size & Supplier Types (Q21, Q11-13)

Another combination worth exploring was whether small versus large companies exhibited the same or different preferences for the three supplier types (see §5.2.3) when they managed (somewhat) incremental or (somewhat) radical innovations with suppliers. The three pairs of supplier types (shown in the following Table) were foreign versus domestic, new versus current, and small versus large suppliers. The Figure below shows mean values from 5-point Likert-scales[121]. It did not suggest significant different preferences of small versus large companies.

As could be expected from the below Figure 48, a Kruskal-Wallis test revealed no significant differences in the mean ranks within the pairs. (Table 75 below). Therefore, the respondents' preferences on the three supplier types when managing innovations with suppliers or with/for customers were considered similar in small versus large companies.

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[121] Normal Q-Q plots, box plots and Kolmogorov-Smirnov and Shapiro-Wilk tests revealed non-normal distributions. The 5-point Likert-scales:
Foreign versus domestic: 1 only domestic, 2 mainly domestic, 3 both domestic and overseas, 4 mainly overseas, 5 only overseas suppliers.
New versus current: 1 only new, 2 mainly new, 3 both new & current, 4 mainly current, 5 only current suppliers.
Small versus large: 1 only small, 2 mainly small, 3 both large and small, 4 mainly large 5 only large suppliers.
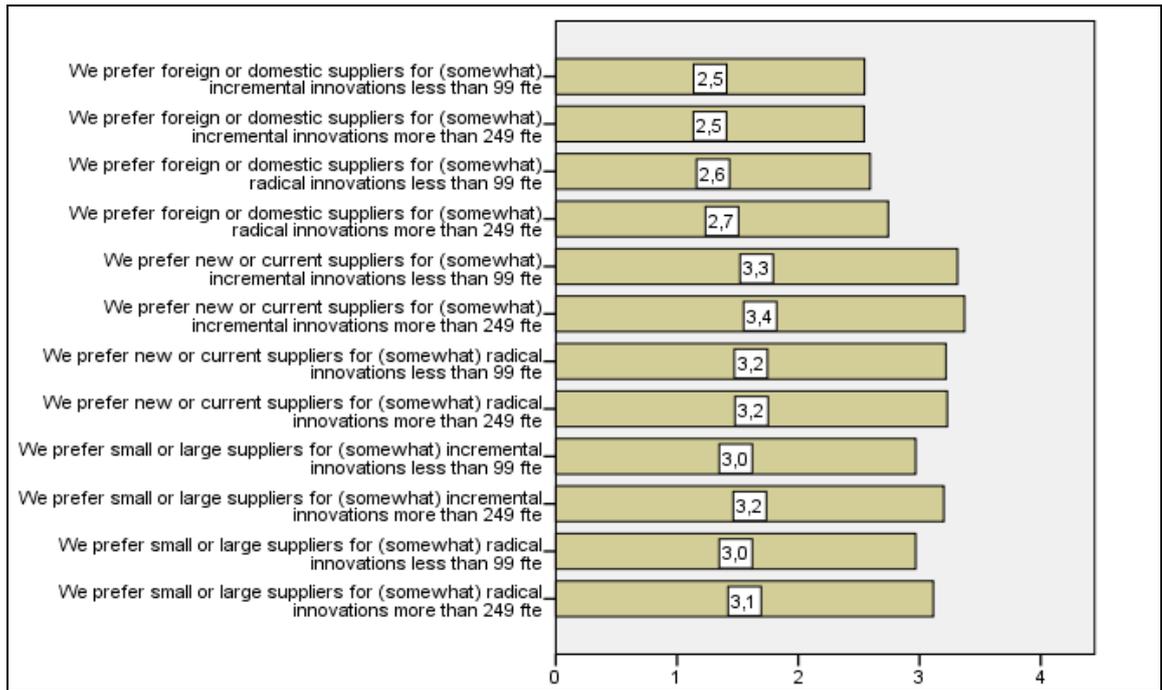
Figure 48: The effects of company size with several pairs of supplier types (Scales 1 to 5)

Table 71: Three supplier types controlled for company size (N_{small}=64; N_{large}=35)

Test Statistics[a,b]						
	We prefer foreign or domestic suppliers for (somewhat) incremental innovations	We prefer foreign or domestic suppliers for (somewhat) radical innovations	We prefer new or current suppliers for (somewhat) incremental innovations	We prefer new or current suppliers for (somewhat) radical innovations	We prefer small or large suppliers for (somewhat) incremental innovations	We prefer small or large suppliers for (somewhat) radical innovations
Chi-Square	,008	1,260	,323	,156	3,329	1,194
df	1	1	1	1	1	1
Asymp. Sig.	,929	,262	,570	,693	,068	,274

a. Kruskal Wallis Test

b. Grouping Variable: ComSize Small (< 99) vs Large (> 249)

Section summary-conclusion:

11. *Small and large companies exhibited similar supplier preferences in the 3x2=6 pairs of supplier types for either (somewhat) incremental versus (somewhat) radical supplier innovations.*

12. *Literature was scarce on supplier type preferences with innovative suppliers and only discussed these preferences in general terms. (§2.3.3, §2.3.6). It was particularly inconclusive on foreign versus domestic suppliers. Agndal (2006) found that Danish SMEs (46-164 staff) would be more passive in foreign sourcing. However, Overby & Servais (2005) found that Danish SMEs (10-499 staff) actively used foreign suppliers for cost and quality reasons. Canham & Hamilton (2013) found that 56% of New Zealand SMEs (M=60 staff) would not offshore for fear of loss of quality.*

13. *Generally, literature stated that SMEs would be loyal to their current suppliers, and only switched for innovations or when benefits were clear. (See Appendix §2.3.3).*

14. *Jorgensen & Koch (2012) found that Danish SMEs (30–100 staff) managed large suppliers "with varying success". Lee & Drake (2010) found differences in managing small or small suppliers. Morrissey & Pittaway (2006) found that SMEs were reluctant to collaborate with large suppliers.*

15. *Whereas literature was inconclusive on differences for the three supplier types, the data from Survey I did not suggest any statistical differences on preferences when controlled for company size.*

6.1.4 Company Size & Intensity of Supplier Relations (Q21, Q8)

As small companies have limited own resources, their dependence on supplier innovations could be higher than for large companies and hence they could have more intense supplier relations (see §5.2.4). On the other hand, it could be argued that large companies were more professional in managing innovative suppliers and had more resources available for intense relations. The following Table show differences on the intensity of supplier relations in means and standard deviations[122].

Table 72: Descriptives on intensity in supplier relations on a Likert-scale (*N*=99)

Group Statistics					
	ComSize Small (< 99) vs Large (> 249)	N	Mean	Std. Deviation	Std. Error Mean
Intensity of relationships with suppliers providing services	less than 99 fte	64	3,03	,689	,086
	more than 249 fte	35	3,37	,808	,136
Intensity of relationships with suppliers manufacturing products	less than 99 fte	64	3,00	,777	,097
	more than 249 fte	35	2,77	,973	,164
Intensity of relationships with suppliers in wholesale or distribution	less than 99 fte	64	2,36	,966	,121
	more than 249 fte	35	2,34	,838	,142

A Kruskal-Wallis test (Table below) revealed that only service providers relations differed between large and SMEs. Large companies had statistically more intensive relations with service providers. This was in line with lower priorities in the idea and develop phase (§6.1.1).

Table 73: Intensity of supplier relations controlled for company size (*N*=99)

Test Statistics[a,b]	Intensity of relationships with suppliers providing services	Intensity of relationships with suppliers manufacturing products	Intensity of relationships with suppliers in wholesale or distribution
Chi-Square	6,332	1,147	,009
df	1	1	1
Asymp. Sig.	,012	,284	,923

a. Kruskal Wallis Test

b. Grouping Variable: ComSize Small (< 99) vs Large (> 249)

Section summary-conclusion:

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[122] A 4-point Likert-scale: 1 never used, 2 low intensity, 3 medium intensity, 4 high intensity. Normality tests Kolmogorov-Smirnov and Shapiro-Wilk, Q-Q plots and box plots indicated non-normal ddistributions.

16. *Differences appeared in 1/3 instances. Large companies had significantly more intense relations with service providers than SMEs.*

17. *Literature was inconsistent on company size effects for supplier relations. Teirlinck & Spithoven (2013) and Ellegaard (2006) for example found that smaller SMEs had lower degrees of collaboration. Others, e.g. Spithoven et al. (2012) saw scarce resources as a driver for effective collaboration. Knudsen & Servais (2007) also saw strong ties with foreign suppliers as important. (See also §6.1.2; Appendix of §2.3.3). SMEs that were optimistic about industry growth considered cooperation more important (Kasouf & Celuch, 1997).*

18. *In line with findings of §6.1.1 on managing relations, these findings could be explained as large companies had resources for managing more intense relations with service providers.*

6.1.5 Company Size & Innovation Types (Q21, Q9-10)

This Section explores whether small or large companies showed differences when they developed (radical or incremental) innovations with innovative customers versus innovative suppliers. (See §5.2.5). It also explores whether such companies showed differences when they developed products or process innovations with their innovative customers versus innovative suppliers[123]. The following Table suggests some differences in means. However, a Kruskal-Wallis test indicated that these differences on innovation types of small versus large companies were not statistically-significant at the *p*<.05 level.

Table 74: Two innovation types with supplier versus customers controlled for company size[124]

Group Statistics

	ComSize Small (< 99) vs Large (> 249)	N	Mean	Std. Deviation	Std. Error Mean
We develop product or process innovations /with our innovative customers	less than 99 fte	64	3,14	,833	,104
	more than 249 fte	35	2,89	,718	,121
We develop product or process innovations with our innovative suppliers	less than 99 fte	64	3,23	,584	,073
	more than 249 fte	35	3,06	,482	,081
We develop radical or incremental innovations for/with our innovative customers	less than 99 fte	64	3,23	,868	,109
	more than 249 fte	35	3,54	,980	,166
We develop radical or incremental innovations with our innovative suppliers	less than 99 fte	64	3,19	,852	,107
	more than 249 fte	35	3,34	,968	,164

Section summary-conclusion:

19. *Literature was (again) inconclusive. Inbound innovation could create more radical innovations (Kumar, 2010: 50), whereas closed innovations could create incremental innovations. (Inauen Schenker, 2012). Wynarczyk (2013) found that SMEs would cooperate with suppliers for product innovations, whereas Inauen Schenker (2012) found that SMEs*

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[123] Normality tests Kolmogorov-Smirnov and Shapiro-Wilk, Q-Q plots and box plots indicated that distributions were non-normal.

[124] A 5-point Likert-scale: 1 only process innovations; 2 mainly process innovations; 3 both; 4 mainly product innovations and 5 only product innovations. Likewise: 1 only radical, 2 mainly radical; 3neutral; 4 mainly incremental; 5 only incremental.

would use suppliers for process innovations. Ignoring company size, most literature suggested companies would cooperate with suppliers for product innovations (§5.2.5).

20. *Preferences on the two innovation types with innovative suppliers versus innovative customers for small versus large companies were not significantly different. Hence data could not confirm nor reject findings from extant literature.*

6.1.6 Company Size & Entrepreneurial Orientation with Suppliers (Q21, Q7)

Another relevant aspect in the Conceptual Model II was the entrepreneurial orientations towards suppliers in small versus large companies. The survey used four constructs from Lumpkin & Dess (1996) complemented with a trust variable, all on a 5-point Likert-scale[125]. (See §2.7.1; for descriptives on the total sample see §5.1.2, §5.2.6).

Table 75: Effects of company size on entrepreneurial orientation with suppliers (*N*=97)

Group Statistics					
	ComSize Small (< 99) vs Large (> 249)	N	Mean	Std. Deviation	Std. Error Mean
Innovating activities with Innovative Suppliers	less than 99 fte	61	1,70	,760	,097
	more than 249 fte	34	2,06	,851	,146
Risk taking towards Innovative Suppliers	less than 99 fte	60	2,48	,948	,122
	more than 249 fte	33	2,21	,960	,167
Opportunities with Innovative Suppliers	less than 99 fte	61	1,92	,781	,100
	more than 249 fte	33	2,09	,843	,147
Aggressiveness in Supplier Markets	less than 99 fte	61	3,16	1,186	,152
	more than 249 fte	34	2,71	,906	,155
Trust with innovative Suppliers	less than 99 fte	61	1,30	,460	,059
	more than 249 fte	35	1,49	,612	,103

The importance of entrepreneurial activities varied in 3/5 instances with small versus large companies. (See Table below). Except for aggressiveness, the standard deviations with SMEs were also smaller, suggesting a more uniform behaviour. This Table below with results from a two-independent-samples test indicated two statistical differences. SMEs found innovative activities with innovative suppliers statistically more important (*M*=1.70) with *p*<.042.

Likewise, SMEs found aggressiveness towards supplier markets statistically less important (*M*=3.16) with *p*<.041. Differences of the other three relations were not significant. The above Table indicates that trust was considered most important. Aggressiveness was considered least important Considering the often-antagonistic buyer-seller relationship in

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[125] Normality tests Kolmogorov-Smirnov and Shapiro-Wilk, Q-Q & box plots indicated that distributions were non-normal. A 5-point Likert-scale: 1 very important, 2 important, 3 moderately important, 4 not important, 5 not at all important.

the construction industry (see Chapter 2, see e.g. Hinton, 2013), this finding was not expected although it was in line with findings from the exploratory interviews.

Moreover, the similar scores of small versus large companies on risk behaviour was remarkable. SMEs have smaller resources and limited negotiation power; hence it could be expected that they would behave more cautious in this respect and attached less importance to risk-taking. The findings from the dataset however indicated that small and large companies found risk-taking towards suppliers equally important.

Table 76: Entrepreneurial orientation variables controlled for company size (*N*=97)

Test Statistics[a,b]					
	Innovating activities with Innovative Suppliers	Risk taking towards Innovative Suppliers	Opportunities with Innovative Suppliers	Aggressiveness in Supplier Markets	Trust with innovative Suppliers
Chi-Square	4,138	1,854	,797	4,195	2,183
df	1	1	1	1	1
Asymp. Sig.	,042	,173	,372	,041	,140

a. Kruskal Wallis Test

b. Grouping Variable: ComSize Small (< 99) vs Large (> 249)

Section summary-conclusion:

21. *Trust with innovative suppliers (see also §5.1.2) was considered most important, aggressiveness least important for both company sizes. This was different from the total New Zealand population (See §5.2.6).*
22. *SMEs considered aggressiveness in supplier markets statistically less important than large companies. This was probably because of their limited negotiation power.*
23. *SMEs considered innovative activities with innovative suppliers statistically more important than large companies.*
24. *Differences of the other (3/5) relations were not significant.*
25. *Literature could offer little guidance on these aspects. Ellegaard (2008, 2009) and others found that procurement in small SMEs focused on continuity and long-term relations (though not intense), instead of finding opportunities. Jones (1996) found that SMEs in conservative markets had low levels of trust with their suppliers. On the other hand, for example Knudsen & Servais (2007) found that building strong ties and trust were important with foreign sourcing. Chesbrough & Crowther (2006) found that SMEs were reluctant to take risks. Drechsler et al. (2012) found that SMEs without market or technology knowledge would not be open to supplier innovations. Similarly, Lee & Drake (2010) and Ortiz Urbina Criado (2012) found that SMEs would use open innovations less than large companies, i.e. search less for opportunities or innovate less. Skiffington et al. (2013) found that New Zealand SMEs preferred longer relations for opportunities.*
26. *Small and large companies exhibited similar preferences on risk-taking towards innovative suppliers. This was remarkable considering the smaller resources and limited negotiation power SMEs generally have. (See e.g. Ellegaard, 2008). It could be concluded that SMEs were*

inclined to take relatively higher risks. This would be in line with findings from the interviews of Chapter 4, and in line with part of the extant literature.

6.1.7 Conclusions from Company Sizes on Mediating Procurement Variables
This Subsection answers the hypothesis:

H4a: Differences in company size had significant effects on procurement management variables.

Small versus large companies from the dataset exhibited specific differences and similarities in their procurement management variables. However, the data did not suggest differences on all explored relations. On a higher level, the empirical data showed similarities with the extant (often inconclusive) literature on differences between procurement of small versus large companies. A more nuanced picture emerges from the data. (See Table).

Table 77: Summary of procurement management variables & practices controlled for company size

Variables & Practices	Extent of differences
Idea & Develop Phase	Small and large companies both saw specify-needs and find-select suppliers in both phases as most important. Overall (6/8; 75%) both company sizes displayed similar procurement step priorities for the 2x4 procurement steps in the idea and develop phase. These findings were unable to confirm or reject the inconclusive findings from extant literature.
TOP 3 Procurement Practices	Overall (35/36; 97%) similar preferences for procurement practices in the four procurement steps. This finding differed from extant research. Both small and large companies generally showed a holistic and cooperative attitude towards innovative suppliers. This differed from the general attitude in New Zealand companies in construction supply chains.
Supplier Types	Identical (6/6; 100%) preferences with the 2x3 supplier types for (somewhat) incremental or (somewhat) radical innovations. Whereas literature was inconclusive on differences for the supplier types, data did not suggest any statistical differences.
Intensity of Supplier Relations	Mostly (2/3; 67%) similar intensities in supplier relations. However, large companies had significantly more intense relations with service providers. Extant literature was inconclusive on this aspect.
Innovation Types	Identical (2/2; 100%) preferences with product versus process innovation, and with radical versus incremental innovations. These findings could not confirm nor reject the inconclusive findings from literature.
Entrepreneurial orientation with innovative suppliers	Reasonably (3/5; 60%) similar preferences. However: (1) SMEs considered aggressiveness in supplier markets statistically less important than large companies. (2) SMEs considered innovative activities with innovative suppliers statistically more important (3) Both companies sizes had similar preferences on risk-taking; hence SMEs could be relatively more inclined to take risks. (4) Both company types considered trust most important, aggressiveness least important. Findings would be in line with exploratory intervirews. Inbound innovation of procurement literature with SMEs could offer little guidance on this aspect.

Consequently, Hypothesis H4a was largely rejected.

Statistically-significant differences are shown in the summary Table of §6.5.

6.2 Effects of Entrepreneurial Orientation on Procurement Management

This Section discusses (in five Subsections) to what extent independent (recoded[126]) variables on entrepreneurial orientation towards innovative suppliers have (causal or correlation) relations with mediating procurement management variables. As was discussed in Chapter 2 (§2.7), procurement behaviour could vary when controlled for entrepreneurial orientation variables. Therefore the research hypothesis for this Section is:

H4b: Differences in entrepreneurial orientation towards innovative suppliers had significant effects on procurement management variables.

NOTES:

1. Section §6.1 contrasted companies <99 staff versus companies >249 staff. The following Sections included the company size class of 99 to 249 staff. (Hence maximum sample size *N*=112).
2. For readability purposes, most of the Tables and Figures used in the remaining part of this Chapter can be found in the corresponding Appendices.
3. For the remaining part of this Chapter, the comparison with literature was mainly done with the main text of Chapter 2.
4. Please note that extant literature gave little specific guidance on the effects of entrepreneurial orientation analysed in §6.2.

6.2.1 Entrepreneurial Orientation & Procurement Priorities Idea & Develop (Q7,Q1-2)

This Subsection discusses procurement step priorities in the idea phase and develop phase when controlled for entrepreneurial orientation towards innovative suppliers. Combined Tables in the corresponding Appendix give statistics on different priorities when respondents score either high versus low on entrepreneurial orientation. As the data were not-normal a two-independent-samples was applied to test for significances.

Idea phase

When controlled for innovating with innovative suppliers (see Table in corresponding Appendix), respondents scored different priorities for the find-select step. Respondents who ranked such innovating activities "very important" considered the find-select step statistically more important. The opposite occurred (same Table) when controlled for

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[126] For this Subsection the entrepreneurial orientation variables were recoded from an initial 5-point Likert-scale: High=very important; Low=moderately to not at all important. (*N* varied from 54 to 67).

opportunities with innovative suppliers in the find-select step. Respondents who ranked such opportunities "very important" considered the find-select step statistically less important.

Develop phase

When controlled for trust levels with innovative suppliers respondents scored significantly different in the negotiate-contract step. Respondents who thought trust with innovative suppliers "very important" considered this negotiate-contract step statistically less important. (Note the skewness of the data).

NOTES:

1. The other three entrepreneurial orientation variables (3/5) with innovative suppliers during the <u>idea</u> phase did not yield significant differences.
2. The other four entrepreneurial orientation variables (4/5) with innovative suppliers during the <u>develop</u> phase did not yield significant differences.

These four reported significances appeared from an analysis of five entrepreneurial orientation variables on the four procurement steps during the two phases. Hence from (5x4x2=) 40 possible inferentials, only four (4/40) proved to be statistically-significant. Overall, it could be not concluded that entrepreneurial orientation variables had large effects on priorities in procurement steps of the two innovation phases.

Section summary-conclusion:

27. *During the two innovation process phases, respondents with a high entrepreneurial orientation as measured in 2x4x5=40 instances prioritized their procurement steps similar (36/40) compared to respondents with a low entrepreneurial orientation.*
28. *This was somewhat surprising. From a risk, opportunity or trust perspective, differences could have been expected for negotiate-contracts and manage-relations. However, the data were unable to detect any significant differences. The research was unable to reveal literature to compare these findings.*

6.2.2. Entrepreneurial Orientation & Procurement Practices (Q7, Q3-6)

This Subsection analysed effects of five recoded variables high versus low entrepreneurial orientation towards innovative suppliers on the TOP 3 practices within each of the four procurement steps.

Based on SurveyMonkey data, the research used a relative cut-off point ≥10% to find "possibly-relevant differences". (See §3.6.4.2; §5.2.2).

The combined Figure in the corresponding Appendix summarises the effects of *four* entrepreneurial orientation variables. In Chapter 5, a correlation analysis revealed that aggressiveness in supplier markets was negatively related to the other entrepreneurial orientation variables. Hence this variable was not incorporated in this summary as it would make the data less distinctive. Using the cut-off ≥10%, the respondents' prioritisation of practices in each of the four procurement steps looked rather similar for high versus low entrepreneurial levels. Hence the aggregated data as presented showed no possibly-relevant differences of procurement management practices in the four steps.

However, zooming in on the *five* individual entrepreneurial orientation variables (including aggressiveness) produced a more detailed and varied picture per variable.

The combined Figure below gives an overview of *innovating activities* with innovative suppliers and shows 6/36 possibly-relevant differences. Respondents who considered innovating activities "very important" reported that innovative suppliers had to be flexible and cooperative (cut-off ≥10%), and focused on opportunities (cut-off ≥10%), and much less on written contracts but instead on emails and verbal agreements (combined cut-off ≥10%).

Figure 49: Practices controlled for innovating with innovative suppliers (N_{very}=43; N_{low}=23)[127]
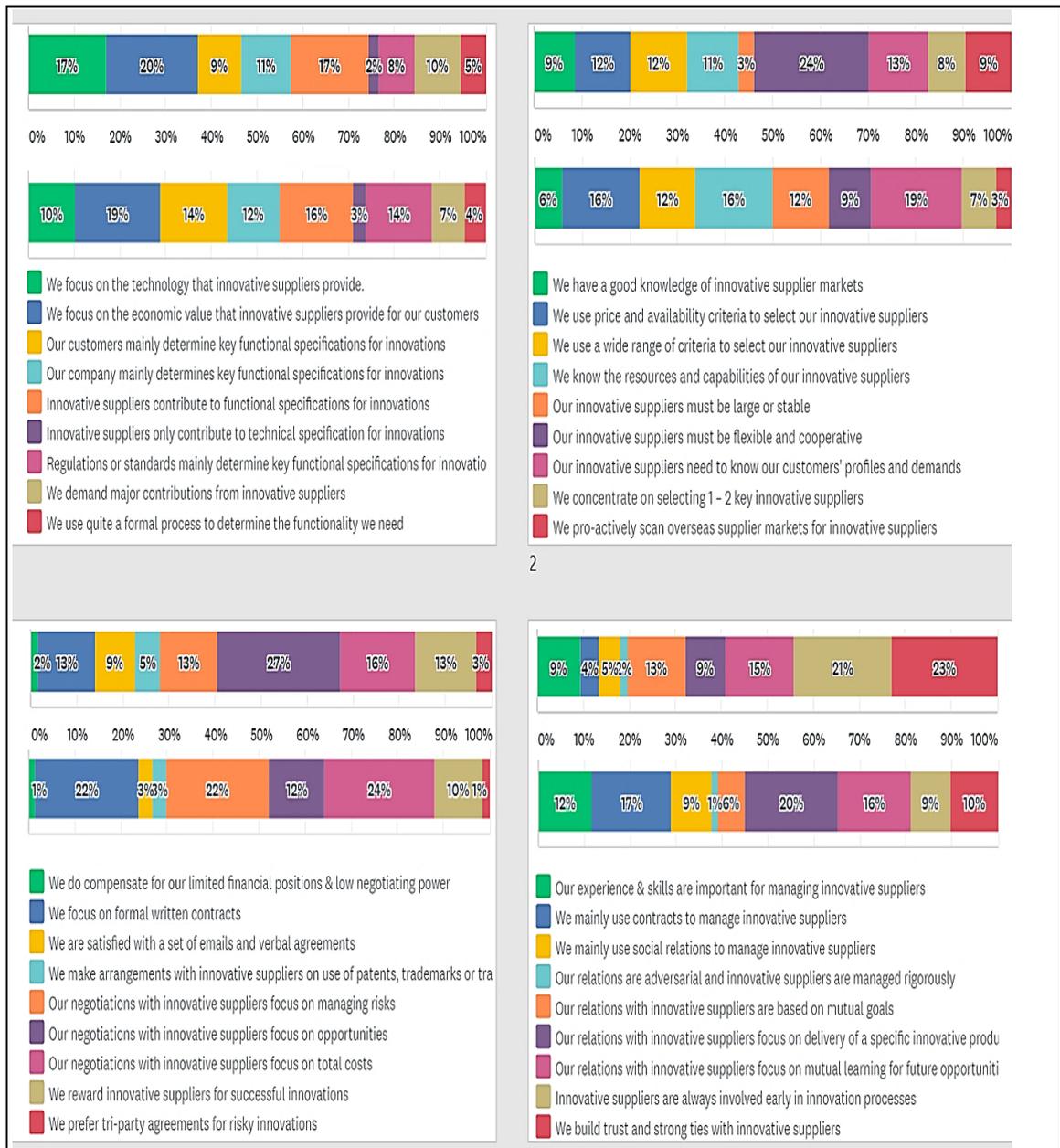
The below combined Figure gives an overview of *opportunities* with innovative suppliers. The greater amount of details gave 3/36 possibly-relevant differences. Respondents who considered opportunities with innovative suppliers "very important" reported less often that innovative suppliers should contribute to functional specifications for innovations, and less that their customers determined key functional specifications. Instead they built more

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[127] For this Figure and the next 3 Figures: Top left=specify-needs step; top right=find-select supplier step; bottom left=negotiate-contract step; bottom right manage-relations step. For each step, the top stacked bar chart relates to high (N_{high}, or N_{very}) levels, the below bar chart relates to low levels (N_{low}) of the specific entrepreneurial orientation variable. (Samples size N=111; high & low is listwise).

trust and strong ties with innovative suppliers and involved them more often early in innovation processes.

Figure 50: Practices controlled for opportunities with innovative suppliers (N_{very}=30; N_{low}=24)

The below combined Figure on *risk-taking* with innovative suppliers only shows 1/36 possibly-relevant differences ≥10% cut-off. Hence it is assumed that the two groups of respondents did not significantly differ in their risk-taking with innovative suppliers.

Figure 51: Procurement practices controlled for risks w innovative suppliers (N_{very}=18; N_{low}=44)

The below combined Figure on *aggressiveness* in supplier markets showed 5/36 possibly-relevant differences ≥10% cut-off. Respondents who considered aggressiveness "very important" reported more often that their customers determined key functional specifications. They also put less focus on the economic value that suppliers provided to customers, and their suppliers contributed less to functional specifications. They thought flexibility with suppliers was less important and scanned the overseas supplier markets more often. They however did not differ in the use of formal contracts or verbal agreements. It must be noted that the aggressiveness data were skewed, so these findings must be taken with some care.

Figure 52: Procurement practices controlled for aggressiveness w suppliers (N_{very}=10; N_{low}=67)

Finally, the Figure below shows the procurement practices when controlled for high versus low levels of *trust* with innovative suppliers. This entrepreneurial variable produced most (21/36) possibly-relevant differences. Hence it could be concluded that different trust levels led to different procurement management practices.

Respondents who considered trust with innovative suppliers "very important" focused more often on supplier technology, but less on economic value from suppliers. Their companies determined less key functional specifications, instead relied more in such specifications from their innovative suppliers. They also used a wide range of selection criteria for suppliers and depended less on price and availability criteria. They were less concerned that

their supplier had to be large or stable. Respondents who considered trust very important focused more on opportunities, and less on cost and risks when they negotiated with their suppliers, they used less contracts or social relations. Instead these high scoring respondents focused on mutual goals and mutual learning for future opportunities, and involved suppliers earlier.
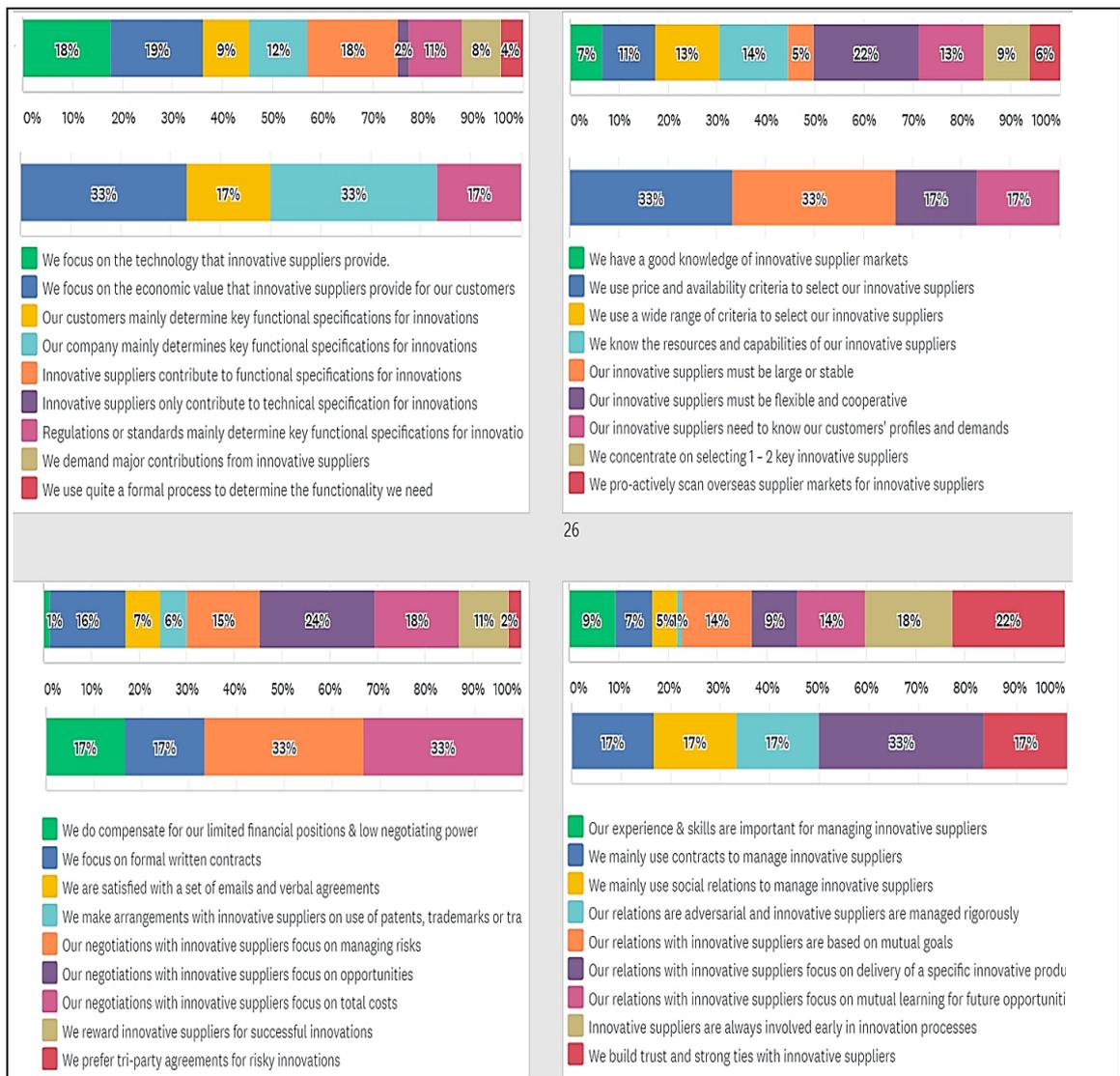
Figure 53: Procurement practices controlled for trust w. innovative suppliers (N_{very}=72; N_{low}=2)

Section summary-conclusion:

29. *The data on procurement practices in the dataset were nominal and a constant, and consequently this Subsection analysed descriptive statistics based on a ≥10% cut-off.*

30. *The entrepreneurial orientation variables of this Subsection first measured four combined aspects of entrepreneurship. (Aggressiveness was not included in this analysis). When analysed in combination, these four variables on entrepreneurial orientation towards suppliers yielded no possibly-relevant differences ≥10%.*

31. *However when considered separately, the five variables on entrepreneurial orientation to suppliers showed possibly-relevant differences ≥10% with some practices and no such differences with other practices.*
32. *The variable risk-taking with innovative suppliers gave least possible (1/36) relevant differences; the variable trust with innovative suppliers gave the highest number (20/36) of possibly-relevant differences.*
33. *These findings indicated that respondents mostly had similar procurement practices when controlled for levels of entrepreneurial orientation. Depending how they rated individual entrepreneurial orientation variables, in some instances respondents however preferred different procurement practices. Possible differences were most notable in the manage-relations step (12/40), and least notable in the negotiate-contract step (6/40).*
34. *The research was unable to find relevant literature on procurement management controlled for entrepreneurial orientation, but findings could be in line with the entrepreneurial orientation construct from §2.7 and §2.8.2.*

6.2.3 Entrepreneurial Orientation & Supplier Types (Q7, Q11-13)

A series of Kruskal-Wallis tests was conducted on the five (recoded) entrepreneurial orientation variables controlled for radical versus incremental innovations with three supplier types. This yielded one significant (1/30 instances) preference on the 2x3 supplier types[128] as the Tables in the corresponding Appendix show. The statistically-significant difference was that respondents who considered innovating with innovative suppliers "very important", more often preferred small suppliers for (somewhat) *incremental* innovations. In general, small suppliers have a higher risk profile and it could be that respondents accepted or appreciated such higher risk levels. However for the 29/30 other entrepreneurial orientation variables, the respondents from the dataset did *not* suggest different preferences for the 2x3 supplier types.

Section summary-conclusion:

35. *Findings from the dataset implied that respondents who scored high versus low on entrepreneurial orientation variables with suppliers on radical versus incremental innovations in 29/30 instances exhibited similar preferences with the 2x3 supplier types. Respondents who considered innovating with innovative suppliers "very important" statistically preferred small suppliers for (somewhat) incremental innovations. Findings in §5.2.3 correlated this small supplier preference moderately (Rho=.501) with (somewhat) radical innovations, but this Subsection was unable to find such significant differences.*

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[128] Shapiro-Wilk tests, Q-Q-plots and especially box plots (exclude cases pairwise) found significant non-normality for the recoded supplier entrepreneurial orientation variables as IV and the supplier types as DV. Applied a 5-point Likert-scale: 1 only domestic, 2 mainly domestic, 3 both domestic and overseas, 4 mainly overseas, 5 only overseas suppliers. And: 1 only new, 2 mainly new, 3 both new & current, 4 mainly current, 5 only current suppliers. And: 1 only small, 2 mainly small, 3 both large and small, 4 mainly large 5 only large suppliers. A series of ANOVA tests was unable to indicate more significant results.

36. *Although the research was unable to find relevant literature, this lack of differences (29/30)*
   was somewhat surprising. It was expected that respondents with high entrepreneurial
   orientation levels would have a higher preference for new or foreign suppliers with
   (somewhat) radical innovations from an opportunity or risk-taking perspective.

6.2.4 Entrepreneurial Orientation & Intensity of Supplier Relations (Q7, Q8)

As in the previous Subsections, a series of Kruskal-Wallis tests was conducted with the five

recoded entrepreneurial orientation variables towards innovative suppliers[129]. This showed

four significant (4/15) results on intensity of supplier relations[130]. (See Appendix).

Section §5.2.4 revealed that relations with service providers were seen as most intensive,

then with manufacturers and then with wholesale-distribution suppliers. The combined

Tables (see corresponding Appendix) provide details on differences when controlled for high

versus low entrepreneurial orientation variables towards suppliers. The intensities in the

supplier relations varied significantly for respondents who scored either high versus low on

4/15 entrepreneurial orientation variables with innovative suppliers.

The intensity of relations with *service providers* scored relatively high (see §5.2.4). However,

according to the Tables in the Appendix this relation only differed significantly (1/5) with

levels of aggressiveness. A majority of respondents (*n*=67) who scored <u>low</u> on

aggressiveness considered intense relations with service providers significantly important;

a minority of respondents (*n*=10) who scored high on aggressiveness considered such

intense relations significantly less important.

Somewhat surprisingly, this was the opposite for manufacturers: respondents who reported

high on aggressiveness with suppliers, had intense relations with manufacturers. When trust

or opportunities with innovative suppliers were considered important, respondents also

reported high relation intensities with *manufacturing* suppliers. Hence, respondents who

scored high on 3/5 entrepreneurial orientation variables towards suppliers had more

intense relations with their *manufacturers*. No differences (0/5) could be found for

wholesale-distribution suppliers, nor for the variables risk-taking and innovating with

innovative suppliers.

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[129] A series of Shapiro-Wilk tests, Q-Q plots and boxplots found significant non-normality for intensity of supplier relations as MV controlled for the recoded entrepreneurial orientation variables (IV). Very important=high; moderately to not at all important=low.
[130] A 4-point Likert-scale was applied on the intensity of supplier relations: 1 never used, 2 low intensity, 3 medium intensity, 4 high intensity.

> **NOTE:**
> The recoded dataset was skewed, so interpretation had to be done with caution.

Section summary-conclusion:

37. *Respondents who scored high versus low on five entrepreneurial orientation variables towards suppliers differed significantly in 4/15 instances in their intensity of supplier relations.*
38. *This was especially the case for respondents who scored high on 3/5 entrepreneurial orientation variables towards suppliers (aggressiveness, opportunities, trust): they had more intense relations with manufacturers. Contrarily, respondents who scored high on aggressiveness had less intense relations with service providers. But then again, they had more intense relations with manufacturers.*
39. *Interpretation should be done with caution. Although the research was unable to find relevant literature, findings could be in line with entrepreneurial orientation construct.*

6.2.5 Entrepreneurial Orientation & Innovation Types (Q7, Q9-10)

Finally, this Subsection investigated how respondents who scored high versus low on five entrepreneurial orientation towards suppliers would differ for two generic innovation types with their innovative suppliers[131]. (See also §5.2.5).

Table 78: Innovation types controlled for entrepreneurial orientation variables to suppliers

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[131] Test of normality Kolmogorov-Smirnov and Shapiro-Wilk, Q-Q plots and especially box plots indicated non-normal distributions. The lower the means were for the product – process variables: the more focus on process innovations. The lower the means were for the radical – incremental variables: the more focus on radical innovations.

Test Statistics[a]

	We develop product or process innovations with our innovative suppliers	We develop radical or incremental innovations with our innovative suppliers
Mann-Whitney U	61,000	36,000
Wilcoxon W	64,000	2.737,000
Z	-,480	-1,296
Asymp. Sig. (2-tailed)	,632	,195
Exact Sig. [2*(1-tailed Sig.)]	,715[b]	,260[b]

a. Grouping Variable: Trust with innovative Suppliers - recoded

b. Not corrected for ties.

The combined Table above shows results from non-parametric tests on the relation between entrepreneurial orientation to suppliers with the two innovation type variables. Respondents who scored high on risk-taking and on innovating (2/10) with innovative suppliers also significantly developed more product innovations respectively more radical innovations. The other 8/10 instances did not yield significant differences on innovation types towards innovative suppliers.

Section summary-conclusion:

40. *Overall, the innovation types with innovative suppliers were found to be similar in 8/10 instances for respondents who scored high versus low on entrepreneurial orientation variables towards suppliers. Respondents who scored high on risk-taking and on innovating (2/10) with innovative suppliers significantly developed more product innovations respectively more radical innovations*

41. *Although the research was unable to find relevant literature, findings could be in line with the entrepreneurial orientation construct.*

6.2.6 Conclusions from Entrepreneurial Orientation on Procurement Management
This Subsection answers the hypothesis:

H4b: Differences in entrepreneurial orientation towards innovative suppliers had significant effects on procurement management variables.

Respondents who scored high versus low on the five entrepreneurial orientation variables towards suppliers hardly seemed to score significantly different on the procurement management variables & practices as analysed in this Subsection. (See the following Table).

Table 79: Summary of procurement management variables controlled for entrepreneurial variables

Variables & Practices	Extent of differences
Idea & Develop Phase	Overall (36/40; 90%) similar procurement step priorities during the idea and develop phase. This was somewhat surprising. From a risk, opportunity or trust perspective, differences could have been expected for negotiate-contracts and manage-relations. However, the data were unable to

	detect any significant differences. The research was unable to reveal literature to compare these findings.
TOP 3 Procurement Practices	No differences when analysed for the construct (i.e. the five variables combined). Mostly similar (average 24/36; 67%) when controlled for each of the five entrepreneurial orientation variables seperately. The variable risk-taking with innovative suppliers had lowest 1/36 (3%) relevant possibly-relevant differences; trust with innovative suppliers had highest 20/36 (56%) differences. Differences were most notable during the manage-relation step; and least during the negotiate-contract step. The research was unable to reveal literature to compare these findings.
Supplier Types	Overall (29/30; 97%) similar for the three supplier types. This was somewhat surprising as it could be expected that especially preferences for new or foreign suppliers would vary with levels of entrepreneurial orientation.
Intensity of Supplier Relations	Mostly (11/15; 73%) similar for the intensity of supplier relations. Although the research was unable to find relevant literature, findings could be in line with entrepreneurial orientation construct. (Looking for opportunities or innovating activities would need higher supplier interactions).
Innovation Types	Mostly (8/10; 80%) similar for the two innovation types. Although the research was unable to find relevant literature, findings could be in line with the entrepreneurial orientation construct.
Entrepreneurial orientation with innovative suppliers	Not applicable. (See §5.1).

Hypothesis H4b was therefore largely rejected.

Statistically-significant differences are shown in the summary Table of §6.5.

6.3 Effects of Experience Levels on Procurement Management

Section §5.1.4 discussed five experience types and revealed moderate correlations among these types. This Subsection controlled for (causal or correlation) effects of experience levels on several procurement management variables. It aimed to find an answer on the following hypothesis.

H4c: Differences in experience levels had significant effects on procurement management variables.

The research was only able to find general extant literature; these are discussed in §6.3.7

6.3.1 Experience Levels & Procurement Priorities Idea & Develop Phase (Q29, Q1-2)

The priorities of procurement steps during the idea and develop phase were controlled for the respondents' experience levels[132]. A series of Kruskal-Wallis tests (see combined Table

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[132] Test of normality Kolmogorov-Smirnov and Shapiro-Wilk, Q-Q plots and box plots indicated non-normal distributions. When the assumption of non-normality was ignored, a series of *t*-tests revealed no further differences. The management & strategy data were skewed.

in the corresponding Appendix) revealed statistical differences for 5/40 instances with the five experience types[133].

Significant differences were notably found for the specify-needs (2/40) or the find-select step (3/40). In 3/40 instances in the idea phase; in 2/40 instances in the develop phase.

Analysed differently: in 4/40 instances, respondents thought a particular step was significantly less important. (Notably with specify-needs controlled for overseas experience, with specify-needs and find-select in idea phase controlled for innovation experience, and find-select in develop phase controlled for management experience). In 1/40 instances, respondents with high or low innovation experience levels statistically differed on the ranking of the find-select step. Note that rankings were relative.

Section summary-conclusion:

42. *Respondents who scored high versus low on the five experience types had fairly similar (35/40) preferences with regards to the 2x4 procurement steps during the idea and the develop phase.*

6.3.2 Experience Levels & Procurement Practices (Q29, Q3-6)

This Subsection focussed on the respondents' preferences for procurement practices when controlled for their procurement & supply chain experience, and also for their management & strategy experience. Based on SurveyMonkey data, the research used a relative cut-off point ≥10% to find "possibly-relevant differences" (§3.6.4.2).

The Figure in the corresponding Appendix gives details on the procurement practices when controlled for levels of procurement & supply chain experience. None of the differences was ≥10% cut-off.

The next Figure in the same Appendix gives details controlled for levels of management & strategy experience. Most differences (32/36) were below the ≥10% cut-off, and hence should not be seen as possibly-relevant differences. Also, it must be noted that the population with a low level of management experience was n=4 respondents. Hence answers suffered from a small-sample bias[134].

Section summary-conclusion:

43. *In general, respondents with high versus low procurement & supply chain experience (36/36), and with high versus low levels of management & strategy experience (32/36)*

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[133] Sample sizes for high experience and low experience varied with the experience types. (See §5.1.3).
[134] Additionally combining low and medium experience levels gave N=48. This sample also did not give possibly-relevant differences on the procurement practices in the four steps when contrasted with the high experience group. (N=64).

showed similar practices for each of the four procurement steps. (Other experience types were not tested).

44. *Due to the data structure of procurement practices, relations with procurement levels could not be tested on significance levels.*

6.3.3 Experience Levels & Supplier Types (Q29, Q11-13)

The experience types with supplier types were non-normally distributed[135]. (See also §5.2.3). Hence a series of Kruskal-Wallis tests was used analyse to relations high versus low levels of experience on the 2x3 supplier types. Only when controlled for management & strategy experience, and for innovation or NPD experience, the tests found significant differences (2/30) for "We prefer small versus large suppliers for (somewhat) radical innovations". (See the combined Table in the Appendix[136]).

This result would imply that respondents who indicated high experience levels in NPD & innovation, or respondents who indicated high experience levels in management & strategy[137] had significantly higher preferences to using small suppliers for (somewhat) radical innovations. One explanation could be that these more experienced respondents accepted the higher risk levels with (somewhat) radical innovations. This relation was not found for (somewhat) incremental innovations. No relations were found on other supplier types variables when controlled for high versus low levels of overseas, procurement, or marketing experience.

Section summary-conclusion:

45. *Findings from the dataset indicated that high levels of NPD & innovation experience, and high levels of management & strategy experience equalled significantly higher preferences for small suppliers for (somewhat) radical innovations. No significant effects were found in the other 28/30 instances when controlled for the 2x3 supplier types.*

6.3.4 Experience Levels & Intensity of Supplier Relations (Q29, Q8)

This Subsection investigated intensities of supplier relations with service providers, manufacturers and wholesale-distribution companies controlled for experience levels. (See also §5.2.4). The distribution was non-normal[138]. High versus low levels of experience did not yield significant differences in intensity of supplier relations. (See the combined Table in

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[135] Tests for normality, Q-Q plots and histograms indicated non-normality.

[136] Foreign or domestic: 1 only domestic, 2 mainly domestic, 3 both domestic and overseas, 4 mainly overseas, 5 only overseas suppliers. New or current: 1 only new, 2 mainly new, 3 both new & current, 4 mainly current, 5 only current suppliers. Small or large: 1 only small, 2 mainly small, 3 both large and small, 4 mainly large 5 only large suppliers.

[137] Four respondents had low experience levels, so this group was combined with medium level (n=43) group ($N_{m+l}=47$).

[138] Tests for normality, Q-Q plots and histograms indicated non-normality.

the Appendix with a series of Kruskal-Wallis tests). This was an unexpected effect, as professionals with high experience levels could be expected to apply their experience in their relations with innovative suppliers.

Section summary-conclusion:

46. *High versus low levels of experience types did not yield significant different levels (15/15) of intensity in supplier relations with service providers, manufacturers, or with wholesalers.*

6.3.5 Experience Levels & Innovation Types (Q29, Q9-10)

As in the previous Subsections, the types of experience levels with innovation types (§5.2.5) was non-normally distributed. Again, a series of Kruskal-Wallis tests was unable to find statistical differences in the preference for the innovation type to suppliers controlled for high versus low levels or experience. See the *example* in the combined Table below on levels of procurement experience. (See corresponding Appendix).

Table 80: Innovation types controlled for procurement level experience (example)

Ranks

	procurement experience recoded into high and low	N	Mean Rank
We develop product or process innovations with our innovative suppliers	high	32	27,86
	low	25	30,46
	Total	57	
We develop radical or incremental innovations with our innovative suppliers	high	32	27,44
	low	25	31,00
	Total	57	

Test Statistics[a,b]

	We develop product or process innovations with our innovative suppliers	We develop radical or incremental innovations with our innovative suppliers
Chi-Square	,608	,713
df	1	1
Asymp. Sig.	,435	,399

a. Kruskal Wallis Test

b. Grouping Variable: procurement experience recoded into high and low

Section summary-conclusion:

47. *High versus low levels in the five experience types did not yield significant differences (0/10) with the two innovation types (product versus process, radical versus incremental) with innovative suppliers. (Note that this differed from #48).*

6.3.6 Experience Levels & Entrepreneurial Orientation to Suppliers (Q29, Q7)

Finally, the entrepreneurial orientation towards suppliers was controlled for experience levels. (See also §5.1.2; §5.2.6). The data were non-normally distributed. A series of Kruskal-Wallis tests gave significance in 4/25 instances as shown in the combined Table in the corresponding Appendix.

Findings showed that respondents with high levels of NPD & innovation experience had significantly higher priorities on innovating activities with suppliers and on opportunities with suppliers. Likewise, findings showed that respondents with high levels of overseas experience had significantly higher priorities on working with innovative suppliers and on aggressiveness in supplier markets. The dataset showed no other significant differences in other experience levels (21/25) when controlled for the five entrepreneurial orientation variables towards suppliers. Note that this finding contradicted the findings from the previous Subsection.

Section summary-conclusion:

48. *High versus low levels of experience types in 4/25 instances equalled significant differences in the entrepreneurial orientation towards innovative suppliers. ((Note that this differed from #47).*

6.3.7 Conclusions from Experience Levels on Procurement Management
This Subsection answers the hypothesis:

H4c: Differences in experience levels had significant effects on procurement management variables.

Findings from the dataset led to conclude that experience levels overall did not relate to different procurement management preferences or behaviour. (See the Table below).

From §5.1.4 it was concluded that respondents generally had high and broad experience levels. Findings in §6.3 were contrary to the limited extant procurement literature presented in §2.6, §2.3.3 and §2.3.6. Notably Luzzini *et al.* (2015), for SMEs James *et al.* (2012) and Axelsson & Larson (2002). They posited that companies needed higher levels of procurement experience to improve on their performance. In their research on small SMEs (1-99 staff) Cagliano & Spina found that procurement management decisions in subcontractors were taken based on intuition or personal experience, which could lead to bad performance. Bäckstrand *et al.* (2016: 6) noted that lower procurement competence levels would imply different ways to design and execute procurement processes. The empirical experience level data from Survey I however was unable to detect major significant differences in the usage of procurement variables.

NOTE:
Most respondents reported high-to-medium experience levels. However, results could suffer from respondent-bias. (See Table 52 in §5.1.4).

Table 81: Summary of procurement variables controlled for experience levels

Variables & practices	Extent of differences
Idea & Develop Phase	Overall similar (35/40; 90%) procurement step priorities during the idea and develop phase.
TOP 3 Procurement Practices	In general, respondents with high versus low procurement & supply chain experience (36/36; 100%), and with high versus low levels of management & strategy experience (32/36; 88%) reported similar practices for each of the four procurement steps. (Other experience types were not tested).
Supplier Types	Overall similar (28/30; 93%) for the three supplier types. High levels of NPD & innovation experience, and high levels of management & strategy experience equalled significantly higher preference for small suppliers for (somewhat) radical innovations.
Intensity of Supplier Relations	Similar (15/15; 100%) intensities of the three supplier relations.
Innovation Types	Similar (10/10; 100%) for the two innovation types.
Entrepreneurial orientation towards innovative suppliers	Overall similar (21/25; 84%) for the entrepreneurial variables.

Hypothesis H4c was therefore largely rejected.

Statistically-significant differences are shown in the summary Table of §6.5.

6.4 Effects of Strategies on Procurement Management

This Section investigates procurement management variables controlled for (causal or correlation) effects of two strategy types: customer strategies and company strategies. These two strategy types were discussed in §2.8.2, §2.8.3; in §5.1.3, and in §5.1.6. A comparison with literature was done in §6.4.7. The Section aimed to find an answer on the following hypothesis.

H4d: Differences in strategy types had significant effects on procurement management variables.

6.4.1 Strategy Types and Procurement Priorities Idea & Develop Phase (Q26, Q1-2)

The data were non-normally distributed. A series of Mann-Whitney tests as shown in the combined Tables in the Appendix[139] did not produced significant results when controlled for high versus low levels of each of the customer strategy variables.

When controlled for company strategies, 4/24 significant differences were found for the specify-needs steps during the idea and the develop phase. Findings suggested that

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[139] Tests for normality, Q-Q plots and histograms indicated that the data overall were non-normally distributed. A series of independent-samples *t*-test also did not give significant results.

respondents who scored high on entrepreneurial or lifestyle strategies considered the specify-needs step in both phases significantly *less important*. This suggested that such respondents would rely on other procurement steps; indeed the data indicated that such respondents then considered manage-relations statistically more important.

Section summary-conclusion:

49. *High versus low levels of the three customer value propositions did not seem to lead to significant differences (0/24) in the priorities of the procurement steps during the idea or the develop phase.*

50. *High versus low levels of lifestyle and entrepreneurial strategies gave 6/24 significant differences in the priorities of the procurement steps during the idea or the develop phase. (Survival did not seem to have effects).*

6.4.2 Strategy Types & Procurement Practices (Q26, Q3-6)

The three combined Figures (see Appendix[140]) were made with SurveyMonkey data (*N*=111). The research used a relative cut-off point ≥10% to find "possibly-relevant differences" within the 4x9 practices. (See §3.6.4.2). However, respondents appeared to have identical (36/36) preferences (that is below the ≤10% cut-off).

NOTE:
The research did <u>not</u> analyse effects of company strategies on procurement practices.

Section summary-conclusion:

51. *High versus low levels on the three customer value propositions did not (0/36) give possibly-relevant differences in procurement activities for the four procurement steps. Due to the data structure, this could not be tested on significance levels.*

6.4.3 Strategy Types & Supplier Types (Q26, Q11-13)

The data were fairly non-normally distributed. A series of Mann-Whitney test is shown in the combined Table in the corresponding Appendix.

When controlled for customer strategies, respondents who considered product leadership "very important" favoured more foreign suppliers for (somewhat) incremental innovations,

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[140] For this combined Figure and the other two combined Figures: top left=specify-needs step; top right=find-select supplier step; bottom left=negotiate-contract step; bottom right manage-relations step. For each step, the top stacked bar chart relates to high levels, the below bar chart relates to low levels of the specific experience variable.

and small suppliers for (somewhat) radical innovations. The dataset did not give other significant differences on customer strategies.

When controlled for company strategies, respondents who considered lifestyle orientation (n=35) "very important" more often preferred small suppliers for (somewhat) incremental innovations. These findings could be explained from the lower risk profile that such lifestyle companies would have. Likewise, respondents who scored high on survival mode (n=10) preferred current suppliers for (somewhat) radical innovations. They also preferred large suppliers for both (somewhat) incremental and (somewhat) radical innovations. These findings could partially be explained from the risk profile that such survival companies would have. The dataset did not give other significant differences on company strategies. (No Table provided).

Section summary-conclusion:

52. *High versus low levels on the three customer value propositions equalled significant differences on 2/18 supplier types of foreign versus domestic suppliers, new versus current suppliers, and small versus large suppliers. (Respondents with product leadership "very important" seemed to favour more foreign suppliers for (somewhat) incremental innovations, and small suppliers for (somewhat) radical innovations).*

53. *Likewise, high versus low levels on the three company strategies equalled 4/18 significant differences on supplier types. (Respondents with lifestyle orientation "very important" seemed to prefer more often small suppliers for (somewhat) incremental innovations).*

6.4.4 Strategy Types & Intensity of Supplier Relations (Q26, Q8)
The data were non-normally distributed. A series of Mann-Whitney tests is shown in the combined Tables in the corresponding Appendix. The Table showed non-significant differences (17/18) in intensity of all three supplier types for respondents when controlled customer strategies. Only respondents who scored high on customer intimacy, statistically had a more intense relation with manufacturing suppliers than respondents who scored low on this value proposition.

High versus low levels of company strategy variables did not lead to statistical differences on the intensity of supplier relations.

Section summary-conclusion:

54. *Respondents with high levels of customer intimacy gave significantly different and higher intense relations with manufacturing suppliers. The intensity of other 8/9 supplier relations seemed not significantly affected by customer strategies.*

55. High versus low levels of company strategy did not lead (0/9) to statistical differences on the intensity of supplier relations.

6.4.5 Strategy Types & Innovation Types (Q26, Q9-10)

The data were non-normally distributed. Tables with series of Mann-Whitney test on the relation of customer strategies and two innovation types[141] are shown in the Appendix. High versus low levels of customer strategies showed two statistically-significant relations.

When controlled for product leadership, respondents who scored high on product leadership statistically seemed to have more often (mainly) product innovations instead of process innovations with innovative suppliers. (1st Table in corresponding Appendix). This is understandable from the focus on innovative products in this customer strategy. Respondents who scored high, seemed to develop more product innovations with innovative suppliers.

When controlled for operational excellence, respondents who scored high on this variable, statistically seemed to have more often (mainly) process innovations instead of product innovations with innovative suppliers. (2nd Table in corresponding Appendix). This is understandable from the focus of process improvements in this customer strategy. When controlled for the three company strategies, respondents who scored high on entrepreneurial strategy would more often develop radical innovations with suppliers. (3rd Table in corresponding Appendix).

Likewise, when controlled for company strategies, respondents who scored high on lifestyle strategy would less often develop radical innovations with innovative suppliers. (4th Table in corresponding Appendix).

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[141] The two innovation type variables use a 5-Likert-scale: 1 only process innovations ... 5 only product innovations. And: 1 only radical innovations ... 5 only incremental innovations).

NOTES:
1. When controlled for the customer intimacy strategy, no statistical differences were found for the product versus process innovation variable.
2. When controlled for customer strategy variables, no statistical differences were found for radical versus incremental innovations.
3. When controlled for the company strategy survival, no significant differences were found for radical versus incremental innovations, nor for radical versus incremental innovations.

Section summary-conclusion:

56. Respondents who scored high on product leadership excellence would statistically develop more product innovations with innovative suppliers. Respondents who scored high on operational excellence would statistically develop more process innovations with innovative suppliers. The other instances (4/6) on innovation types controlled for customer strategies proved not significantly different.

57. Respondents who scored high on entrepreneurial strategy would more often develop radical innovations with innovative suppliers. Contrarily, companies that scored high on lifestyle would more often develop incremental innovations with innovative suppliers. The other instances (4/6) on innovation types controlled for company strategies proved not significantly different.

6.4.6 Strategy Types & Entrepreneurial Orientation to Suppliers (Q26, Q7)
Finally, this Subsection explores the effects of customer and company strategies on the entrepreneurial orientation towards suppliers. Again, the data were non-normally distributed[142]. A series of Mann-Whitney tests is shown in corresponding Appendix. Findings did not suggest statistical differences. (Note: The research did not analyse effects of company strategies on entrepreneurial orientation).

Section summary-conclusion:

58. Respondents who scored either high versus low on each of the three customer strategies exhibited similar levels (15/15) for the five entrepreneurial orientation variables towards suppliers.

6.4.7 Conclusions from Strategy Types on Procurement Management
This Subsection answers the hypothesis:

H4d: Differences in strategy types had significant effects on procurement management variables.

Findings from the dataset led to conclude that strategies overall did not statistically relate to different procurement management preferences or behaviour. (See the following Table).

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[142] Tests of normality, Q-Q plots, histograms, and boxplots indicated non-normality.

This generally differed from (scarce) extant literature in §2.8. Notably, it was expected that the customer strategies (see Table 17; §2.8.3) would give different results. The lack of distinctive differences with company strategies was in line with results on entrepreneurial orientation in §6.2.6.

Table 82: Summary of procurement management variables controlled for customer strategies

Variables & practices	Extent of differences	
	Customer strategies	Company strategies
Idea & Develop Phase	Similar (24/24; 100%) priorities.	Overall similar (18/24; 75%) priorities
TOP 3 Procurement Practices	Similar (36/36; 100%) procurement practices.	Not tested.
Supplier Types	Overall similar (16/18; 88%)	Overall similar (14/18; 78%)
Intensity of Supplier Relations	Overall similar (8/9; 89%)	Similar (9/9; 100%)
Innovation Types	Overall similar (4/6; 67%)	Overall similar (4/6; 67%)
Entrepreneurial orientation with innovative suppliers	Similar (15/15; 100%)	Not tested.

Hypothesis H4d was therefore largely rejected.

Statistically-significant differences are shown in the summary Table of §6.5.

6.5 Chapter Summary

The research question of this Chapter was answered with support of the high-level hypothesis H4.

(RQ6) What relations existed between company variables and procurement management variables & practices in New Zealand companies that managed innovative suppliers in construction supply chains?

The qualitative answers to the hypotheses can be construed from the four Section summary Tables and the 59 Section summary-conclusions. Answers are stated below.

H4: Differences in company variables had significant effects on procurement management variables & practices.

> *H4a: Differences in company size had significant effects on procurement management variables. (§6.1). Largely rejected.*
> *H4b: Differences in entrepreneurial orientation towards innovative suppliers had significant effects on procurement management variables & practices. (§6.2). Largely rejected.*
> *H4c: Differences in experience levels had significant effects on procurement management practices. (§6.3). Largely rejected.*

H4d: Differences in strategy types had significant effects on procurement management practices. (§6.4). <u>Largely rejected</u>.

Overall, hypothesis H4 was largely rejected.

As discussed in the Section summary-conclusions, extant literature from Chapter 2 often was not very helpful or suggested different results. However, a systematic focus on details produced a more nuanced picture. The following summary Table (next page) therefore shows results from the Section summary-conclusions and Section summary Tables.

This Table shows statistically-significant relations (in dotted light-blue cells) of 21 dependent procurement management variables (*rows*) controlled for 17 independent company variables (*columns*). These relations were calculated based on their relative frequencies of statistical differences for each relation. For example, the idea & develop phase had 2x4=8 instances where statistical difference could occur when controlled for company size. The SPSS analysis found two significant differences; hence the relative frequency was 2/8=25%. (See top-left cell). This was done for all dotted cells[143].

The Table also provides sums and relative sums percentages[144]. For assessing possibly-significant row or column results for the rel%SUM, the research applied cut-offs of 15% (yellow cells) and ≥20%. (light-green cells). These cut-off percentages could be considered arbitrary but tried to balance between Type I and Type II errors. The two bright yellow cells (bottom-right) indicate the means (*M*=11%) of the relative sum percentages.

Chapter 7 discusses inferential statistics on procurement performance variables controlled for company variables and procurement variables. Chapter 9 gives discussions and conclusions on RQ6.

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[143] Similarly for the 9 procurement practices controlled for each of the five entrepreneurial orientation variables. For example: three practices differed with the specify-needs step when controlled for opportunities with innovative suppliers. Hence this calculated into a relative frequency of 3/9=33%. Table gives several light-blue cell with 100%. This also indicated a statistical difference, for example with preferences for product versus process innovation controlled the product leadership strategy.

[144] SUMS give significant counts /row or /column. Total Row and Total Column frequencies are calculated as percentages significant counts /row or /column. Note that absolute ROW and COLUMN counts varied for different variables. Hence relative percentages (rel% SUM) were compared. These relative percentage SUM give percentage of significant counts. (Not-investigated relations shown as dark-grey cells).

Table 83: Summary of procurement management variables controlled for company variables

Company variables / Proc. mgmt variables	size ($6.1) comp. size	entrepreneurial orientation towards innovative suppliers ($6.2) inno-vating	risk-taking	opportu nities	aggres sivene ss	trust	Experience levels ($6.3) proc urem ent	mang mnt & strat.	NPD & innova tn	Market ing-sales & BD	over-seas	customer strategies ($6.4) operat. excel-lence	prodt. leader-ship	cust. inti-macy	company strategies ($6.4) entre-preneu rial	life-style	survi-val	SUM	TOTAL	rel % SUM >20% = green
Idea & Develop Phase	25%	25%		13%		13%		13%	25%		25%				38%	38%		2,1	17	13%
specify-needs				33%	33%	44%												1,1	11	10%
find-select		22%			22%	44%												0,9	11	8%
negotiate-contract		11%				56%		11%										0,8	11	7%
Manage-relations	11%	33%	11%	11%		78%		33%										1,8	11	16%
foreign vs domestic for (sw) *incremental*													100%					1,0	17	6%
new vs current for (sw) *incremental*																		0,0	17	0%
large vs small for (sw) *incremental*		100%														100%	100%	3,0	17	18%
foreign vs domestic for (sw) *radical*																		0,0	17	0%
new vs current for (sw) *radical*																	100%	1,0	17	6%
large vs small for (sw) *radical*								100%	100%				100%				100%	4,0	17	24%
provide services	100%			100%														2,0	17	12%
manufacture products				100%	100%	100%								100%				4,0	17	24%
wholesale or distribution																		0,0	17	0%
process or product innovations			100%									100%	100%					3,0	17	18%
radical or incremental innovations		100%													100%	100%		3,0	17	18%
innovating	100%								100%									2,0	9	22%
risk taking																		0,0	9	0%
opportunities									100%		100%							2,0	9	22%
aggressiveness	100%										100%							2,0	9	22%
trust																		0,0	9	0%
SUM	3,4	2,9	1,1	1,6	2,6	3,3	0,0	1,6	3,3	0,0	2,3	1,0	3,0	1,0	1,4	2,4	3,0	33,68	293	11%
TOTAL	21	16	16	16	16	16	21	21	17	17	17	21	21	21	12	12	12	293		
rel % SUM >20%=green	16%	18%	7%	10%	16%	21%	0%	7%	19%	0%	13%	5%	14%	5%	11%	20%	25%	11%		

Row groupings (left labels): TOP 3 procurement management practices (specify-needs, find-select, negotiate-contract, Manage-relations); supplier types for incr or rad innovations (foreign vs domestic...radical); Intensity of Supplier relations (provide services, manufacture products, wholesale or distribution); innovation types (process or product innovations, radical or incremental innovations); Entrepreneurial orientation w innovative suppliers (innovating, risk taking, opportunities, aggressiveness, trust).

Chapter 7

Survey I:

Company & Procurement Variables on Performance

Life is what happens to you, while you are busy doing a PhD project.
Based on J. Lennon (1940 – 1980).

Chapter 7

Survey I: Company & Procurement Variables on Performance

This Chapter discusses (correlational or causal) relations of 37 company and procurement management variables on 11 (dependent) procurement performance variables. It tries to answer the following empirical research question:

(RQ7) What relations existed between company variables, procurement management variables, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains.

Each Section of this Chapter discusses a part of the following two hypotheses.

H5: Differences in company variables had significant effects on procurement performance variables. (§7.2).

H6: Differences in procurement management variables have several significant effects on procurement performance variables.
  H6a: Differences in procurement step priorities variables had significant effects on performance variables. (§7.3).
  H6b: Differences in supplier type variables had significant effects on performance variables. (§7.4).
  H6c: Differences in supplier relation intensity variables had significant effects on performance variables. (§7.5).
  H6d: Differences in innovation type variables had significant effects on performance variables. (§7.6).
  H6e: Differences in entrepreneurial orientation with suppliers had significant effects on performance variables. (§7.7).

This Chapter starts (§7.1) with discussing relations among four performance variables. Section §7.2 then discusses the relations of four company variables on procurement performance variables. Sections §7.2-§7.6 discuss the relations of procurement management variables on procurement performance variables. (See Conceptual Model II in

the Figure below; copy §2.13, §3.5). The Chapter ends with a summary and conclusions (§7.8).
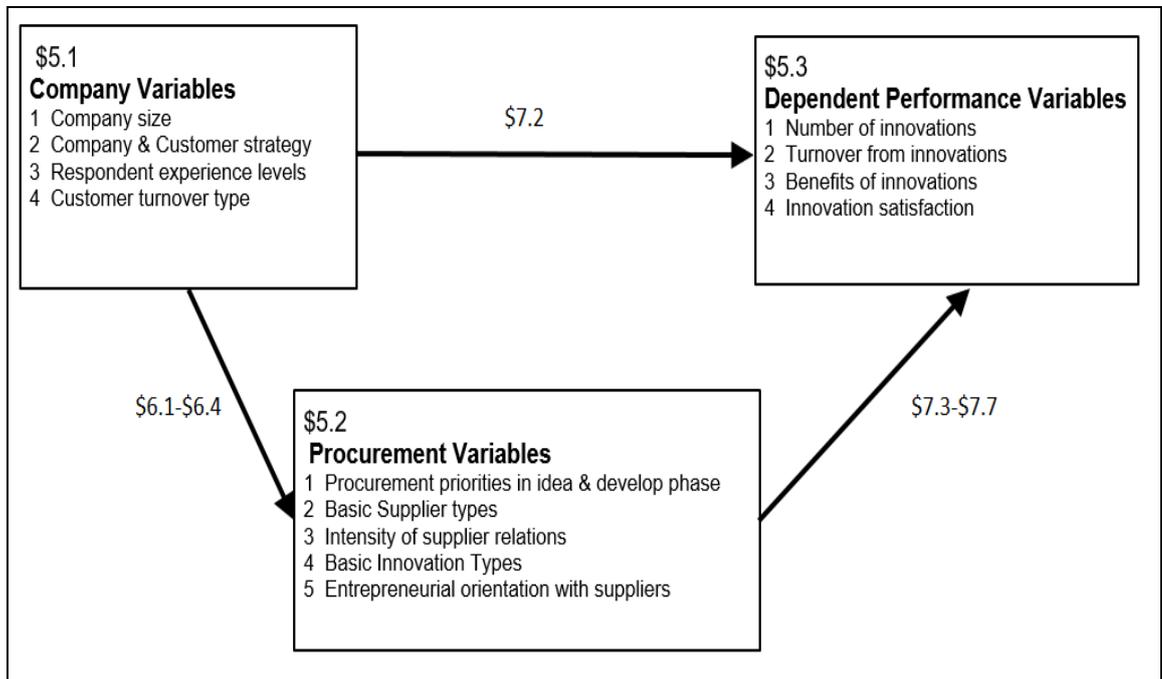
Figure 54: Conceptual Model II on company, procurement, and performance variables (copy §2.13)

In line with §5.3, the data on estimated innovation numbers and estimated percentage of turnover from innovations developed with all suppliers over the last three years were recoded. (See the two combined Table below). This Chapter used both the uncoded and recoded variable[145].

Table 84: Estimated innovations all suppliers last three years (uncoded top; recoded down)

Statistics		
Estimated number of innovations developed with all suppliers last 3 yrs		
N	Valid	82
	Missing	30
Mean		7,98
Median		5,00
Std. Deviation		13,389
Range		100
Minimum		0
Maximum		100

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[145] This recoded variable was non-normally distributed. (Criteria recommended by Löfgren; 2013, based on Cramer, 1998 and Cramer & Howitt, 2004).

Recoded Nbr of innovations w suppliers last 3 years		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 to 5 innovations	51	45,5	62,2	62,2
	6 to 100 innovations	31	27,7	37,8	100,0
	Total	82	73,2	100,0	
Missing	System	30	26,8		
Total		112	100,0		

Table 85: Estimated turnover percentage w.a. suppliers last three years (uncoded top; recoded bottom)

Estimated % of turnover from innovations developed with all suppliers last 3 yrs		
N	Valid	74
	Missing	38
Mean		15,70
Median		10,00
Std. Deviation		19,568
Range		100
Minimum		0
Maximum		100

Estimated % of turnover recoded in 3 groups		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0% to 32%	66	58,9	89,2	89,2
	33% to 65%	6	5,4	8,1	97,3
	66% to 100%	2	1,8	2,7	100,0
	Total	74	66,1	100,0	
Missing	System	38	33,9		
Total		112	100,0		

NOTES:

1. To enhance the readability of this Chapter, the longer SPSS tables can be found in the corresponding Appendices for Chapter 7. This Chapter aimed to suggest whether relations could be causal or correlational. (See also §3.2.4; §3.5).

2. The data structure of the practices in the four procurement steps did not allow for inferential statistics on procurement performance, so this was not tested in this Chapter. (See also §5.5.2). As mentioned in §5.3, data on all innovations with suppliers over the last three years was recoded into <5, and >5 innovations.

3. Similar to inferentials in Chapter 6, this Chapter used uncoded and recoded variables as this strategy should help to detect more significant results. The uncoded variables had somewhat larger sample sizes, which should help in finding significant results. The recoded variables focused on extreme (high versus low) values. Such extremes should also help to find significant results. Tests were therefore conducted twice.

4. Hence the research used 2x16 independent company variables, and 2x21 independent procurement management variables. The research often applied only the *uncoded* variables for innovation numbers and percentage of innovation turnover. Therefore the research used (2+(2x9))=20 uncoded and recoded dependent performance variables.

5. Consequently, *per relationship* the research could analyse potential significance in 40 instances. In case one such significance occurred, this was indicated as 1/40 instances, two

such instances as 2/40, etc. The research interpreted this as an indication of the *potential* relevance or importance of this relationship.

6. Similar to Section §6.5, Section §7.8 provides two summary tables on non-significant and significant differences in performance variables when controlled for company variables and for procurement management variables. These tables show the individual instances, and also totals per variable-pairs.

7. The research made limited use of relative or calculated effects sizes as the sample size was too small and most of the data were non-normal. (Sullivan & Feinn, 2012: 217; Lavery, 2015: 28). Moreover, calculating effect sizes in all instances would go well beyond the purpose of this broadly-designed quantitative research. Where relevant, it analysed correlations. (See also §5.1; §10.3).

8. A selection of company and procurement variables from conceptual model II (Chapter 5) were used for inferential statistics in Chapter 7. Inferential relations of procurement practices on procurement performance were not established due to the data structure. (§5.2.2).

The following Table shows the 11 (uncoded) procurement performance variables that were analysed throughout this Chapter.

Table 86: Overview of procurement performance variables analysed in this Chapter (uncoded)

	N	Minimum	Maximum	Mean	Std. Deviation
Estimated number of innovations developed with all suppliers last 3 yrs	82	0	100	7,98	13,389
Estimated % of turnover from innovations developed with all suppliers last 3 yrs	74	0	100	15,70	19,568
Innovations with suppliers are beneficial for our company recoded	71	1	2	1,07	,258
Innovations with suppliers are beneficial for the natural environment recoded	52	1	2	1,23	,425
Innovations without suppliers are beneficial for our company recoded	55	1	2	1,42	,498
Innovations without suppliers are beneficial for the natural environment recoded	56	1	2	1,52	,504
Satisfaction with procurement with innovative suppliers	104	1	5	3,40	,830
Satisfaction with innovation with innovative suppliers	103	2	5	3,44	,800
Satisfaction with marketing&sales with innovative customers	104	1	5	3,30	,774
Satisfaction with innovation with innovative customers	103	1	5	3,44	,882
Satisfaction with internal innovation activities	105	1	5	3,52	,856
Valid N (listwise)	15				

Section summary-conclusion:
1. *Chapter 7 analyses the effects of 16 company variables, and 21 procurement management variables on 11 procurement performance variables. (Due to the data structure, inferential relations of procurement practices on performance could not be established).*

7.1 Effects among Performance Variables (Q14-15)

This Section discusses two (scale) performance variables (innovations numbers and innovation turnover) when controlled for other nine (ordinal) performance variables. (See §2.12; for descriptives, see §5.3). The rationale (based in quality management thinking) for this distinction into two types of performance variables, was that said two performance variables could be considered as outcome or (*more accurately*) output variables; whereas remaining nine variables on innovation-benefits and satisfaction rates could be considered

process variables that acted as proxies for the output variables. (See §2.12; see e.g. ISO 20400, 2017:22). This Section discusses significance and correlations with series of Kruskal-Wallis and oneway ANOVA tests[146]. (See Appendix §7.1 for data).

7.1.1 Correlations among Performance Variables (Q14-15)

Respondents reported *M*=7.98 innovations over the last three years (*N*=82), and *M*=15.70 of estimated percentage of turnover with these innovations (*N*=74). (See §5.4.8). However a correlation analysis of this data (both parametric and non-parametric) led to assume that there was no direct correlation between these two output-performance variables. This could explain why the OECD innovation manual (OECD, 2005) and others recommended to use more variables as performance indicators. (See §2.12).

Furthermore, in many instances this research was unable to detect strong (significant) correlations of these two output-performance variables with the nine process-performance variables. The analysis suggested that only three process variables (recoded) moderately correlated with estimated innovation numbers. These variables were: satisfaction on procurement (*Rho*=.449; moderate correlations, with *p*≤.001), satisfaction with innovative suppliers (*Rho*=.420; moderate correlation with *p*≤.003), and satisfaction with internal innovation activities (*Rho*=.386, moderate correlation with *p*≤.001; Cramer & Howitt, 2004; 39). The process variable (recoded) satisfaction with marketing-sales & business-development correlated significantly with the estimated percentage of turnover (*Rho*=.394, moderate correlation with *p=.034*). (The parametric analysis yielded no significant correlations).

This implied the research had to analyse effects on all twelve performance variables in order to be able to answer the related hypotheses for this Chapter.

7.1.2 Correlations Innovation-benefits & Innovation-satisfaction (Q17-20, Q30)

As expected, the four *innovation-benefits* (uncoded and recoded) showed moderate Spearman correlations among each other (Ranging from *Rho*=.383, *p*=.004 to *Rho*=.510, *p*≤.001). This implied that the benefit innovation variables had multi-collinearity i.e.

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[146] Tests for an approximate level of normality (Löfgren, 2013; based on Cramer & Howitt, 2004) questioned whether data for each of the independent performance variables (i.e. benefits and satisfaction) were "approximately" normally distributed, as some Kurtosis and Skewness values exceeded |1.96|, some Shapiro-Wilk test statistics gave significance of *p*<.05, and visual assessment of some boxplots and histograms showed non-normality. As there are no 'hard rules' in this respect (Fields, 2009), the research applied both parametric tests and non-parametric tests.
Note: sample sizes were considered too low for performing a cluster analysis.

measuring the same construct. (See Table in corresponding Appendix; below a part of the Table is shown as an example).

Table 87: Example of correlations among innovation-benefits variables (uncoded & recoded)

		Innovations with supplier interaction are beneficial for the natural environment	Innovations without supplier interaction are beneficial for our company	Innovations without supplier interaction are beneficial for the natural environment	Innovations with suppliers are beneficial for our company recoded	Innovations with suppliers are beneficial for the natural environment recoded	Innovations without suppliers are beneficial for our company recoded	Innovations without suppliers are beneficial for the natural environment recoded
Innovations with supplier interaction are beneficial for our company	Correlation Coefficient	,620**	,196*	,272**	,510**	,630**	,208	,383**
	Sig. (2-tailed)	,000	,038	,004	,000	,000	,127	,004
	N	112	112	112	71	52	55	56

The five *innovation-satisfaction* variables (uncoded and recoded) also showed moderate Spearman correlations among each other. (Ranging from $Rho=.524$, $p\leq.001$ to $Rho=.315$, $p=.009$). This also implied that the innovation-satisfaction variables had multi-collinearity i.e. measuring the same construct. (See an example in the Table below).

Table 88: Example of correlations among innovation-satisfaction variables (uncoded & recoded)

		Satisfaction with procurement with innovative suppliers	Satisfaction with innovation with innovative suppliers	Satisfaction with marketing&sales with innovative customers	Satisfaction with innovation with innovative customers	Satisfaction with internal innovation activities	Satisfaction innovation procurement recoded	Satisfaction innovative suppliers recoded	Satisfaction MS w customers recoded	Satisfaction innovation w customers recoded	Satisfaction internal innovation activities recoded
Satisfaction with procurement with innovative suppliers	Correlation Coefficient	1,000	,645**	,249*	,482**	,285**	,890**	,524**	,368**	,499**	,315**
	Sig. (2-tailed)	.	,000	,011	,000	,003	,000	,000	,009	,000	,009
	N	104	103	103	103	104	67	67	49	72	68

The Table below provides an example of Spearman correlations on innovation-benefits and on innovation-satisfaction variables. Not all relations were significant at the $p \leq.01$ or $p\leq.05$ level. (See also Appendix §7.1.3).

Table 89: Correlations of innovation-satisfaction controlled for innovation-benefits

		Satisfaction with procurement with innovative suppliers	Satisfaction with innovation with innovative suppliers	Satisfaction with marketing&sales with innovative customers	Satisfaction with innovation with innovative customers	Satisfaction with internal innovation activities	Satisfaction innovation procurement recoded	Satisfaction innovative suppliers recoded	Satisfaction MS w customers recoded	Satisfaction innovation w customers recoded	Satisfaction internal innovation activities recoded
Innovations with supplier interaction are beneficial for our company	Correlation Coefficient	-,287**	-,320**	-,209*	-,180	-,127	-,268*	-,182	-,277	-,139	-,116
	Sig. (2-tailed)	,003	,001	,033	,068	,198	,028	,141	,051	,243	,341
	N	104	103	104	103	105	67	67	50	72	69
Innovations with supplier interaction are beneficial for the natural environment	Correlation Coefficient	-,151	-,331**	-,223*	-,335**	-,186	-,180	-,366**	-,245	-,358**	-,265*
	Sig. (2-tailed)	,127	,001	,023	,001	,058	,145	,002	,086	,002	,028
	N	104	103	104	103	105	67	67	50	72	69
Innovations without supplier interaction are beneficial for our company	Correlation Coefficient	-,215*	-,240*	-,209*	-,080	-,042	-,155	-,117	-,144	-,108	-,040
	Sig. (2-tailed)	,029	,015	,033	,423	,673	,209	,347	,320	,368	,743
	N	104	103	104	103	105	67	67	50	72	69
Innovations without supplier interaction are beneficial for the natural environment	Correlation Coefficient	-,233*	-,388**	-,274**	-,274**	-,095	-,173	-,387**	-,261	-,333**	-,149
	Sig. (2-tailed)	,017	,000	,005	,005	,334	,161	,001	,067	,004	,221
	N	104	103	104	103	105	67	67	50	72	69

NOTE:
Correlations between innovation-satisfaction and innovation-benefits were negative. This was due to the fact that the measurement scales in Survey I had been designed reverse[147]. (See §3.6.4.2; see SPSS code-book in the Appendices of §5.1).

7.1.3 Conclusions from Performance Variables

1. *In line with literature discussed in §2.12, the research had selected 11 generic performance variables.*

2. *A Spearman and Pearson correlation test was unable to identify strong correlations among the two output-performance variables based on the OECD innovation manual (OECD 2005).*

3. *A series of Spearman and Pearson correlation tests was unable to indicate (0/9) major (strong) statistically-significant differences and correlations in the two output-performance variables when controlled for 9 corresponding uncoded process-performance variables (i.e. innovation-benefits and innovation-satisfaction variables).*

4. *Survey I respondents with relatively high versus low innovation numbers, and respondents with relatively high versus low turnover percentages from innovations did not differ markedly in their perceived benefits.*

5. *Spearman correlation tests produced 4/11 moderate correlations:*

   a. *Respondents with relatively high or low innovation numbers could differ in their satisfaction on innovation procurement, on innovative suppliers, and on their internal innovation activities.*

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[147] Q17-20, Innovation-benefits: 1=always important …. 5=never important.
   Q30, Innovation-satisfaction: 1=very unsatisfied …. 5=very satisfied.

b. *Respondents with relatively high or low turnover percentage from innovations could differ in their satisfaction on marketing-sales activities with innovative customers.*

c. *Respondents' data revealed several moderate correlations within innovation-benefit variables, and within innovation-satisfaction variables. (Note that scales were reverse).*

6. *The previous point #5 suggested that Van Donk & Van der Vaart (2005: 36-37) for supply chain integration, and Paik (2011: 13) for SME procurement were correct with their conclusions that defining performance variables should be done with care.*

7. *A first reason could be the weakness of performance variables due to intersubjectivity (Van Donk & Van der Vaart, ibid: 36). Another reason could be that respondents did not have their company data readily available and just made rough estimates on these numbers as they completed the online questionnaire. (cf. Schiele et al., 2007, on measured benefits with maturity and performance). Yet another reason could be that the companies in part were too young, (Especially with SMEs. Note that 17 companies in the survey were <3 years old). Finally, the somewhat lower response rate (N=80) on these two survey questions to a certain extent suggested that respondents did not have information available. Additionally, respondents could consider some information as too sensitive or confidential (Hardie, 2011b: 260) and consequently were not willing to provide this data. (See also §1.7; §3.6.4.1. See §5.1.5 on response rates). Finally, there was a possibility that this could be a Type II error, where indeed companies would be equally satisfied and equally perceive benefits, irrespective of the actual innovation output performance. However, descriptive statistics in §5.3.2 and §5.3.3 reported positive benefits and neutral-to-satisfied ratings.*

8. *All performance variables related to the concept of performance in some respect. As a consequence, the research had to apply both process and output-performance variables in the remaining part of this Chapter. Combining process-performance variables into a new performance variable via cluster analysis would at best draw correlations to a new (lower mean). Moreover the sample size was considered too small for clustering. (Field, 2009). Therefore, this Chapter analysed effects of individual 11 process and output-performance variables.*

7.2 Effects of Company Variables (Q21, Q25-27, Q29)

In line with conceptual model II (see the beginning of this Chapter), the independent company variables could have direct and indirect (causal or correlation) effects on performance variables. In the context of this research and based on the literature review, four company variables needed further study: possible effects of company size, of the respondents' experience levels, of company or customer strategies, and of company turnover types. (See §5.1. See Appendix §7.2 for results). The hypothesis for this Section was:

H5: Differences in company variables had significant effects on performance variables.

7.2.1 Effects of Company Size (Q21)

Effects of company size on procurement performance seemed only distinct in 1/40 instances, notably that innovations with supplier interactions were beneficial for the natural environment. For this variable, SMEs (*N*=64; <99 staff) had statistically lower mean ranks than large companies (*N*=35; >249 staff). Hence SMEs reported more benefits for the natural environment.

This research also investigated whether company size would affect the innovation numbers with all suppliers over the last three years. The research found no significant differences between company size classes in absolute numbers. (*N*=72, *p=.129*).

However, in relative numbers, the data in the crosstab Table below (amended in Excel) suggested that smaller companies developed more innovations with all suppliers over the last three years than larger companies. Due to the data structure it was cumbersome to recalculate the exact innovation numbers per employee. Hence this research used the modus as a proxy. Applying the modus per size class as an indication for numbers of staff, the below crosstab Table (for most right columns) indicated than the smallest companies had *M*=7.5 innovations per employee; this decreased to *M*=0.03 innovations per employee for the largest size class.

Table 90: Number of innovations per company size class (SPSS crosstab amended in Excel; *N*=80)

*Company size in classes * Recoded number of innovations with all suppliers last 3 years*
Count

		innovations with suppliers			innovations * size	
		0 to 5 innovations	6 to 100 innovations	Total	modus	Inno/empl.
	employees: 0 - 4	11	4	15	2*	7,50
	employees: 5 - 9	7	3	10	7	1,43
	employees: 10 - 19	6	2	8	15	0,53
Company size in classes	employees: 20 - 99	10	6	16	60	0,27
	employees: 100-249	5	3	8	175	0,05
	employees: 250-499	4	2	6	375	0,02
	employees: above 499*	8	9	17	> 499*	< 0,03
Total		51	29	80		

Note*: Excel calculation. The modus for the smallest class was assumed to be 2; for the largest class to be larger than 499.

Data revealed that 80 respondents (*n*=80) reported a total of 616 innovations with all suppliers over the past three years. The data revealed one company with between 20-99 staff with 100 innovations over the last three years, and six companies with 0 (zero) innovations over the last three years. Even when these companies would be considered

outliers, the manual operation in Excel revealed that SMEs were more innovative per employee than large companies.

The overview Table revealed a significant but weak Spearman correlation ($Rho=.245$; $N=80$; $p=.028$) of company size versus estimated innovation numbers developed with all suppliers over the last three years. Hence the data confirmed that SMEs in the dataset significantly applied more supplier innovations than large companies.

Additionally the turnover performance variable was investigated for company size. Turnover percentages varied within size categories. When the companies with 0% (zero) and 100% turnover were considered outliers, a manual operation in Excel revealed an average turnover percentage of $M=14\%$ over the company-size classes. (See below).

Table 91 Average turnover per company, per company-size class ($n=72$, listwise)

	employees: 0 - 4		employees: 5 - 9		employees: 10 - 19		employees: 20 - 99		employees: 100-249		employees: 250-499		employees: above 499	
	count	%turnover	count	%turnover	count	%turnover	count	%turnover	count	%turnover	count	%turnover	count	%turnover
totals	15	141	9	235	8	80	15	297	6	45	6	69	13	191
turnover / company		9		26		10		20		8		12		15
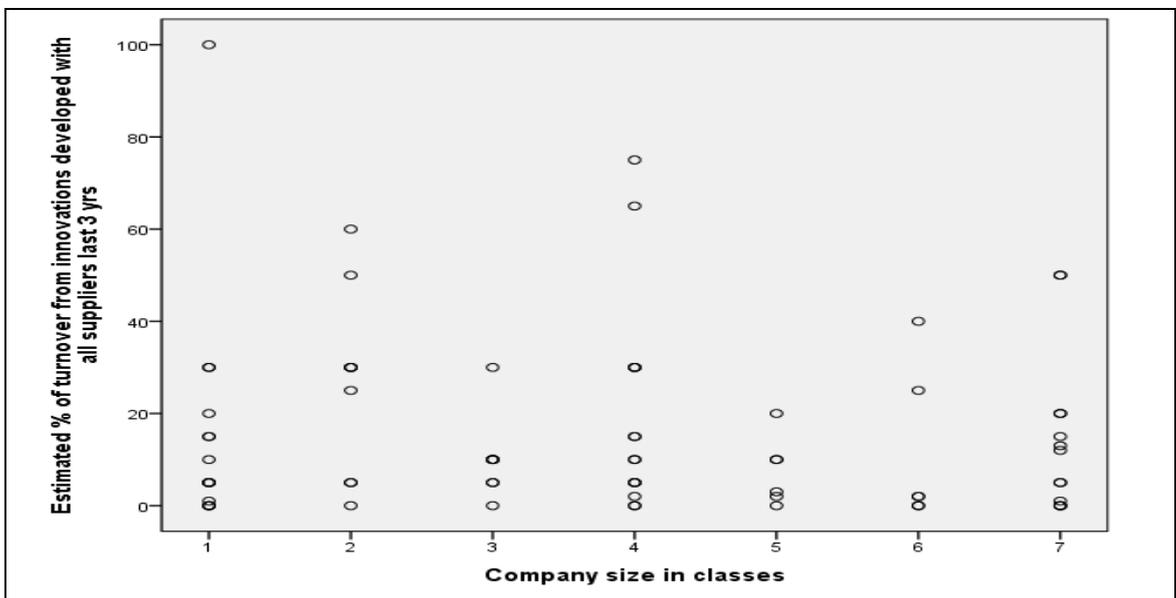
Figure 55: Scatter plot on company size versus estimated percentage of turnover

Micro companies with 5-9 ($n=9$) staff and middle-sized companies with 20-99 ($n=15$) staff appeared to score above average. However the data did not indicate a significant correlation between company size and estimated percentage of turnover ($Rho=-.86$, and $p=. 472$; Table

below). Hence the estimated percentages of innovation turnover did not seem to vary with company size.

The dataset produced a weak positive Spearman correlation (*Rho*=.297; *N*=80; *p*=.08) on estimated innovation numbers versus the numbers of staff involved in innovation procurement. It also produced a weak Spearman correlation (*Rho*=.267; *N*=80; *p*=.017) on estimated innovation numbers versus the numbers of staff involved with innovative suppliers. Hence from the data it could be confirmed (though weakly) that there was a positive relation with human resources allocated on procurement of innovations, and estimated innovation numbers. However, the date was unable to find such correlations with estimated percentage of turnover.

Finally, and as could be expected the data suggested strong and positive relations of company size versus the numbers of staff allocated to supplier innovations or to innovation procurement[148].

Table 92: Bivariate correlations on staff, company size, and performance (*n*=72, pairwise)

			Estimated number of innovations developed with all suppliers last 3 yrs	Estimated % of turnover from innovations developed with all suppliers last 3 yrs	Number of staff involved in innovations with suppliers	Number of staff involved in procurement of innovations with suppliers	Company size in classes	ComSize Small (< 99) vs Large (> 249)
Spearman's rho	Estimated number of innovations developed with all suppliers last 3 yrs	Correlation Coefficient	1,000	,175	,267*	,297**	,245*	,180
		Sig. (2-tailed)	.	,135	,017	,008	,028	,130
		N	82	74	80	80	80	72
	Estimated % of turnover from innovations developed with all suppliers last 3 yrs	Correlation Coefficient	,175	1,000	,013	-,011	-,086	-,124
		Sig. (2-tailed)	,135	.	,916	,927	,472	,321
		N	74	74	72	72	72	66
	Number of staff involved in innovations with suppliers	Correlation Coefficient	,267*	,013	1,000	,864**	,859**	,758**
		Sig. (2-tailed)	,017	,916	.	,000	,000	,000
		N	80	72	99	98	99	90
	Number of staff involved in procurement of innovations with suppliers	Correlation Coefficient	,297**	-,011	,864**	1,000	,778**	,662**
		Sig. (2-tailed)	,008	,927	,000	.	,000	,000
		N	80	72	98	98	98	89
	Company size in classes	Correlation Coefficient	,245*	-,086	,859**	,778**	1,000	,845**
		Sig. (2-tailed)	,028	,472	,000	,000	.	,000
		N	80	72	99	98	109	99
	ComSize Small (< 99) vs Large (> 249)	Correlation Coefficient	,180	-,124	,758**	,662**	,845**	1,000
		Sig. (2-tailed)	,130	,321	,000	,000	,000	.
		N	72	66	90	89	99	99

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

7.2.2 Effects of Company Strategy or Customer Strategy (Q26, Q27)

The following Table compares the three customer strategies (Treacy & Wiersema, 1997) when seen as "most important". On average, 63% of respondents reported 0-5 innovations

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[148] Note that these bivariate correlations probably suffered from collinearity. However, SPSS version 23 did not have an option to conduct partial non-parametric correlations in SPSS. (A partial Pearson correlation did not produce significant results; probably due to the non-normal distribution of the data).

over the last three years. Around 52% of all innovations were reported with the product leadership strategy; only 16% were reported with the operational excellence strategy. The innovation numbers however did not change significantly when controlled for the customer strategy levels.

Table 93: Innovations numbers controlled f customer strategies (recoded ≤5 & ≥6 innovations)

		product leadership counts	Product leadership % ROW total	customer intimacy counts	customer intimacy % ROW total	operational excellence counts	operational excellence % ROW total	row totals (Count, %)
Recoded Number of innovations w suppliers last 3 years	0 to 5 innovations	25	50%	17	34%	8	16%	50
	0 to 5 innovations %	61%		68%		62%		63%
	6 to 100 innovations	16	55%	8	28%	5	17%	29
	6 to 100 innovations %	39%		32%		38%		37%
	column total (Counts, %)	41	52%	25	32%	13	16%	79

N=79; customer strategy reported as "most important"

Overall, the effects of the customer strategy variables on the procurement performance variables was medium (8/40). This effect appeared most dominant (6/40) when controlled for product leadership: the mean ranks of estimated percentage of turnover was significantly higher when the variable product leadership was important. Satisfaction with internal innovation activities was also higher when controlled for product leadership. Contrarily, innovation-benefits for own company were high when controlled for operational excellence. (See corresponding Appendix for details).

Hence, it seemed that performance on some variables was better with high levels versus low levels of product leadership. Following the literature in §2.8.3, such companies would need a large supply base and an agile supply chain. Note however that performance was largely unaffected (32/40) when controlled for customer strategies.

Similarly, the following Table compares the three company strategies when seen as "most important". Again, on average, 63% of respondents then reported 0-5 innovations over the last three years. Around 49% of all innovations were reported with the entrepreneurial strategy; 39% were reported with the lifestyle and only 13% with the survival strategy. These innovation numbers however did not change significantly when controlled for company strategy levels

Table 94: Innovations numbers controlled f company strategies (recoded ≤5 & ≥6 innovations)

		entrepreneurial (counts)	entrepreneurial (% ROW total)	lifestyle (counts)	lifestyle (% ROW total)	survival mode (counts)	survival mode % ROW total	row totals (Count, %)
Recoded number of innovations w suppliers last 3 years	0 to 5 innovations	23	51%	17	38%	5	11%	45
	0 to 5 innovations %	66%		61%		56%		63%
	6 to 100 innovations	12	46%	11	42%	3	12%	26
	6 to 100 innovations %	34%		39%		33%		37%
	column total (counts %)	35	49%	28	39%	9	13%	71

N = 71; company strategy reported as "most important"

The effects of company strategies were mainly statistically-significant (3/40) on satisfaction with procurement with innovative suppliers, and on internal innovation activities when controlled for the lifestyle strategy. (The other two company strategies did not lead to significant differences. See corresponding Appendix for details).

7.2.3 Effects of Levels of Experience (Q29)

As discussed in §5.1.4, the experience levels of respondents could have causal relations or correlations with procurement performance. This was tested for recoded and uncoded independent variables on the 20 dependent variables that together represented the 11 performance variables. The following Table shows the variation in number of supplier innovations controlled for experience levels.

Table 95: Innovation numbers (recoded) controlled for experience levels

		procurement experience recoded into high and low		Mgmt experience recoded into high and low		Experience in sales mrktg BD recoded into high and low levels		Experience overseas recoded high - low		NPD or Innovation experience recoded into high and low	
		high	low	high	low	high	low	high	low	high	low
0 to 5 innovations	Count	19	11	28	3	16	11	18	17	12	17
6 to 100 innovations	Count	5	5	18	0	14	7	8	10	14	3

7.2.3.1 Procurement or Supply Chain Experience

The research could detect a total of 2/40 statistically-significant differences for high levels of procurement or supply chain experience with satisfaction rates on internal innovation activities.

7.2.3.2 Management or Strategy Experience

The research was unable to detect (0/40) statistical differences on high levels of management & strategy experience with the estimated percentage of turnover.

7.2.3.3 Innovation or New Product Development Experience

The research could detect a total of 12/40 significant different instances when controlled for levels of experience in innovations or NPD. In 10/40 of these instances, high satisfaction rates were related to higher levels of this type of experience. Another 2/40 instances found positive statistically-significant between high levels of innovation or NPD experience, and estimated innovation numbers.

7.2.3.4 Marketing-sales or Business Development Experience

The research could detect a total of 5/40 significant different instances when controlled for marketing-sales or business development levels. In all five instances, high satisfaction rates were related to higher levels of this type of experience.

7.2.3.5 Overseas Experience

The research could not (0/40) distinguish statistical differences when controlled for overseas experience levels.

7.2.4 Effects of four Company Turnover Types (Q25)

The correlations or causal relations of turnover sources on procurement performance levels seemed low for the three main business activities, including the residual category. (See §5.1.3 and §2.8.1). The research notably found (3/40) differences on turnover from distribution or wholesale when controlled for levels of supplier innovation-benefits for the natural environment. Respondents who reported that these activities were important, perceived *lower* benefits.

The research notably found significant differences (4/40) on satisfaction with marketing-sales & business-development when controlled for the residual turnover type variable (not relevant or other). Respondents who reported that residual activities were important, were significantly *less* satisfied with marketing-sales or business development. (The research found 2/40 and 1/40 positive relations respectively when controlled for providing services and manufactured products).

The following Table compares the turnover type strategies when seen as "most important". On average, 65% of respondents reported 0-5 supplier innovations over the last three years; a minority of 35% of respondents reported 6-100 of such innovations. Around 69% of all innovations were from companies providing services; 19% from manufacturers; 12% were wholesale or distribution. Comparing these findings with absolute company turnover type frequencies (§5.1.3; Table 51), service companies were most active with supplier

innovations. An alternative explanation could be that service companies depended more on such supplier innovations (Pries & Janszen, 1995; Koebel 2008).

Table 96: Number of innovations with suppliers last three years controlled for company turnover type

		turnover from providing services, counts	turnover from providing services, %	turnover from manufact. products, counts	turnover from manufact. products, %	turnover from wholesale or distribution, counts	turnover from wholesale or distribution, %	row totals (counts, %)
Recoded number of innovations w suppliers last 3 years	0 to 5 innovations	33	75%	7	16%	4	9%	44
	0 to 5 innovations %	70%		54%		50%		65%
	6 to 100 innovations	14	58%	6	25%	4	17%	24
	6 to 100 innovations %	30%		46%		50%		35%
	column total (counts %)	47	69%	13	19%	8	12%	68

N=68; turnover from "most important" turnover type

7.2.5 Conclusions from Company Variables

9. *Overall, the performance variables when controlled for company size, yielded 1/40 significant differences. (SMEs significantly reported more benefits from innovations for the natural environment).*

10. *When studied in more detail other differences appeared.*

11. *As could be expected, data produced positive correlations between company size and numbers of staff allocated to supplier innovations or innovation procurement.*

12. *The data revealed a significant negative correlation between company size and number of innovations developed with suppliers over the last three years. Smaller companies had relatively higher numbers of supplier innovations. The data revealed that companies with 5-9 and 20-99 staff had higher turnover percentages from innovations developed with all suppliers over the last three years.*

13. *However, that data did not reveal a significant correlation between company size and turnover percentage. Hence the data only partly suggested that SMEs were more innovative than large companies.*

14. *Literature was inconclusive on performance controlled for company size. Paik et al. (2009) and Paik (2011: 13, 20) found that SMEs (<99 staff) would have lower procurement performances than large companies (100–499 staff). Paik (ibid) used multiple performance measures, viz. profit as a percentage of sales. Ellegaard (2009), Pearson & Ellram (1985) and Pressey et al. (2009) found that SMEs could achieve similar results with their informal ways of selecting suppliers. Jong & Vermeulen (2006: 599) found that small firms (<100 staff) were equally successful in introducing new products on their markets than large firms. (However, their study did not relate to supplier innovations). Spithoven et al. (2013) found that SMEs (<250 staff) would need supplier resources and would be more effective in open innovations with suppliers than large companies (>250 staff).*

15. *Empirical findings in this Section hence supported some of the extant research, that in general company size made limited differences but could still make a difference on a specific performance variable.*

16. *The effects of customer strategies seemed largest (6/40) with product leadership, but then mainly because of differences in satisfaction levels for internal innovation. More importantly, this proposition also showed a significance for estimated percentage of turnover. Therefore, respondents who reported that this proposition was important, reported significantly higher estimated percentages of innovation turnover. This was logical from the value propositions as described in §2.8.3; such companies would need large supply bases and agile supply chains. Effects of other customer strategies were limited. Effects were less than indicated in literature of §2.8.2.*

17. *The effects (3/40) of company strategy variables on performance was limited.*

18. *Therefore, from the data it could not be concluded that company or customer strategies had significant effects on procurement performance variables.*

19. *Literature (§2.6.2; §5.1.4) indicated a positive relation between experience levels and performance. This was only partially confirmed in the findings. Innovations and NPD experience levels seemed to have a positive effect (12/40) on procurement performance. Positive effects of marketing-sales & business-development experience on performance seemed limited (5/40). The other three experience had zero (0/40) effects. High levels of innovation and NPD experience related to high innovation-benefit levels and high innovation-satisfaction levels. (It was not investigated whether this was caused by bias of respondents responsible for innovations and NPD).*

20. *Note that 60% of respondents reported high management & strategy experience levels, and on average 33% of respondents reported high levels in the other four areas (cf. §5.1.4). Based on the above findings, effects from the other experience types on procurement performance levels seemed however limited. Literature in general (§2.6.2) mentions a positive relation with performance and experience, but findings were unable to confirm this.*

21. *Finally, from the data it could be concluded that performance variables had low-medium effects (10/40) when controlled for company turnover types. Notably, wholesale or distributor respondents seemed less satisfied (3/40) on their procurement performance. (The research was unable to find relevant literature on this aspect)*

22. *Note that most differences were not statistically-significant, hence overall procurement performance seemed not affected by company variables.*

7.3 Effects of Procurement Priorities in Idea & Develop Phase (Q1-2)

This Section discusses performance variables and (correlation or causal) relations on priorities of the four procurement steps[149] during the innovation idea phase and the innovation develop phase. (See §5.2.1; See corresponding Appendix §7.3 for results).

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[149] The relative ranking of specify-needs, find-select, negotiate-contract, or manage-relations.

A series of Kruskal-Wallis tests detected a total of 6/40 significant differences, notably (4/40) that respondents who gave high versus low priorities to find-select innovative suppliers in the idea phase significantly differed on the variable that innovation with supplier interactions are beneficial for their companies.

Overall however, the research was unable to detect major differences in procurement performance controlled for respondents who differed in their priorities to specify-needs or who differed in their priorities to find-select innovative suppliers.

NOTE:
Performance levels were only assessed controlled for the specify-needs step and the find-select step, as respondents considered these two steps as most important. (See §5.2.1).

Section summary-conclusion:

23. *The research detected (2/40) significant differences for the specify-needs steps in the idea and develop phase, and (0/40) difference for the find-select step in the develop phase.*

24. *The research identified (4/40) significant differences on innovation-benefits and innovation-satisfaction levels for the find-select step of the idea phase.*

25. *The research could not find relevant extant literature on this aspect. The research did not test differences for the negotiate-contract and the manage-relation steps.*

7.4 Effects of Three Basic Supplier Types (Q11-13)

This Section discusses possible (causal or correlation) relations between three basic supplier types (§5.2.3) and procurement performance. It first shows descriptives on the (recoded) innovation numbers variable, and then discusses inferential statistics on the 11 procurement performance variables. (See Table 102 for an overview; see corresponding Appendix §7.4 for details).

7.4.1 New versus Current Suppliers for Radical versus Incremental Innovations

The first analysis was to control performance for new versus current suppliers. The descriptive Table below shows frequency counts on new or current suppliers for (somewhat)

radical versus (somewhat) incremental innovations, when controlled for innovation numbers[150]. Overall, this supplier variable proved significant.

Table 97: New or current supplier preferences with (somewhat) radical or incremental innovations

			We prefer new (1) or current (5) suppliers for (somewhat) incremental innovations - recoded		We prefer new (1) or current (5) suppliers for (somewhat) radical innovations - recoded	
			Only or mainly new suppliers	Only or mainly current suppliers	Only or mainly new suppliers	Only or mainly current suppliers
Recoded Nbr of innovations w suppliers last 3 years	0 to 5 innovations	Count	2	14	4	13
	6 to 100 innovations	Count	2	13	5	8

The research then analysed the 11 performance variables when controlled for this supplier type variable for (somewhat) <u>incremental</u> innovations. The research was unable to detect any statistical differences (0/40) on the performance variables.

Similarly, the research analysed the 11 performance variables when controlled for the supplier type variable on preference for new versus current suppliers for (somewhat) <u>radical</u> innovations. The research was unable to detect any statistical differences (0/40) on the performance variables.

For both innovation types, most respondents preferred <u>only or mainly</u> current suppliers; a minority would prefer <u>only or mainly new</u> suppliers. However, the number of innovations did not statistically differ.

7.4.2 Small versus large Suppliers for Radical versus incremental Innovations

The second analysis was to control the performance variables for small versus large suppliers. The descriptive Table below would show a small preference for <u>large</u> suppliers when controlled for innovation numbers.

Table 98: Small or large supplier preferences with (somewhat) radical or incremental innovations

			We prefer small (1) or large (5) suppliers for (somewhat) incremental innovations - recoded		We prefer small (1) or large (5) suppliers for (somewhat) radical innovations	
			Only or mainly small suppliers	Only or mainly large suppliers	Only or mainly small suppliers	Only or mainly large suppliers
Recoded Nbr of innovations w suppliers last 3 years	0 to 5 innovations	Count	4	6	6	8
	6 to 100 innovations	Count	2	4	3	5

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[150] Similar results were obtained with the supplier types for turnover percentage recoded into high-low.

The research then analysed the 11 procurement performance variables when controlled for this supplier type for (somewhat) <u>incremental</u> innovations. The research was unable to detect (0/40) statistical differences on the performance variables. Similarly, the research analysed the 11 performance variables when controlled for this supplier type variable for (somewhat) <u>radical</u> innovations. The research could detect 2/40 statistical difference, notably innovation-satisfaction with innovative customers.

Finally, as noted in §5.2.3, respondents had preferences for both small and large suppliers. After recoding this variable, performance differences were not significant both with (somewhat) radical versus (somewhat) incremental innovations.

Some research mentioned (Jorgenson & Koch, 2012; Morrissey & Pittaway, 2006) that SMEs could prefer small suppliers (§2.9.1). The research found (§7.2.1) that small companies would be more innovative. However according to the mean ranks, most respondents preferred large suppliers.

7.4.3 Foreign versus Domestic Suppliers for Radical versus incremental Innovations

The research finally analysed preferences for foreign versus domestic suppliers for (somewhat) radical versus (somewhat) incremental innovations. The descriptive Table provides preferences for domestic suppliers when controlled for innovation numbers.

Table 99: Domestic or foreign supplier preferences w (somewhat) radical / incremental innovations

| | | | We prefer domestic (1) or foreign (5) suppliers for (somewhat) incremental innovations - recoded | | We prefer domestic (1) or foreign (5) suppliers for (somewhat) radical innovations - recoded | |
			Only or mainly domestic suppliers	Only or mainly foreign suppliers	Only or mainly domestic suppliers	Only or mainly foreign suppliers
Recoded Nbr of innovations w suppliers last 3 years	0 to 5 innovations	Count	24	2	25	3
	6 to 100 innovations	Count	13	3	9	2

The research then analysed the 11 procurement performance variables when controlled for this supplier type for (somewhat) <u>incremental</u> innovations. In 6/40 instances performance differences were significant. An analysis of the mean ranks notably showed and a small number of respondents who preferred mainly foreign suppliers had significantly higher performance levels on estimated percentage of turnover and on innovation-benefits with suppliers for the natural environment. Similarly, the research analysed performance levels

controlled for this supplier type variable with (somewhat) <u>radical</u> innovations. Notably, (1/40) the estimated percentage of turnover was higher for respondents who preferred only or mainly foreign suppliers.

However, in 34/40 and 39/40 instances, the research was unable to find statistical differences in performance levels when controlled for preferences on <u>foreign versus domestic</u> suppliers for either (somewhat) incremental or radical innovations.

7.4.4 Conclusions from Basic Supplier Types

26. *Both for (somewhat) <u>incremental</u> and <u>radical</u> innovations, the research was unable to detect statistical differences (0/40) on the procurement performance variables when controlled for <u>new versus current</u> innovative suppliers. Hence performance levels seemed not affected by using new or current suppliers.*

27. *The research could detect one statistical difference (2/40) on the performance variables when controlled for <u>small versus large</u> suppliers for (somewhat) radical innovations. Notably innovation-satisfaction was significantly higher with only or mainly small suppliers. The research was unable to detect (0/40) statistical differences on the performance variables when controlled for small versus large suppliers for (somewhat) <u>incremental</u> innovations. Some literature and findings from Survey I (§7.2.1) indicated that small suppliers were relatively more innovative. However, findings indicated a general preference for large suppliers for both (somewhat) incremental and radical innovations. Performance levels seemed not affected (39/40) by using small versus large suppliers.*

28. *The research found (§7.2.1) that small companies relatively had more supplier innovations than large companies. Such small companies were often suppliers in the beginning of construction supply chains (§2.1.2). However, most respondents did not show a preference for such small and innovative suppliers.*

29. *The research could detect some statistical differences (6/40) on the performance variables when controlled for <u>foreign versus domestic</u> innovative suppliers. Notably the reported estimated percentage of turnover with (somewhat) <u>incremental</u> innovations, and the innovation-benefits for the natural environment (for a subset of n=5 respondents) were significantly higher with <u>only or mainly foreign</u> suppliers. Similarly (for a subset of n=5 respondents; 1/40) the estimated percentage of turnover was significantly higher for only or mainly foreign suppliers with (somewhat) radical innovations. It seemed that the higher risk-profile for incremental and for radical innovations with foreign suppliers brought advantages.*

30. *Note that in many instances, the research was unable to find any significant difference in performance levels when controlled for these three supplier types.*

7.5 Effects of Intensity in Three Types of Supplier Relations (Q8)

This Section discusses the performance variables, when controlled for three types of intensities in supplier relations as used in this research. (See §2.9.4; §5.2.4; See corresponding Appendix §7.5 for details).

The research analysed effect of intensity of relations with suppliers providing <u>services</u>. In 12/40 instances, the performance variables scored significantly higher. This was notably true for satisfaction with innovative customers, and to a lesser extent with innovative suppliers. High relation intensities led to significantly higher satisfaction rates. Similarly, high relation intensities led to higher perceived innovation-benefits for the own company.

Performance variables when controlled for intensity in relations with suppliers that <u>manufactured</u> products differed in 4/40 instances. Notably, innovation-satisfaction rates with innovative suppliers were significantly higher with more intense relations with manufacturers.

Finally, performance variables when controlled for intensity of relations with <u>wholesale-distribution</u> suppliers differed in 6/40 instances. Again, innovation-satisfaction rates with innovative suppliers were significantly higher with more intense relations with wholesalers of distributors.

Section summary-conclusion:

31. *Performance variables differed significantly in 12/40 instances for high versus low levels of intensity with services, 6/40 with wholesale-distribution suppliers, and in 4/40 instances with manufacturers*

32. *Extant literature would generally suggest that relations with service providers would be more intense (§2.10.2; §2.9.3). Some literature also indicated (§2.9.3) that a more intense supplier relation would lead to higher performance. Again, in many instances this research was unable to detect statistical differences in performance levels.*

7.6 Effects of Two Basic Innovation Types (Q9, Q10)

This Section presents performance variables when controlled for two types of innovations as discussed in §2.10 and §5.2.5. (See Appendix §7.6 for results).

The research was unable (0/40) to detect significant differences in performance when controlled for <u>product versus process</u> innovations with innovative suppliers. Contrary, the research indicated significant (9/40) differences in several performance variables when controlled for <u>radical versus incremental</u> innovations with innovative suppliers. Notably the effect on satisfaction level with procurement with innovative suppliers differed.

Respondents' innovation-satisfaction rates significantly increased with when the innovation with suppliers was considered more <u>radical</u>, and was lowest with only <u>incremental</u> innovations. To a somewhat a lesser extent this was also statistically-significant for innovation-satisfaction rates with innovative suppliers. Perhaps more interesting, the estimated percentage of turnover was also significantly higher for the N=19 respondents who only or mainly developed <u>radical</u> innovations versus N=35 respondents who only or mainly developed <u>incremental</u> innovations[151].

Section summary-conclusion:

33. *The research was unable to detect significant differences (0/40 instances) in performance variables when controlled for <u>product versus process</u> innovations with innovative suppliers. Hence based on the data, products or process innovations could be equally profitable. Literature from §2.10 gave little further guidance on explaining these results.*

34. *The data indicated that in 9/40 instances, performance significantly differed when controlled for <u>radical versus incremental</u> innovations with innovative suppliers.*

35. *The data indicated that (N=28) respondents who were only or mainly involved in <u>radical</u> innovations in these 9/40 instances reported a significantly higher estimated percentage of turnover from all suppliers over the last three years, higher innovation-satisfaction rates on procurement and innovative suppliers, and higher benefits for the own company.*

36. *Extant literature (§2.10) suggested that <u>incremental</u> innovations were less risky, but could also equal fewer rewards. The survey data suggested that more radical innovations would give higher supplier satisfaction rates and higher innovation turnovers. (See also footnote below).*

37. *Again, in 31/40 instances, the data were unable to detect significant differences.*

7.7 Effects of Entrepreneurial Orientation with Suppliers (Q7)

This Section presents performance variables and (correlation or causal) relations with of entrepreneurial variables with innovative suppliers as discussed in §5.2.6. (See Appendix §7.5 for results). Except for aggressiveness, the performance variables showed several significant differences when controlled for entrepreneurial variables. These are discussed below.

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[151] Note that roughly 25% of survey respondents reported to develop only or mainly radical innovations with innovative suppliers, whereas roughly 42% developed only or mainly incremental innovations. (cf. §5.2.5; based on SurveyMonkey data).

7.7.1 Innovating Activities with innovative Suppliers

As could perhaps be expected, respondents who reported that this innovating activity variable was very important, seemed to score significantly better on several innovation-benefit variables and on several innovation-satisfaction variables. (12/40 instances were significant). This implied that organisations innovating with innovative suppliers perceived benefits and were satisfied. Note that roughly 79% of respondents considered innovating with innovative suppliers (very) important. (§5.2.6; SurveyMonkey data).

7.7.2 Risk-taking with innovative Suppliers

Respondents who reported that this risk-taking variable was very important, scored significantly better on two innovation-benefit variables and on four innovation-satisfaction variables. (6/40 instances were significant).

This could imply that companies who considered risk-taking with innovative suppliers perceived benefits and were satisfied. Note that roughly 60% of respondents considered risk-taking with innovative suppliers (very) important. (§5.2.6; SurveyMonkey data).

7.7.3 Opportunities with innovative Suppliers

Notably the variables innovation-benefits, satisfaction with innovation procurement, and satisfaction with innovative suppliers showed differences. Respondents who reported that this opportunities variable was very important, scored significantly better on several innovation-benefit variables and on several innovation-satisfaction variables. (19/40 instances were significant).

This could imply that organisations looking for opportunities with innovative suppliers perceived benefits and were satisfied. Note that roughly 76% of respondents considered opportunities with innovative suppliers (very) important. (§5.2.6; SurveyMonkey data).

7.7.4 Aggressiveness in Supplier Markets

The date indicated 2/40 significant relations (uncoded) between the aggressiveness variable with benefits for the natural environment (i.e. aggressive is important leads to more benefits). Also, marketing-sales satisfaction was higher when aggressiveness was ranked as very important. Note that only roughly 41% of respondents considered aggressiveness with suppliers (very) important. (§5.2.6; SurveyMonkey data).

7.7.5 Trust with innovative Suppliers

The data indicated 13/40 significant relations with trust levels. Respondents who reported that this trust variable was very important, scored significantly better on several innovation-benefit variables and on several innovation-satisfaction variables.

This would imply that organisations who considered trust with innovative suppliers important perceived benefits and were satisfied. Note that roughly 98% of respondents considered trust with suppliers (very) important. (§5.2.6; SurveyMonkey data).

7.7.6 Conclusions from Entrepreneurial Orientation

38. *The research was unable to detect (direct) effects on the two output-performance variables when controlled for entrepreneurial practices with suppliers.*

39. *However, entrepreneurial orientation variables, notably innovating (12/40), opportunity-seeking (19/40) and trust (13/40) with innovative suppliers had several significant effects on procurement process performance variables. Risk-taking had moderate effects (6/40). The research found only minor differences (2/40) in performance levels when controlled for aggressiveness towards supplier markets.*

40. *Overall, a relatively large part of respondents considered the entrepreneurial orientation variables with their innovative suppliers (very) important. (Again with the exception of aggressiveness).*

41. *Higher levels of the three entrepreneurial variables towards innovative suppliers had positive effects on several innovation-benefits and innovation-satisfaction levels. (Note that these two process-performance variables had reverse scales).*

42. *Extant literature generally mentioned a positive relation between entrepreneurial orientation and performance but acknowledged that such relations would not always be straight-forward (Davidson et al., 2005; Wiklund & Shephard, 2005; Franz, 2018; §2.12).*

43. *For a substantial part, the research was unable to detect positive or negative effects on performance when controlled for entrepreneurial orientation towards suppliers. Based on the findings, the detected positive effects on performance varied from almost zero (2/40) to moderate (19/40).*

7.8 Chapter Summary

This Chapter aimed to answer the following empirical research question.

(RQ7) What relations existed between company variables, procurement management variables, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains?

The research question was supported by two hypotheses. The qualitative answers can be construed from the 43 Section summary-conclusions. Answers are given underlined below.

H5: Differences in company variables had significant effects on procurement performance variables. (§7.2). <u>Largely rejected</u>, only the innovation experience had positive performance effects.

H6: Differences in procurement management variables had significant effects on procurement performance variables.

H6a: Differences in procurement step priorities variables had significant effects on performance variables. (§7.3). <u>Largely rejected</u>.

H6b: Differences in supplier type variables had significant effects on performance variables. (§7.4). <u>Largely rejected</u>. Only for foreign versus domestic suppliers for (somewhat) incremental innovations.

H6c: Differences in supplier relation intensity variables had significant effects on performance variables. (§7.5). <u>Only partly confirmed</u>. Especially with suppliers providing services.

H6d: Differences in innovation type variables had significant effects on performance variables. (§7.6). <u>Rejected</u> for product versus process innovations. <u>Confirmed</u> for developing radical versus incremental supplier innovations.

H6e: Differences in entrepreneurial orientation variables with suppliers had significant effects on performance variables. (§7.7). <u>Confirmed</u> for the four variables innovating, risk-taking, opportunity-seeking and trust with innovative suppliers. <u>Largely rejected</u> for aggressiveness in supplier markets.

Therefore, hypothesis H5 was largely rejected, hypothesis H6 was partially rejected.

Again, an analysis of the 43 Section summary-conclusions produced a more nuanced picture. The following two Tables summarise significant relations of performance controlled for company variables and for mediating variables from Sections §7.2-7.7. (With significance levels of p<.05). The Tables present effects for uncoded and recoded independent and dependent variables[152]. The sums of significant occurrences are shown in the right SUM column, and in the bottom SUM row. The Tables also provide subtotals on innovation-benefits and innovation-satisfaction.

A Note on the Interpretation of the Tables
Variables without any significant relationships were indicated by empty cells. Variables with significant relationships were indicated by their count. Relatively high counts (≥3) were

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[152] As mentioned in §7.1, except for the 2 dependent output variables, the 9 dependent process- performance dependent variables had been split out in uncoded & recoded variables. The independent variables had also been used as uncoded and recoded variables. This enhanced the chance of detecting significances. Hence these summary Tables show significant differences for a total of 2x20=**40** dependent variables. In the Tables these can be found in the bottom row with SUM instances.

indicated in orange cells. Their relative row and column SUM ≥15% and SUMs ≥20% cut-off are indicated in bold green.

A visual assessment of the Tables indicated that the research was unable to find statistical differences for the large majority of the investigated relationships. Differences that did appear could be considered stronger with higher SUMs on the independent and dependent variables.

The output-performance variables showed few relations, and hence the related process-performances were applied as a proxy. (See also §7.1).

Also, some of these process-performance variables were considered more relevant to the research objectives than others, especially when they occurred in combination.

Moreover from a *post-hoc* perspective, the effect of company variables on the satisfaction variables for marketing & sales, customers and internal activities were only relevant for a comparison with supplier and procurement satisfaction. For example the variables satisfaction with procurement or satisfaction with innovative suppliers could be considered more important for this research than the variable satisfaction with internal innovation activities. Although the sum total of this latter variable was high, it was difficult to understand how this variable alone could be a good predictor for the output procurement performance variables.

The following Chapter 8 discusses findings from Survey II.

Chapter 9 answers RQ7.

Table 100: Summary of performance variables controlled for company variables

Company variables → Performance variables	Company Size	operational excellence	customer intimacy	product leadership	towards customers or suppliers entrepreneurial	towards customers or suppliers is lifestyle	towards customers or suppliers is survival mode	Experienced in Procurement or Supply Chain	Experienced in Mgmt or Strategy	Experienced in NPD or Innovation	Experienced in Sales Marketing or BD	Experience in Oversea	Turnover from services	Turnover from manufacturing	turnover from wholesale or distribution	Not relevant or from other activities	SUM	rel%SUM (≥15% = green)
Estimated innovations developed w all suppliers last 3 yrs										2							2	6%
Estimated % of turnover innovations developed w a suppliers last 3 yrs				2													2	6%
Innovations with supplier interaction are beneficial for our company		2															2	6%
Innovations with supplier interaction are beneficial f/t natural environment	1												2		2		5	16%
Innovations without supplier interaction are beneficial for our company																	zero	0%
Innovations without supplier interaction are beneficial f/t natural environment															1		zero	0%
Satisfaction with procurement with innovative suppliers						1				1	2						4	13%
Satisfaction with innovation with innovative suppliers										3							3	9%
Satisfaction with marketing&sales with innovative customers										1	2					4	7	22%
Satisfaction with innovation with innovative customers										1	1						2	6%
Satisfaction with internal innovation activities				4		2		2		4					1	1	14	44%
subtotal satisfaction																	30	19%
SUM	1	2	zero	6	zero	3	zero	2	zero	12	5	zero	2	1	4	4		
SUM instances	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		
relx of SUM (≥15%=green)	3%	5%	0%	15%	0%	8%	0%	5%	0%	30%	13%	0%	5%	3%	10%	10%		

Table 101: Summary of performance variables controlled for procurement management variables

Procurement variables → / Performance variables ↓	Specify Needs idea	Specify Needs Develop	Find&Select idea	Find & Select develop	We prefer domestic /foreign suppliers for (sw) incremental innovations	We prefer domestic / foreign suppliers for (sw) radical innovations	We prefer new / current suppliers for (sw) incremental innovations	We prefer new/ current suppliers for (sw) radical innovations	We prefer small /large suppliers for (sw) incremental innovations	We prefer small/ large suppliers for (sw) radical innovations	Intensity of relationships w suppliers providing services	Intensity of relationships w suppliers manufacturing products	Intensity of relationships w suppliers in wholesale or distribution	We develop radical/ incremental innovations w innovative suppliers	We develop product/ process innovations w innovative suppliers	Innovating activities with Innovative suppliers	Risk taking towards Innovative suppliers	Opportunities with innovative suppliers	Aggressiveness in supplier markets	Trust with innovative suppliers	SUM	rel%SUM (≥20%=green)
	procurement priorities ($7.3)				supplier types ($7.4)						intensity relations ($7.5)			innovation types ($7.6)		entrepreneurial orientation towards suppliers ($7.7)						
Estimated innovations developed w all suppliers last 3 yrs																					zero	0%
Estimated % of turnover innovations developed w a suppliers last 3 yrs					2	1								1							4	10%
Innovations with supplier interaction are beneficial for our company			1							1	2	1	2	1		3		2		1	14	35%
Innovations with supplier interaction are beneficial f/t natural environment	1				3						1	1	1			2	1	4	1	3	18	45%
Innovations without supplier interaction are beneficial for our company																					zero	0%
Innovations without supplier interaction are beneficial f/t natural environment		1																2			3	8%
Satisfaction with procurement with innovative suppliers			1								2				3	4	2	4		3	19	48%
Satisfaction with innovation with innovative suppliers			1									2	3	2		3	2	4		4	21	53%
Satisfaction with marketing&sales with innovative customers											1								1		2	5%
Satisfaction with innovation with innovative customers										1	4			1			1	3		1	11	28%
Satisfaction with internal innovation activities			1		1						2	0		1						1	6	15%
subtotal satisfaction																					59	30%
SUM	1	1	4	zero	6	1	zero	zero	zero	2	12	4	6	9	zero	12	6	19	2	13		
SUM instances	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		
rel%SUM ≥20%=green	3%	3%	10%	0%	15%	3%	0%	0%	0%	5%	30%	10%	15%	23%	0%	30%	15%	48%	5%	33%		

Chapter 8

Survey II:

Key-Variables & Procurement Best-Practices

Chapter 8

Survey II: Key-Variables & Procurement Best-Practices

This final empirical Chapter presents results from Survey II on the same target-population. Survey I produced insights on procurement practices, but these could not be analysed in depth in relation to innovation or supplier variables. The objective of Survey II therefore was to explore the effects of a selection of independent supplier and innovation variables on a selection of procurement practices. (See conceptual model III below).

Key Supplier Innovation Variables

Mainly with radical innovations
Mainly with incremental innovations
When green aspects are important
When quality aspects are important
When cost aspects are important
Mainly with new innovative suppliers
Mainly with existing innovative suppliers
Mainly with NZ innovative suppliers
Mainly with foreign innovative suppliers

Procurement best-practices for:

Specify needs step
Find & select step
Negotiate & contract step
Manage relations step

Figure 56: Conceptual model III used in Survey II

The Chapter first discusses the selection of variables & practices for Survey II (§8.1). It then presents results from one focus-group discussion (§8.2), and presents descriptive Survey II statistics that give a profile of the Survey II respondents and their procurement best-practices (§8.3). The Chapter continues with a visualisation of key supplier-innovation variables versus procurement best-practices (§8.4), and related inferential statistics (§8.5). It ends with a summary and conclusions (§8.6).

This Chapter tried to answer the following empirical research question and high-level hypothesis.

(RQ8) What relations existed between (independent) supplier-innovation variables and (dependent) procurement management best-practises in New Zealand companies that managed innovative suppliers in construction supply chains?

H7: Differences in supplier-innovation variables had significant effects on procurement practices.

Section summary-conclusion:

1. *Chapter 8 discusses a selection of 3x4 procurement practices controlled for nine supplier-innovation variables.*

8.1 Selection of Key-Variables and Best-Practises; Survey Respondents

The case companies managed innovative suppliers from their particular context[153]. The supplier-innovation variables of Survey II described generic supplier types (§2.9) and innovation types (§2.10). Based on literature and findings, this research posited that these three types of variables would affect the choice of particular procurement practices in each of the four procurement steps.

Hence the research selected nine supplier-innovation variables as independent variables and selected twelve (3x4) procurement variables as dependent variables. It *added* dichotomous variables on costs, quality and green aspects based on Kibbeling (2010). It *omitted* the large versus small supplier, and the process versus product innovations variables as this variable pair had not led to relevant finding in the preceding Chapters. (See also Table 87 in §6.5). This research furthermore selected four company control variables (§8.2) from Survey I for information on the context of the innovation and company profile[154].

These selections were based on significant or substantive findings of Chapter 4, 6 and 7, and based on the researcher's business and academic experience on the topic (§3.2.4). The Figure below shows conceptual model III. Selections were validated in one exploratory world-research café session (roundtable discussion; §8.2) and then used for Survey II. Validation did not result in modifications (§3.6.4.4).

An example to show how model III would work: a focal company was engaged in radical innovations, and hence could use a specific set of procurement practices. If that company were engaged in incremental innovations, it could well use different procurement practices. (Each would lead to performance, e.g. benefits or satisfaction rates from Model II).

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[153] Hence these variables could be called "context variables", "situational variables" or perhaps "purpose variables". To show the relation with the variable names from previous Chapters, this research preferred "company variables".

[154] An argument could be made to turn the independent and dependent variables around. However the design of Survey II started from the context of the supplier innovation, and then identified practices (interventions) that companies could use to realise performance.

The same (N=1097) invitees from Survey I who consented received an email-link to SurveyMonkey for online Survey II. Survey I had a nett response of N=112. As expected, Survey II yielded a lower response rate with N=36 completed and three partial responses. After data cleaning and removing outliers, this research further analysed data from N=33 respondents[155]. (See §3.6.4.1).

Internal validity: To some extent, the response rate N=33 could have affected the internal validity. However, Survey II used validated variables (see §3.6.4, §3.7.2). Furthermore, the response rate N=33 was adequate for conducting a series of Chi-Square tests[156].

External validity: Findings from Survey I indicated that respondent profiles were aligned with the target-population (§5.4). Due to the limited number of profiling questions, this was not directly clear from Survey II. Hence this research compared available survey respondents' names, and three questions that were similar or identical in both surveys.

The participants' name data from Survey II did *not* suggest that a substantive part of Survey II respondents were a subset of Survey I respondents. From n=33 named respondents in Survey II, n=9 respondents mentioned their names with Survey I. Hence, n=24 Survey II respondents were not named[157] in Survey I. This suggested that Survey II respondents were not merely a subset of Survey I respondents. Alternatively, it could be that such respondents did not submit their names with the first Survey, but did so with the second Survey.

Tables 102 below give details on identical or similar survey questions; Table 103 gives results for Chi-Square tests (goodness-for-fit) on these survey questions.

Table 102: Identical or similar questions in Survey I and II

Variable	Survey I	Survey II
Company size (recoded)	(Q21) The size of our company … (Recoded <99, and >249 staff)	(Q6) The size of our company is … (Recoded <99, and >249 staff)
Company type[158]	(Q25) Our estimated annual turnover (in percentages) comes from; please rank from most important (1) to least important (4)	(Q7) Our main turnover comes from…

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[155] Cases #5, #9, #15, #23, and #33 were considered outliers and omitted from the analysis.

[156] Chi-Square tests are the last resort and can be used for nominal variables with independent observations. Minimum sample sizes with Chi-Square tests vary with the number of cells. Grande (2017) recommended a minimum of five times the number of cells. VanVoorhis & Morgan (2007: 48) recommended a minimum of N=20 overall. (See footnote with §8.5). Common additional requirements: ≤20% of the categories should have expected frequencies <5 (Lavery, 2013). No cell should have a frequency <3 (Grande, 2017).

[157] This could either mean they did not complete Survey I, or completed Survey I anonymously.

[158] Ranking question in Survey I; list question in Survey II. For a good comparison only "most important" (N=98) of the Q25 ranking question was compared with the list question Q7 in Survey II.

Variable	Survey I	Survey II
Customer strategy[159]	(Q26) Our strategy towards our customers is; please rank from most important (1) to least important (3)	(Q8) Our strategy towards our customers mainly is …

Table 103: Results Chi-Square test on association on three questions in Survey I versus Survey II[160]

Variable	Association of Survey II versus Survey I
Company Size (recoded)	Populations did <u>not differ significantly</u> with recoded company size Chi-Square=.148; df=1; p=.700. (Probably due to the low sample size, uncoded company size gave too high percentages of cells with frequencies <5).
Company type[161]	Populations <u>probably did not differ</u> significantly. Chi-Square=.476; df=2; p=.788. The expected minimum frequency was however violated as one cell (33,%) had an expected frequency <5. (Frequency was 3).
Customer strategy[162]	Populations differed significantly. Chi-Square=12.332; df=2; p=.002. Respondents reported product leadership less than expected from Survey I; the other strategies were reported more often. Nevertheless, in both surveys respondents favoured quality over operational excellence.

Based on these findings there was *reasonable doubt* whether the two survey populations were sufficiently identical. Hence generalisation to the Survey I population should be done with care (cf. Ch10.4); and due to the small sample size generalisation to the target-population should also be done with care. For details on the analysis in the Tables, see §8.3.1.

NOTES:
1. In Survey II, the research did *not* use the company variables for inferential statistics, as the objective was to design a simple and short Survey II to obtain a minimal sample size *N*=20 for non-parametric Chi-Square testing.
2. Instead, it used variables to understand the context of the supplier-innovation variables and to profile the survey respondents. (See §8.3).
3. Chapter 8 could not benefit from extant literature, other than used in the previous empirical Chapters and presented in §2.11.2. Hence the discussion on individual procurement practices was largely done without a comparison with literature.

Section summary-conclusion:

2. *The research selected nine supplier-innovation variables which acted as independent variables and after a group discussion selected twelve (3x4) procurement variables as dependent variables. This research furthermore selected four basic company control variables from Survey I for information on the context of the innovation.*

3. *Variables were based on literature and findings from this research.*

4. *The distributions within three similar or identical questions of Survey I and II were similar to a certain extent. Generalisation to the Survey I population was possible but should be*

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[159] Same as in previous footnote.
[160] Smits & Edens (2016: 128, 133).
[161] Ranking question in Survey I; list question in Survey II. For a good comparison only "most important" (*N*=98) of the Q25 ranking question was compared with the list question Q7 in Survey II.
[162] As in previous footnote.

done with care. Due to the small sample size, generalisation to the target-populations should also done with care.

5. *Nevertheless, the nett sample size N=33 was considered adequate for conducting a series of Chi-Square tests. The research was unable to find relevant literature on the findings in Chapter 8.*

8.2 Results from Focus-Group Discussions

The roundtable discussions had two outcomes. Despite a structured design for the focus-group process (§3.6.3), the actual discussions on procurement steps specify-needs and find-select with innovative suppliers proved to be more qualitative. The actual discussions on procurement steps negotiate-contract with suppliers and manage-relations with innovative suppliers were more quantitative.

8.2.1 Procurement Step: Specify-needs Practices with innovative Suppliers

Based on a template, participants discussed five procurement practices, within the context of nine supplier type pairs (§2.9) and innovation type pairs (§2.10). The five procurement practices had been selected based on rankings in Survey I (§5.2.2). The discussion confirmed and enriched findings from the literature and interviews[163]. (For details, see Appendix §8.2.1). Notes were taken on flip charts. Findings are shown below.

Table 104: Specify-needs for innovations: findings from roundtable discussion

	Remarks from one or more participants	Relevance for this research
1	The use of best-practices depends on the requirements	This would confirm that application of best-practices is contextual.
2	Construction innovations are driven by the industry. The supplier has the knowledge and companies need reputable suppliers.	This would confirm that construction-innovations are supplier-driven. This would be in line with Pavitt's (1984) classifcation.
4	Overseas suppliers need a local representation and need to give support and guarantees.	This would confirm that in daily business operations participants would distinguish between foreign and domestic suppliers.
5	Not always easy to switch overseas suppliers.	This is in line with literature that SMEs would have little resources for a overseas supplier market scan or means to switch suppliers. (e.g. Carr & Pearson, 1999)
6	Relationships are necessary for building trust, in order reduce risks and uncertainties with innovation activities with suppliers. This trust will also reduce cost in the supply chain.	This would confirm the purposeful management of relations.
7	Construction innovation are risky and need to be tried and tested.	This was in line with §2.2
8	Outsourcing pushes risks away from company	Depending on contract and relations, could also create new risks.
9	When customers determine key functional specs, this is done mainly during the development phase	In line with extant literature (Von Hippel, 1986), although unclear how customers

[163] Note that participants could be biased as they could select from five practices. However the template offered the possibility to add other practices. Participants came from a mix of small and large organisations.

	and with incremental innovations and with process innovations.	would be involved with process innovations.
10	Customers determine whether green functionality is important or not, and customer input on specification seems to be more important when companies have less experience.	This could also relate to the experience levels of respondents in the surveys.
11	Customers have no idea of quality and costs; they do not want innovations, but trusted solutions; nor do they want risks. They want better costs or benefits.	Hence the focal company is interested in the outcome of supplier innovations.

This discussion only *indirectly* validated supplier-innovation variables (§2.9; §2.10), and the ranking on procurement practices (§5.2.2).

8.2.2 Procurement Step: Find-select Practices with innovative Suppliers

Based on a template, participants discussed five procurement practices, within the context of nine supplier type pairs (§2.9) and innovation type pairs (§2.10). No extensive notes were taken on best-practices and supplier and innovation variables. Findings are shown below.

Table 105: Find-select suppliers: findings from roundtable discussion

	Remarks from one or more participants	Relevance for this research
1	The innovation takes place before the contract.	This would confirm an informal way to manage supplier innovations.
2	Companies seem to focus on technology during the idea phase, but more on the economic value during the develop phase	This would confirm that practices could change during an innovation process
3	Participants remarked that they worked with known suppliers, and had no time to find new suppliers.	This would confirm a preference for existing suppliers. It also confirmed extent literature on time constraints.
4	Due dilligence was needed with domestic, but expecially with overseas suppliers. Focal companies depend on supplier certificates for quality aspects.	This would confirm that although trust and relations were seen as important, more formal practices would also be considered important.

This discussion only *indirectly* validated supplier-innovation variables (§2.9; §2.10), and the ranking on procurement practices (§5.2.2).

8.2.3 Procurement Step: Negotiate-contract Practices with innovative Suppliers

The approach on the last two procurement steps was more structured. Based on a template, participants again discussed seven innovation-supplier variable-pairs and five practices in two teams and two discussion rounds. Participants (*N*=14) were encouraged to agree on one or two best-practices for each of the innovation or supplier variable-pairs[164]. This resulted in a ranking of procurement practices. (See Table in corresponding Appendix).

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[164] Although stimulated, participants did not write-down other best-practices.

A note on the interpretation of the Table. Procurement practices that were selected at least five times, were indicated with "YES". A "NO" indicated that all participants did not choose a particular practice. In some instances, participants preferred two best-practices (two "YES" on one row). In several instances, <5 participants agreed on a particular practice, indicated with a "??". As "NO" is inherently stronger (none of the participants preferred this practice) than "YES", this Table gives the "NO" in bold. Likewise, the two procurement practices that participants overall preferred most (SUM =YES-NO), are shown in bold.

The procurement practices only aligned 1/3 with rankings from Survey I (Table 56, §5.2.2). The discussion hence *partially* validated the ranking of procurement practices.

8.2.4 Procurement Step: Manage-relations Practices with innovative Suppliers
From a process identical to the previous Subsection, the Table in the corresponding Appendix shows results for the last procurement step on manage-relations. Participants appeared more unified in their preferences on best-practices; that Table shows in bold the two procurement practices that were selected most.

As with the previous Subsection, best-practices were partially (1/3) aligned with the ranking from Survey I. (Tables 56, 57 in §5.2.2). Consequently, the discussion *partially* validated the ranking of procurement practices.

8.2.5 Conclusions from Focus-Group Discussions
6. *The (qualitative) roundtable discussions on specify-needs, and find-select suppliers only indirectly validated the ranking of selected procurement practices in §5.2.2.*

7. *The (quantitative) roundtable discussions on negotiate-contract, and manage-relationships partially validated the ranking of selected procurement practices in §5.2.2.*

8. *Generally, participants could well-relate to the 14 (2x7) supplier and innovation variables. Participants did not propose other practices.*

9. *For reasons of simplicity and time-constraints, the research decided to further analyse 9/14 of the supplier-innovation variables in Survey II. It decided to further analyse in Survey II the ranking of 3x4 procurement practices from §5.2.2.*

8.3 Descriptive Statistics on Survey II
This Section starts with presenting descriptive statistics from Survey II on company variables (§8.3.1). Then it discusses procurement management variables (§8.3.2).

8.3.1 Descriptives on Company Variables

The following Table gives the distribution of company size. Respondents relatively often worked for large companies. Therefore, from this perspective the sample was not representative for the focal New Zealand companies (§2.1.1; §2.6; §8.1).

Table 106: Company variables: distribution of company size in Survey II (*N*=33)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-4	8	24,2	25,0	25,0
	5-9	4	12,1	12,5	37,5
	10-19	1	3,0	3,1	40,6
	20-99	6	18,2	18,8	59,4
	100-249	1	3,0	3,1	62,5
	250-499	3	9,1	9,4	71,9
	more than 500	9	27,3	28,1	100,0
	Total	32	97,0	100,0	
Missing	999	1	3,0		
Total		33	100,0		

The recoded distribution into <99 and >249 staff did not significantly differ from the Survey I recoded distribution (See §5.1.1; see §8.1). By-and-large the uncoded distributions of the two surveys could be similar on company size.

The following Table shows finding on the customer value proposition. This distribution statistically differed from the Survey I distribution (§5.1.7; §8.1). Survey II had a higher proportion of operational excellence (34.4%) versus Survey I (23%), and a lower proportion of product leadership (15.6%) versus Survey I (36.5%).

In part, this could be caused by the different explanations in the relevant survey question, in part by an improved structure of the question. The research could not determine to what extent the Survey II population would differ from the target-population. Nonetheless, 66% of Survey II respondents still focussed on quality via product leadership or customer intimacy, which could be a higher percentage compared to companies in New Zealand construction supply chains. (See §2.8.3; §5.1.6)[165].

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[165] Literature often suggested differences between cost focused and differentiators (Cf. Porter, 1995). For example Gerhard & Voigt (2009: 614) found that such "differentiators" more used open innovation methods compared to cost-focussed companies.

Table 107: Company variables: distribution of customer value proposition in Survey II (*N*=33)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Product Leadership - Providing leading edge products or services	5	15,2	15,6	15,6
	Customer Initimacy - Tailoring the products or services to exactly meet customer demands	16	48,5	50,0	65,6
	Operational Excellence - Providing reliable services/products at competitive prices	11	33,3	34,4	100,0
	Total	32	97,0	100,0	
Missing	999	1	3,0		
Total		33	100,0		

Survey I did not inquire the respondents' professions or company types (See §2.1.2). However when analysing Survey I results, it was felt that this knowledge could help to profile the survey sample. The following Table shows the profile of respondents based on NZGBC segmentation (NZGBC, 2016) for Survey II. Respondents varied in their background and covered relevant company types in the supply chain. (§2.12).

Table 108: Company variables: profession & industry type of respondents in Survey II (*N*=33)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Residental builders and Developers	9	27,3	27,3	27,3
	Builiding contractors	2	6,1	6,1	33,3
	Building Product Manufacturers & Distributers	6	18,2	18,2	51,5
	Architects & Design	4	12,1	12,1	63,6
	Engineers	4	12,1	12,1	75,8
	Property & Construction Professionals	4	12,1	12,1	87,9
	Property Owners or Property Occupiers	4	12,1	12,1	100,0
	Total	33	100,0	100,0	

The following Table gives the distributed main turnover types. The design of this survey question differed from that in Survey I. Nevertheless, this turnover distribution was probably consistent with the Survey I distribution (See §5.1.7; §8.1).

Table 109: Main turnover types in Survey II (*N*=33)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	providing services	21	63,6	72,4	72,4
	manufacturing & selling products	6	18,2	20,7	93,1
	wholesale or distribution	2	6,1	6,9	100,0
	Total	29	87,9	100,0	
Missing	999	4	12,1		
Total		33	100,0		

The combined Table below shows crosstabs on recoded company size in Survey II versus the company's main turnover type, and versus recoded customer strategy. The two crosstabs did not indicate major differences on company sizes versus source of turnover or versus customer strategies. (Note that the subsamples were small for a reliable answer). The Tables again displayed the wide variety of case companies in New Zealand construction supply chains.

Table 110: Recoded company size, main turnover type, and recoded customer strategy (*N*=33)

| | | | Main source of our turnover ... | | | |
			providing services	manufacturing & selling products	wholesale or distribution	Total
Company size < 99 or > 99 employees recoded	Less than 100 employees	Count	11	5	1	17
		% within Company size < 99 or > 99 employees recoded	64,7%	29,4%	5,9%	100,0%
	More than 99 employees	Count	10	1	1	12
		% within Company size < 99 or > 99 employees recoded	83,3%	8,3%	8,3%	100,0%
Total		Count	21	6	2	29
		% within Company size < 99 or > 99 employees recoded	72,4%	20,7%	6,9%	100,0%

| | | | Customer Strategy Recoded OE vs PI and CI | | |
			Product Leadership & Customer Inti. recoded	Operational Excellence recoded	Total
Company size < 99 or > 99 employees recoded	Less than 100 employees	Count	12	7	19
		% within Company size < 99 or > 99 employees recoded	63,2%	36,8%	100,0%
	More than 99 employees	Count	9	4	13
		% within Company size < 99 or > 99 employees recoded	69,2%	30,8%	100,0%
Total		Count	21	11	32
		% within Company size < 99 or > 99 employees recoded	65,6%	34,4%	100,0%

8.3.2 Descriptives on Procurement Best-Practices

The Figures below with four high-level pie charts give frequencies of best-practices for each of the four procurement steps. For the *specify-needs* practices (see Figure below, left), most respondents tended to focus on economic value or that suppliers contribute to functional specification. For the *find-select* practices (Figure below, right), most respondents tended to prefer price and availability criteria.
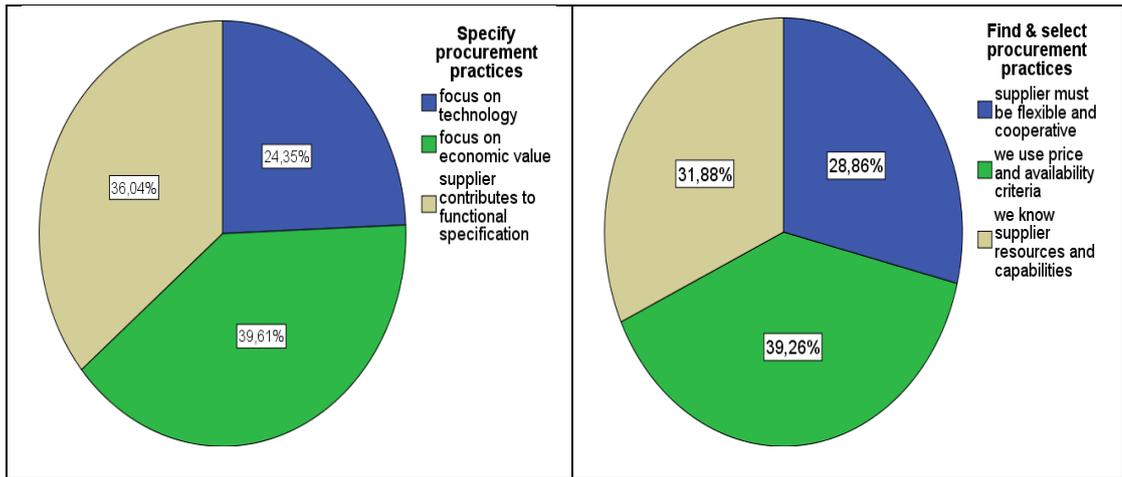
Figure 57: Distribution specify-needs practices (left); find-select practices (right) (*N*=33)

In case of the *negotiate-contract* practices (see Figure below, left) respondents tended to focus on opportunities. In case of *manage-relations* practices (Figure below, right) respondents tended to build trust and strong relationships.
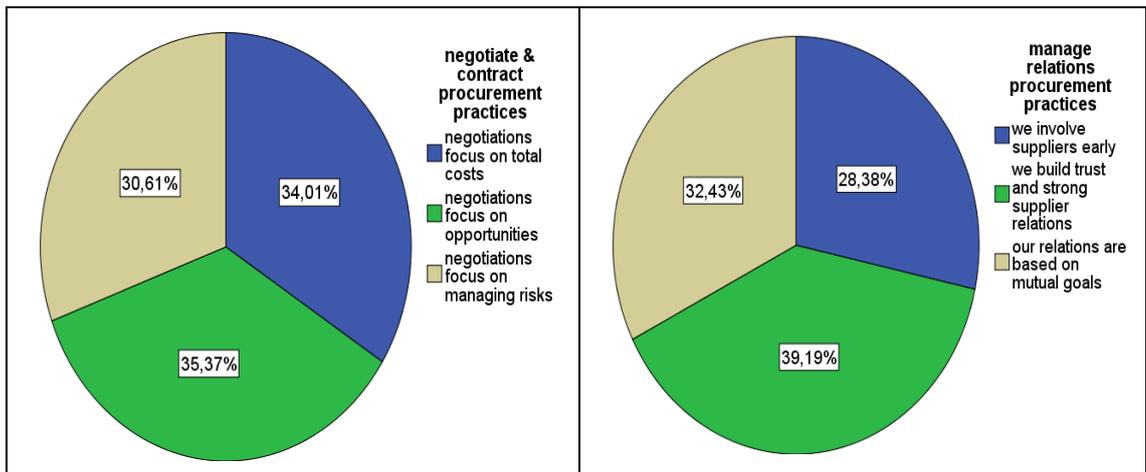
Figure 58: Distribution negotiate-contract practices (left); manage-relations practices (right) (*N*=33)

Preferences on procurement practices within the four procurement steps seemed to vary little. However, the overall differences in distributions seemed not too large i.e. all within the 25% to 40% range. (See §8.5 for inferential statistics). On a higher level, this indicated a fairly equal use of procurement practices when managing innovative suppliers. Nevertheless, when detailed-out per company variable, best-practices varied as the two following Sections demonstrate.

8.3.3 Conclusions from Descriptives Survey II

10. *Findings on the four company variables displayed the wide variety of companies in Survey II (N=33). Most of the case companies provided services, a minority of companies pursued an operational excellence as customer strategy.*

11. *Overall, the findings indicated a fairly equal use of the 3x4 procurement practices when managing innovative suppliers for each of the four procurement steps.*

8.4 Supplier-innovation Variables and Best-Practices

This Section presents visualisations on reported procurement practices. (See §8.5 for inferential statistics). Four Figures in the corresponding Appendix present practices that respondents preferred for specific supplier innovations. The inner circles[166] show the nine supplier-innovation variables; the outer circles show corresponding three (or four) practices (See §8.3 for a high-level ranking of practices). These four doughnut charts give an easy overview of the ranking of 3x4 best-practices respondents with the nine supplier-innovation types. It also showed the low frequencies of residual variables.

Section summary-conclusion:

12. *For each procurement step, doughnut charts produced an easy overview of relations between independent supplier-innovation variables and dependent (corresponding) procurement practices.*

13. *The charts showed that procurement practices would vary with the specific supplier and innovation types.*

8.5 Inferentials on Supplier-innovation Variables and Best-Practices

This Section presents inferential statistics on supplier-innovation variables and procurement practices via a series of Chi-Square tests[167]. In this research, the Chi-Square tests indicated statistically-significant differences within ≥3 categories of procurement best-practices, however without displaying how the categories mutually differed (Lavery, 2013). Therefore, to obtain more details, tests were done with and without the residual-category. (i.e. "Don't know or we use other practices"). The next four Tables show differences within the three practices ("all three best-pract."), and within the three practices including the residual-category ("3 pract. & rest cat") when controlled of each of the nine supplier or innovation

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[166] Built in Excel with a combined pie chart (doughnut chart).

[167] As procurement practices were ordinal, further analyses on size effects with a correlation analysis were not feasible (Huizingh, 2002: 299). Also, a series of Chi-Square crosstab analyses with company variables as predictor variables proved not feasible as too many cells (50% to even 100%) had expected frequencies <5, or even <3. (Grande, 2017). Also corrections with likelihood ratios did not yield significant results. (See footnote in §8.1).

variables. The Tables were built in Excel of SPSS custom tables from Chi-Square tests. Asymptotic significances are displayed with a significance level *p*=.05.

Chi-Square independence tests were a feasible test method. Analysing all four procurement practices in one procurement process step required 2x4 cells. Omitting the residual-category required 2x3 cells. Both tests met the minimal *N*=20 sample size requirement (Vanvoorhis & Morgan; 2007: 48). The latter Chi-Square test also met the stricter requirement on sample sizes of at least 5 times the number of cells (Grande; 2017). (See footnote in §8.1).

Totals are provided in the bottom rows. The first Table (below) shows a total of 5/9 significant differences within practices of the *specify-needs* step. Overall, it shows 7/9

Table 111: Specify-needs: Chi-Square significances of best-practices

Procurement Best-practices	Count	N %	Supplier Innov. Variable	chi-square test all 3 best-pract.	chi-square test 3 best-pract & rest cat.
focus on technology	20	61%	Specify for radical innovations	significant	significant
focus on economic value	5	15%			
supplier contribute to funct. specification	6	18%			
don't know or other practice	2	6%			
focus on technology	2	6%	Specify for incremental innovations	significant	significant
focus on economic value	16	49%			
supplier contribute to funct. specification	14	42%			
don't know or other practice	1	3%			
focus on technology	11	33%	Specify when green aspects are important	non-significant	non-significant
focus on economic value	10	30%			
supplier contribute to funct. specification	10	30%			
don't know or other practice	2	6%			
focus on technology	11	33%	Specify when quality aspects are important	significant	significant
focus on economic value	2	6%			
supplier contribute to funct. specification	20	61%			
don't know or other practice	0	0%			
focus on technology	1	3%	Specify when cost aspects are important	significant	significant
focus on economic value	28	85%			
supplier contribute to funct. specification	4	12%			
don't know or other practice	0	0%			
focus on technology	9	27%	Specify with new innovative suppliers	non-significant	significant
focus on economic value	14	42%			
supplier contribute to funct. specification	9	27%			
don't know or other practice	1	3%			
focus on technology	7	21%	Specify with existing innovative suppliers	non-significant	significant
focus on economic value	14	42%			
supplier contribute to funct. specification	11	33%			
don't know or other practice	1	3%			
focus on technology	2	6%	Specify with New Zealand innovative suppliers	significant	significant
focus on economic value	17	52%			
supplier contribute to funct. specification	13	39%			
don't know or other practice	1	3%			
focus on technology	5	15%	Specify with foreign innovative suppliers	non-significant	non-significant
focus on economic value	7	21%			
supplier contribute to funct. specification	10	30%			
don't know or other practice	*11*	*33%*			
Total	**297**			**5/9 significant**	**7/9 significant**

significant differences with the residual-category. The Table therefore showed insights in preferences. Notable was the preference for a focus on technology with radical supplier innovations (61%), and that the supplier contributes to functional specifications (61%) when quality aspects are important. Also the focus on economic value scored high (85%) when cost aspects are important.

The latter outcome could be the result of bias in the survey question, or just an obvious practice in case of a cost focus. The residual category scored relatively high (33%) on using foreign innovative suppliers for specify-needs. Combined with the non-significant results this implied that respondents had no clear preferences on a procurement practice. Finally, with non-significant findings, respondents often preferred one or two practices over the other practice(s) or residual category. Overall it could be concluded that respondents had clear preferences on procurement practices in the specify-needs step when controlled for a supplier-innovation variable. They were mostly value driven.

The following Table 112 shows to what extent procurement best-practices were significant with supplier-innovation variables in the *find-select* step.

Table 112: Find-select: Chi-Square significances of best-practices

Procurement Best-practices	Count	N %	Supplier Innov. Variable	chi-square test all 3 best-pract.	chi-square test all 3 best-pract & rest cat.
supplier must be flexible and cooperative	15	46%	Find-select for radical innovations	non-significant	significant
we use price and availability criteria	5	15%			
we know supplier resources & capabilities	11	33%			
do not know or other practice	2	6%			
supplier must be flexible and cooperative	10	30%	Find-select for incremental innovations	non-significant	non-significant
we use price and availability criteria	10	30%			
we know supplier resources & capabilities	11	33%			
do not know or other practice	2	6%			
supplier must be flexible and cooperative	7	21%	Find-select when green aspects are important	non-significant	significant
we use price and availability criteria	14	42%			
we know supplier resources & capabilities	10	30%			
do not know or other practice	2	6%			
supplier must be flexible and cooperative	8	24%	Find-select when quality aspects are important	significant	significant
we use price and availability criteria	6	18%			
we know supplier resources & capabilities	17	52%			
do not know or other practice	2	6%			
supplier must be flexible and cooperative	2	6%	Find-select when cost aspects are important	significant	significant
we use price and availability criteria	29	88%			
we know supplier resources & capabilities	1	3%			
do not know or other practice	1	3%			
supplier must be flexible and cooperative	17	53%	Find-select with new innovative suppliers	significant	significant
we use price and availability criteria	7	22%			
we know supplier resources & capabilities	7	22%			
do not know or other practice	1	3%			
supplier must be flexible and cooperative	9	27%	Find-select with existing innovative suppliers	non-significant	significant
we use price and availability criteria	9	27%			
we know supplier resources & capabilities	14	42%			
do not know or other practice	1	3%			
supplier must be flexible and cooperative	7	21%	Find-select with New Zealand innovative suppliers	non-significant	significant
we use price and availability criteria	14	42%			
we know supplier resources & capabilities	11	33%			
do not know or other practice	1	3%			
supplier must be flexible and cooperative	4	12%	Find-select with foreign innovative suppliers	non-significant	non-significant
we use price and availability criteria	13	39%			
we know supplier resources & capabilities	6	18%			
do not know or other practice	*10*	*30%*			
Total	**296**			**3/9 significant**	**7/9 significant**

This Table on the find-select step shows that respondents to a lesser extent agreed with (3/9) significant differences. Overall, it shows 7/9 significant differences including the residual category. Notable was the preference on price and availability criteria when costs were important. Again this could be a biased question or just an obvious practice. Again, the residual category was high with foreign innovative suppliers (30%). Finally, with non-significant findings, respondents often preferred one or two practices over the other

practices or residual category. *Overall it could be concluded that respondents had moderate preferences on procurement practices in the find-select step when controlled for the supplier-innovation variables. They were mostly driven by price and availability.*

Table 113 on the *negotiate-contract* step shows that respondents to a lesser extent agreed with (3/9) significant differences. Overall, it shows 6/9 significant

Table 113: Negotiate-contract: Chi-Square significances of best-practices

Procurement Best-practices	Count	N %	Supplier Innov. Variable	*chi-square test* all 3 best-pract.	*chi-square test* all 3 best-pract & rest cat.
negotiations focus on total costs	1	3%	Negotiate-contract for radical innovations	significant	significant
negotiations focus on opportunities	14	42%			
negotiations focus on managing risks	17	52%			
do not know or other practices	1	3%			
negotiations focus on total costs	13	39%	Negotiate-contract for incremental innovations	non-significant	significant
negotiations focus on opportunities	10	30%			
negotiations focus on managing risks	8	24%			
do not know or other practices	2	6%			
negotiations focus on total costs	10	30%	Negotiate-contract when green aspects are important	non-significant	non-significant
negotiations focus on opportunities	11	33%			
negotiations focus on managing risks	7	21%			
do not know or other practices	5	15%			
negotiations focus on total costs	6	18%	Negotiate-contract when quality aspects are important	non-significant	significant
negotiations focus on opportunities	11	33%			
negotiations focus on managing risks	14	42%			
do not know or other practices	2	6%			
negotiations focus on total costs	25	76%	Negotiate-contract when cost aspects are important	significant	significant
negotiations focus on opportunities	3	9%			
negotiations focus on managing risks	3	9%			
do not know or other practices	2	6%			
negotiations focus on total costs	8	25%	Negotiate-contract with new innovative suppliers	non-significant	non-significant
negotiations focus on opportunities	9	28%			
negotiations focus on managing risks	13	41%			
do not know or other practices	2	6%			
negotiations focus on total costs	10	30%	Negotiate-contract with existing innovative suppliers	significant	significant
negotiations focus on opportunities	19	58%			
negotiations focus on managing risks	3	9%			
do not know or other practices	1	3%			
negotiations focus on total costs	13	39%	Negotiate-contract with New Zealand innovative suppliers	non-significant	significant
negotiations focus on opportunities	12	36%			
negotiations focus on managing risks	4	12%			
do not know or other practices	4	12%			
negotiations focus on total costs	5	15%	Negotiate-contract with foreign innovative suppliers	non-significant	non-significant
negotiations focus on opportunities	6	18%			
negotiations focus on managing risks	11	33%			
do not know or other practices	*11*	*33%*			
Total	**296**			**3/9 significant**	**6/9 significant**

Finally, Table 114 on *manage-relations* step shows that respondents to a lesser extent agreed with (2/9) significant differences. Overall, it shows 7/9 significant differences including the residual category "Don't know or we use other practices". Notable was building trust & strong relations with New Zealand innovative suppliers. Again, the residual category was high with foreign innovative suppliers (38%).

Finally, with non-significant findings, respondents again often preferred one or two practices over the other practices or residual category. *Overall it could be concluded that respondents had moderate preferences on procurement practices in this procurement step when controlled for supplier-innovation variables. They were mostly driven by trust and cooperation.*

Table 114: Manage-relations: Chi-Square significances of best-practices

Procurement Best-practices	Count	N %	Supplier Innov. Variable	chi-square test all 3 best-pract.	chi-square test all 3 best-pract-rest cat.
we involve suppliers early	17	52%	Manage-relations for radical innovations	non-significant	significant
we build trust & strong supplier relations	8	24%			
our relations are based on mutual goals	7	21%			
do not know or use other practices	1	3%			
we involve suppliers early	6	18%	Manage-relations for incremental innovations	non-significant	significant
we build trust & strong supplier relations	13	39%			
our relations are based on mutual goals	13	39%			
do not know or use other practices	1	3%			
we involve suppliers early	9	27%	Manage-relations when green aspects are important	non-significant	non-significant
we build trust & strong supplier relations	10	30%			
our relations are based on mutual goals	11	33%			
do not know or use other practices	3	9%			
we involve suppliers early	9	27%	Manage-relations when quality aspects are important	non-significant	significant
we build trust & strong supplier relations	15	46%			
our relations are based on mutual goals	8	24%			
do not know or use other practices	1	3%			
we involve suppliers early	14	42%	Manage-relations when cost aspects are important	non-significant	significant
we build trust & strong supplier relations	8	24%			
our relations are based on mutual goals	10	30%			
do not know or use other practices	1	3%			
we involve suppliers early	9	28%	Manage-relations with new innovative suppliers	non-significant	significant
we build trust & strong supplier relations	8	25%			
our relations are based on mutual goals	14	44%			
do not know or use other practices	1	3%			
we involve suppliers early	5	15%	Manage-relations with existing innovative suppliers	significant	significant
we build trust & strong supplier relations	17	52%			
our relations are based on mutual goals	10	30%			
do not know or use other practices	1	3%			
we involve suppliers early	3	9%	Manage-relations with New Zealand innovative suppliers	significant	significant
we build trust & strong supplier relations	19	58%			
our relations are based on mutual goals	9	27%			
do not know or use other practices	2	6%			
we involve suppliers early	4	13%	Manage-relations with foreign innovative suppliers	non-significant	non-significant
we build trust & strong supplier relations	10	31%			
our relations are based on mutual goals	6	19%			
do not know or use other practices	12	38%			
Total	**295**			**2/9 significant**	**7/9 significant**

A note on the respondents' preferences for proposed practices versus the residual-category "don't know or we use other practices". Based on the total counts in the four Tables, general preferences could be calculated. In only 94/1,084 instances (9%) the respondents (*N*=33) selected the residual category. In 44/1,084 out of these 94 instances (=4%) this related to the residual category for innovating with foreign suppliers. Consequently, excluding the clear exception of innovating with foreign suppliers, this indicated that respondents for 990/1,084 instances (91%) *generally agreed* on the proposed twelve (3x4) procurement best-practices for nine specific supplier-innovation variables[168].

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[168] Other standard inferential tests on practices within paired company variables where not feasible. The non-normality distributed data had a nominal data type and therefore a series of two-related samples test Mann-Whitney test for differences was impossible. Sample sizes were too low for detailed Chi-Square tests.

A final note on the extent to which respondents preferred procurement best-practices with a particular supplier-innovation variable for the four procurement steps. The following Table shows to what extent respondents generally agreed (significant differences) or disagreed (non-significant differences) on best-practices.

Table 115: Extent of (non-) significant differences for best-practice per supplier-innovation variable[169]

Supplier-innovation variable	Significant differences	Non-significant differences	Rel. agreement on sign. difference
mainly with radical innovations	6	2	75%
mainly with incremental innovations	4	4	50%
when green aspects are important	1	7	13%
when quality aspects are important	6	2	75%
when cost aspects are important	7	1	88%
mainly with new innovative suppliers	4	4	50%
mainly with existing innovative suppliers	6	2	75%
mainly with New Zealand innovative suppliers	6	2	75%
mainly with foreign innovative suppliers	0	8	0%
………………………………………….Totals (*n*=72)	40	32	

Over the four procurement steps, the respondents *agreed* on 40/72 instances (=56%), and on 32/72 instances (=44%) *disagreed* on specific best-practices for the specific supplier innovation types. Note (see above) that 91% of respondents generally agreed on the proposed best-practices; here respondents additionally indicated their preferences of such practices with each supplier or innovation type.

Respondents generally *agreed* on one or two practices with five supplier innovation types (5/9=55%; green). Respondents mutually *disagreed* (2/9=22%; blue) on best-practices to manage innovative suppliers when green aspects were important, and when dealing with foreign suppliers. Finally, respondents were unclear in their preferences on (2/9=22%; yellow) variables: with incremental innovations, and with new innovative suppliers.

Section summary-conclusion:

14. *Survey data (N=33) on nine supplier-innovation variables for the four procurement steps indicated that respondents for 91% agreed on the proposed procurement best-practices. In 4%, respondents selected the residual-category. In another 5%, respondents primarily selected the residual category for innovating foreign suppliers. The reasons are unknown. Probably, respondents preferred a different best-practice, or did not know which best-practice to use.*

15. *There was statistical evidence that respondents in 56% (=5/9) instances preferred procurement best-practices for supplier-innovation variables for the four procurement steps. In 22% (=2/9) instances, respondents mutually disagreed; in another 22% (=2/9) instances preferences were unclear.*

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[169] Significances were totalised within three best-practices and with the three best-practices including the residual category. (Consequently in 9x2x4=72 instances).

16. *Overall, Chi-Square tests indicated that respondents had similar preferences for managing radical innovations, existing suppliers, or New Zealand suppliers, or when quality or costs are important. The tests further indicated that respondents had varying preferences for practices related to green aspects and to foreign innovative suppliers. The tests finally indicated that respondents did not have clear preferences on practices for incremental innovations and for new innovative suppliers.*

17. *These findings partially validated findings from the roundtable discussions. Note however, that best-practices were only validated for the nine supplier-innovation variables as investigated in this Chapter. Notwithstanding the limited possibilities for generalisation (De Jong & Vermeulen, 2006), these findings partially also validated Table 56 (§5.2.2) with 4x9 rankings of practices from literature. Hence, findings from Survey II revealed preferences for a set of best-practices that could be used for specific supplier or innovation types in a similar construction supply chain context.*

18. *Additionally, the Chi-Square tests indicated that specific procurement best-practices could be significant for one specific supplier-innovation variable and hence in one context, but not for another variable and hence not in another context. Consequently, best-practices varied with the supplier or the innovation variables. This was generally in line with findings from Appendices §2.3.3 and §2.3.6.*

19. *Note that the supplier-innovation variables in Survey II were defined as dichotomic ideal types. In business reality, multiple supplier-innovation variables could be relevant in one single innovation process. Hence in one particular procurement step, procurement practices could be used in combination.*

8.6 Chapter Summary

This Section aimed to answer the following empirical research question and supporting high-level hypothesis.

(RQ8) What relations existed between (independent) supplier-innovation variables and (dependent) procurement management best-practises in New Zealand companies that managed innovative suppliers in construction supply chains?

H7: Differences in supplier-innovation variables had significant effects on procurement practices.

The 21 Section summary-conclusions are summarised as follows.

1. For Survey II, the research selected nine independent supplier-innovation variables and twelve (3x4) dependent procurement practices.
2. These variables & practices were selected from §5.2.2 and after a partial validation in a roundtable discussion.
3. The research selected four basic company variables for understanding the context of the innovation. The company data showed the company variety of the respondents.
4. Generalisation of Survey II findings to the Survey I population should be done with care. Due to the small sample size (*N*=33), generalisation of Survey II findings to the target-populations should also done with care.

5. High-level pie charts with selected procurement practices for each of the four procurement steps indicated limited differences in preferences. Detailed doughnut charts (Appendix §8.3.2) presented an easy overview of relations between independent and dependent variables. They also indicated more differences in preferences of procurement practices.

6. Respondents in 92% instances agreed on the proposed procurement best-practices. Respondents in 4% instances selected the residual category for innovating with foreign suppliers; in 5% instances they preferred other residual practices.

7. Findings for a large part validated the selection of 3x4 practices from Table 56 in §5.2.2. This showed that respondents to a certain extent also validated the 4x9 procurement practices identified from extant literature as presented in four Tables in §2.11.2.

8. Similar with Survey I, the Survey II data did not suggest a small set of dominant procurement best-practices.

9. In 56% (=5/9) instances respondents mutually agreed on procurement best-practices for supplier-innovation variables for the four procurement steps. In 22% (=2/9) instances, respondents mutually disagreed; in another 22% (=2/9) instances preferences were mixed.

10. Respondents statistically showed similar preferences (5/9) for managing radical innovations, existing suppliers, or New Zealand suppliers, or when quality or costs are important. Respondents showed statistically different preferences (2/9) for practices on green aspects and foreign innovative suppliers. They were unclear on practices (2/9) for incremental innovations and for new innovative suppliers.

11. Findings indicated that the preferences of practices varied with the particular supplier-innovation variables (§8.4, §8.5). In line with the literature in §2.3.3 and §2.3.6, generalisation to other contexts should only be done with care. (See #4 above).

12. In line with findings from previous Chapters, practices would probably be used in combinations with several supplier-innovation variables. This was in line with extant literature, and again limited generalisation possibilities.

13. Finally, although some best-practices were more preferred than others, Survey II succeeded in revealing a set of best-practices that could be used for specific supplier types or innovation types in a similar construction supply chain context.

This confirms the hypothesis of Chapter 8.

H7: Differences in supplier-innovation key-variables had significant effects on procurement best-practices.

H7 was largely confirmed.

You have reached the end of this Part.

Part III synthesises findings from the research methods and contrast this with literature (Chapter 9).

Part III gives general conclusions, implications, and limitations on the research study (Chapter 10).

PART III

I have not failed. I have just found 10,000 ways that won't work.
Th. A. Edison (1847-1937).

Introduction to Part III

The data exploration in Part II produced an extensive overview of findings from the five interviews, the focus-group discussions, and the two online surveys. Many of the high-level hypotheses were only partly confirmed. In line with the Edison quote this would not indicate a failure of the research design or execution.

Instead, findings produced a "fine-grained and empirical knowledge reservoir" (cf. Franz, 2018: 85) on how these companies managed innovative suppliers in New Zealand construction supply chains. Findings were summarised in the Chapter Summaries throughout Part II.

This final Part III intends to synthesize the literature review and the empirical results. The conceptual models II and III below (from the introduction of Part II) and the research questions with their related hypotheses were used to guide this part of the thesis.
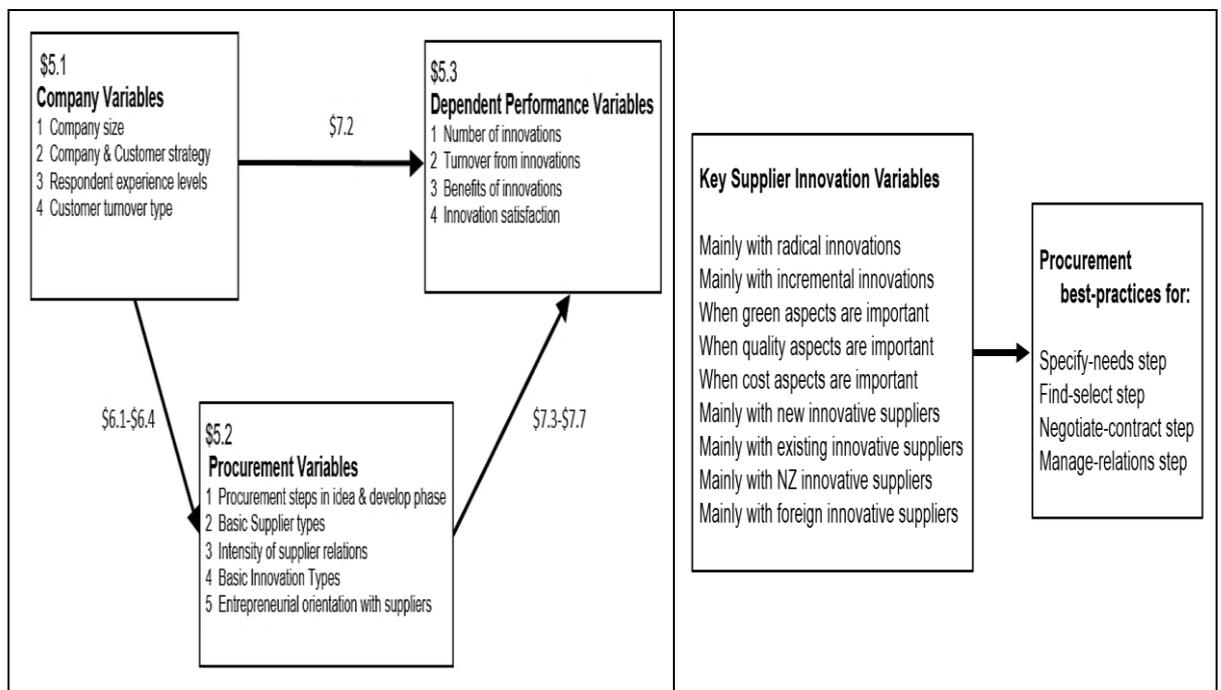
Figure 59: Conceptual models II (left) and III (right) from the quantitative research (from §2.13; §3.5)

Chapter 9 synthesises general conclusions on findings within and over the empirical Chapters; Chapter 10 discusses the outcome of this doctoral research.

Chapter 9

Discussions and Conclusions

Chapter 9

Discussions and Conclusions

Part II presented and discussed descriptive and inferential findings from the empirical research on the Section and Chapter level. Each Chapter contrasted findings with extant literature and ended with a summary. This Chapter 9 synthesises general conclusions on research findings within and over the empirical Chapters. It utilizes Conceptual Models II and III. (See Introduction Part III; §3.5). It aims to answer the following empirical research question:

(RQ9) To what extent did the research answer empirical research questions RQ4-RQ8, also in view of the extant literature from Chapter 2?

RQ4. To what extent did exploratory interviews in five New Zealand companies on how they managed innovative suppliers in construction supply chains increase the understanding of the research domain and confirm the variables &practices and conceptual model II from Chapter 2? (Interviews, Chapter 4)
RQ5. What variables & practices did respondents report, what was the profile of the case companies, and to what extent did these companies represent the target-population? (Survey I, Chapter 5).
RQ6. What relations existed between company variables and procurement management variables & practices in New Zealand companies that managed innovative suppliers in construction supply chains? (Survey I, Chapter 6). This research question was supported by several high-level hypotheses.
RQ7. What relations existed between company variables, procurement management variables & practices, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains? (Survey I, Chapter 7). This research question was supported by several high-level hypotheses.
RQ8. What relations existed between (independent) supplier-innovation variables and (dependent) procurement management best-practises in New Zealand companies that managed innovative suppliers in construction supply chains? (Survey II, Chapter 8). This research question was supported by one high-level hypothesis.

Section §9.1 introduces the topic with RQ1-Q3. The succeeding five Sections then discuss empirical research questions RQ4-RQ8 and draw conclusions. The Chapter ends with a summary.

9.1 Assessment of the Research Topic

The first three Chapters aimed to answer the following structuring research questions.

(RQ1) What were the, context, scope, relevance, and objectives of the research topic?

(RQ2) To what extent did extant literature give guidance on how New Zealand companies in construction supply chains managed innovative suppliers?

(RQ3) What was an appropriate research methodology to explore the research domain in order to achieve the research objective?

Chapter 1 started with the context, scope, and justification (§1.1-§1.3) of the research. The industry needs construction innovations from suppliers, however there was a lack of knowledge in this respect. The overall objective of the research (§1.4) therefore was to increase the understanding how focal companies managed innovative suppliers. The focus was on semi-dyadic relations from the perspective of the buying firm. The locus was New Zealand and the context was the construction industry and its supply chains. Results would be generalisable to a certain extent (§1.7).

Chapter 2 discussed extant literature relevant to this research. It used conceptual model I (from preliminary research) as a basis for the review. This extensive review increased the understanding on many potentially-relevant variables & practices. However, literature produced incomplete and sometimes conflicting interpretations and findings on the relevance or effects of such variables & practices. These were discussed and summarised in several Tables throughout §2.2 to §2.12. The wide array and party-conflicting variables could be explained from the contingency theory (§2.5) and from the early lifecycle of this research domain (§3.2). The review revealed research gaps (§2.13); Section §2.15 provides a summary.

For the empirical research, the review selected several independent company variables and mediating procurement management variables & practices. It also selected dependent procurement performance variables. (See §2.2 to §2.12). Any selection of potentially-relevant practices and variables for the empirical part of the research could impose a

limitation on the internal/construct validity and generalisability of the research. Hence a careful design of the research methodology should help to achieve the research objectives, and generalisation should be done with caution. Conceptual model I was simplified and modified into conceptual model II (§2.14) for the empirical work. Although extant literature gave an incoherent guidance on how companies managed innovative suppliers, it enabled tentative selection of variables & practices and the development of conceptual model II.

Chapter 3 discussed the methodology of this research. It started with further defining the locus, unit-of-analysis, target-population (§3.1), then the profile of research participants (§3.2). The primary research domain was procurement, but perspectives from other domains (small business, innovation, entrepreneurship, construction) could add important contributions (§3.4). The research concluded that the domain was immature (§3.2.4). At an ontological and epistemological level and in consideration of the research objectives, the researcher took a pragmatic perspective. This enabled the researcher to apply a mixed-mode approach (§3.4) The research applied three conceptual models (§3.5).

The research was designed exploratory and descriptive, with limited theory building and testing. The initial part of the empirical research (Chapter 4) was designed inductive and qualitative. Chapter 5 was designed quantitative and descriptive; Chapters 6-7 were quantitative with inferential statistics. The statistical analysis in Chapter 8 built on the previous empirical Chapters and a roundtable discussion, and was designed deductive and quantitative. This was an appropriate approach considering the research objectives and the lifecycle of this research domain.

This answers RQ1-RQ3.

9.2 Exploratory Interviews on Managing Innovative Suppliers
This Section synthesised findings from the interviews of Chapter 4. It aimed to answer the following empirical research question.

(RQ4) To what extent did exploratory interviews in five New Zealand companies on how they managed innovative suppliers in construction supply chains increase the understanding of the research domain, and validate the variables and conceptual model II from Chapter 2?

The research selected innovative or entrepreneurial companies from NZGBC and PrefabNZ industry associations (§3.6.2) for the exploratory interviews. Findings were classified with

conceptual model II and related to extant literature. The following summary Table shows the conclusions for the (constructs of) variables & practices from 24 Section summary-conclusions of Chapter 4.

Table 116: Summary table from exploratory interviews per construct (amended from §4.7)

Main construct	Summarised findings from the interview (§4.7)	*Summarised conclusions*
Company-related aspects	Company size did not seem to matter on innovative behaviour with suppliers: both small and large companies could partner for strategic reasons. Participants had 10+ years of relevant experience. Owners conducted operational and strategic procurement and innovation activities with (key) innovative suppliers. Three companies (3/5) seemed growth-oriented with long-term objectives. They also exhibited similar levels of entrepreneurial orientations towards customers and suppliers. They preferred long-term relations with key innovative suppliers and gave these suppliers a prominent innovation role.	*Participant selection was controlled for company size, innovative behaviour; 2nd or 3rd tier supplier; education and experience level of participants; engaged in managing innovative suppliers.* *Case companies seemed to differ from the New Zealand company population of 2nd or 3rd tier suppliers in the construction industry.*
Innovation-related aspects	Companies mostly procured product innovations. They used suppliers alone or in combination with customers, partners or regulators. Companies were involved in incremental and in radical innovations with their suppliers. Findings confirmed the different phases of idea and development. Findings could not confirm whether suppliers had different roles with the different innovation types.	*The interviews produced limited and indirect indications that the particular innovation type affected procurement activities, and procurement or innovation performance.* *This lack of direct evidence was inherent with the interview design.*
Procurement and supplier-related aspects	Intensity of supplier relations varied, probably with company size (resources), phase of the innovation process, supplier risks & opportunities, trust, and past experiences. Findings suggested a positive relation of intensity with performance. Companies showed varying preferences for foreign versus domestic suppliers. Companies were loyal to existing suppliers, provided they could further innovations or reduce costs. Companies either preferred small suppliers for their loyalty, or large suppliers to get access to overseas innovative products. Depending on the context, companies used a variety of procurement practices.	*The interviews produced limited and indirect indications that the particular supplier type affected procurement activities, and procurement or innovation performance.* *The interview design did not allow to explore relations between procurement activities and specific company contexts*
Performance aspects	Companies seemed to have different company objectives and performance. Performance seemed to depend on several variables, was related to successful supplier management and supplier innovations, and could include benefits for the environment.	*Performance could depend on several variables.* *The interviews were unable to discuss performance in much detail.*

The procurement activities of the case companies were professional and logical within their contexts. Practices and variables as discussed with participants were different or similar with extant literature. Findings reflected the inconclusive results of extant literature. Procurement and innovation variables were probably affected by multiple and possibly interrelating (moderating, mediating, or confounding) variables and characteristics. This also confirmed the relevance of the contingency theory (§2.5).

Inherent to limitations (§10.4) caused by the exploratory nature of the interviews and the intersubjective findings on procurement and innovation activities, to a certain degree the interview findings remained fragmentary. It would need Survey I and II to reveal in structured detail what procurement management variables and practices focal companies would apply under what circumstances. Nevertheless, the interviews analysed together yielded a rich description on how the case companies managed their innovative suppliers. The interviews confirmed and increased the understanding of the research topic from extant literature. Notably, the effects and variety of variables & practices discussed in Chapter 4 added support to the relevance of the contingency theory and conceptual model II, as a basis for the quantitative part of the research.

The interview findings in Chapter 4 led to the conclusion that these companies were representative for the target population. Generalisation of findings to other NZGBC or PrefabNZ members seemed tempting but should be done with caution. Generalisation to other companies in New Zealand construction supply chains was only partially possible due to the specific innovative or entrepreneurial nature of the case companies.

The objective of the interviews was to increase the understanding of relevant procurement practices and variables from the five companies. The interviews succeeded in this objective.

This answers RQ4.

9.3 Discussing the Target-Population via Survey I, and Survey II

This Section synthesised findings on the descriptive statistics of Chapters 5, and 8. It aimed to answer the following empirical research question that was supported by high-level hypotheses H1 to H3.

(RQ5) What variables & practices did respondents report, what was the profile of the case companies, and to what extent did this profile represent the target-population?

a. *What were company variables of New Zealand companies that managed innovative suppliers in construction supply chains?*

b. *What were procurement management variables & practices of New Zealand companies that managed innovative suppliers in construction supply chains?*

c. *What were procurement performance variables of New Zealand companies that managed innovative suppliers in construction supply chains?*

d. *What was the profile of the survey respondents and case companies?*

e. To what extent did respondents and the case companies represent the target-population?

H1: The company data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

H2: The procurement management data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains.

H3: The procurement performance data were representative for the estimated N=3,000 to N=6,000 companies that managed innovative suppliers in New Zealand construction supply chains construction supply chains.

Hypotheses H1 & H3 were confirmed. H2 was largely confirmed. Hence the company data, procurement management data, and procurement performance data were representative for the target-group of companies that managed innovative suppliers. (See §5.4)

One conclusion from Chapter 4 (see §9.2) which matched findings from the literature review (§2.5) was that the context in SME procurement and SME open innovation could play an important role for this research. Therefore, it was important to adequately describe this meso (industry) and micro (company) context of the focal semi-dyadic relations. The first Sections of Chapter 2 described the general context. That macro environment was deliberately kept outside the scope of the empirical research, but could contain moderating or confounding variables. Chapter 2 also gave an overview of potentially-relevant meso and micro variables. From an empirical perspective, Chapter 5 succeeded in describing the more specific context on a meso and micro level.

RQ5a-c: Table 68 in §5.4 was based on 57 Section summary-conclusions. This Table summarised the three types of variables (i.e. company, procurement management, procurement performance) from Survey I as analysed in Chapter 5.

RQ5d: The descriptive data from Survey I revealed a detailed picture of the surveyed population. In conclusion, this led to the following respondents and company profile:

Most case companies provided contractor or specialist services, and most reported that entrepreneurial strategies and product leadership were important. The companies were more entrepreneurial than average New Zealand companies, and were equally entrepreneurial to innovative customers and to innovative suppliers. They could have different entrepreneurial profiles. Most respondents had high experience levels on

management & strategy; less respondents had high procurement, marketing-sales or innovation experience. The generally broad experience-base of respondents could be beneficial in managing innovative suppliers. The case companies were more innovative than average and gave innovative suppliers a dominant role in innovations.

It was unclear how preferences for basic supplier types differed from average companies in New Zealand construction supply chains. Procurement practices seemed more focused on cooperation and opportunities. Companies preferred radical innovations less than incremental innovations, but were still more engaged with radical innovations than New Zealand averages. Companies showed (slight but significant) preferences for new suppliers for radical innovations, more than for incremental innovations. Companies could have slight preferences for small foreign suppliers for radical innovations. Companies showed fairly similar preferences for process and product innovations.

The companies reported high supplier innovation numbers (M=8) and related turnover percentages (M=16%) over the last three years, but both with relatively large standard deviations. They reported innovations with and without supplier interactions as significantly more beneficial to the company, than to the natural environment. However, innovations with supplier interactions were significantly seen as more beneficial to the company and to the natural environment, than innovations without supplier interactions. Hence higher company innovation-benefits could equal higher environmental innovation-benefits. As Survey II confirmed, this company profile from Survey I would fit more with entrepreneurial companies, than companies focused on business continuity or lifestyle. The profile is also in line with interview findings from Chapter 4.

RQ5e: Hypotheses H1 and H3 were confirmed. H2 was largely confirmed. (§5.4). Hence the conclusion was that the profile of these entrepreneurial or innovative case companies was representative for the target-population. This profile differed from the average cost-driven and short-term perspective of many companies in construction supply chains. (See e.g. §1.1; §2.1; §2.2).

Additionally, Survey II respondents (*N*=33) had the same sampled population as Survey I (*N*=112). The conclusion was that Survey II was probably representative for Survey I. Generalisation of findings from Survey II to the larger target-population should still be done with care. (§8.1).

This answers RQ5.

9.4 Company Variables on Procurement Variables & Practices in Survey I

This Section synthesises findings from inferential statistics of Chapter 6 on procurement management variables & practices. It aims to answer the following empirical research question that was supported by high-level hypothesis H4.

(RQ6) What relations existed between company variables and procurement management variables & practices in New Zealand companies that managed innovative suppliers in construction supply chains?

H4: Differences in company variables had significant effects on procurement management variables & practices.

Hypothesis H4 was largely rejected. (See §6.5)

However, a focus on details produced a more nuanced picture. The following conclusions were drawn from the Section summary-conclusions and statistically-significant relations in the Tables of §6.1.7, §6.2.6, §6.3.7, §6.4.7, and from the summary Table of §6.5. Conclusions below were based on cut-off points % (see footnote below[170]) for the dependent and for the independent variables. These conclusions are discussed below from two perspectives: possible effects from independent variables, and possibly affected dependent variables.

Extant literature related to RQ6 was scarce or often inconclusive, as was discussed for each relation throughout the Section conclusion-summaries in Chapter 6. In several instances, findings were unable to confirm or reject this extant literature.

9.4.1 Perspective of the *Independent* Company Variables

From this perspective[171], several (dependent) procurement management variables & practices seemed *moderately affected* by (3/17) company variables (levels of trust, and lifestyle and survival company strategies). Other company variables (size, innovating, aggressiveness, innovation experience) (4/17) seemed to have several *slight* effects; (10/17) company variables seemed to have *none-to-little* effects.

The conclusion is that the company characteristics of respondents varied; a small group (3/17) of company variables seemed to have moderate effects on 21 procurement management variables. (See §9.7 for a comparison with all variables).

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[170] Moderate effect: cut-off >20%; slight effects: between 15% and 20%; none-to-little effects: <15%
[171] See bottom row of Table in §6.5.

9.4.2 Perspective of *Dependent* Procurement Management Variables

Vice versa[172] from this perspective the effects of the company variables varied significantly. For several (5/21) of procurement variables, preferences for large versus small suppliers notably seemed *moderately affected* by experience levels, the product leadership strategy and company survival strategy. Likewise, intense relations with manufacturing suppliers seemed *moderately affected* by three entrepreneurial orientation variables, and with the customer intimacy strategy. Three types of entrepreneurial orientation (innovating, opportunities, aggressiveness) seemed also *moderately* affected by NPD/innovation or overseas experience levels.

Another six procurement variables (6/21) were *slightly affected*. These included the manage-relation step, small or large suppliers for (somewhat) incremental innovations, product versus process innovations, and radical versus incremental innovations. A third group (12/21) of procurement variables was *not-to-little affected.*

The conclusion from these findings was that a minority (5/21) of procurement variables seemed moderately affected by the 17 company variables. (See §9.7 for a comparison with all variables).

9.4.3 Innovation Procurement Management Options: Managing Innovative Suppliers

As concluded earlier, in many instances the research was unable to find statistically-significant relations. Nevertheless, procurement management of innovative suppliers was affected by several company variables. As indicated above, 5/21 procurement variables seemed to respond more strongly (i.e. reacted more sensitive to company variables), and 3/17 of the company variables seemed to have higher effects.

Therefore the research concluded that focal companies had several management options in their innovation procurement, i.e. when they managed innovative suppliers. (See also §9.5.6 and §9.7).

This answers RQ6.

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[172] See right column of Table 83 in §6.5.

NOTES:
1. As explained earlier, variables were analysed in uncoded and recoded versions. (See introductions of Chapter 6 and 7). This research used both versions in the statistical analyses.
2. As explained in §3.5 the research had to be cautious on indicating possible causal relations. Hence the frequent usage of phrases like "seemed".
3. In many instances, the research *was unable to find statistically-significant* differences. (Indicated by empty cells in the summary Tables in §6.5 and §7.8). In many instances effects were at best moderate. This was discussed in §10.2.1.
4. Applying cut-offs of ≥15% or ≥20% seemed somewhat arbitrary for determining effects. (Moderate effect cut-off >20%; slight effects between 15% and 20%; none-to-little effects <15%; See also §3.6.4.2).
5. Combined with the literature review, these cut-off could nevertheless reveal *potentially-relevant* relations. Cut-offs also aimed to balance possibilities of Type I and Type II errors.

9.5 Company & Procurement Variables on Performance in Survey I

This Section synthesised findings from inferential statistics of Chapter 7 on procurement performance. It aimed to answer the following empirical research question that was supported by high-level hypotheses H5 and H6.

(RQ7) What relations existed between company variables, procurement management variables, and procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains?

H5: Differences in company variables had significant effects on procurement performance variables.
H6: Differences in procurement management variables had significant effects on procurement performance variables.

Hypothesis H5 was largely rejected; Hypothesis H6 was partially rejected. (See §7.8)

However, a focus on details produced a more nuanced picture. The following conclusions were based on the two summary Tables in §7.8, and on the 40+ Section summary-conclusions of Chapter 7. (See again §9.7 for a comparison of all variables).

9.5.1 Correlation among *dependent* Performance Variables

The research was unable to identify strong correlations among the two output-procurement performance variables (number of innovations, percentage of innovation turnover). It also was unable to identify strong correlations of these two output-performance variables with

nine <u>process or proxy</u>-performance variables (benefits, satisfaction rates). Hence Chapter 7 had rightly analysed effects on all 11 performance variables[173]. (§7.1).

9.5.2 Perspective of *Independent* Company Variables on Performance Variables

Overall, the five types of independent company variables (§7.2) had *none-to-little* effects on two output-performance levels[174]; also company size seemed to have *none-to-little* effects on levels of procurement performance. Literature was inconclusive (§2.6.1.3) whether SMEs or large companies in construction supply chains would be more innovative. However, the survey data (§7.2.1) suggested that the focal SMEs were more innovative with their suppliers than their large counterparts.

The product leadership strategy had *slight-moderate effects* on performance levels: notably the estimated percentage of turnover of innovations with suppliers seemed higher with high levels of product leadership. According to literature (§2.7-§2.8), such companies would need large supply bases and agile supply chains. Other customer strategies and company strategies had *none-to-limited* effects on performance levels. Partly contrary to extant literature (§2.8.3), the research was unable to confirm that company or customer strategies had significant effects on procurement performance levels.

Innovation & NPD experience had *moderate effects* on procurement performance: high levels of these two experience types generally related to higher innovation-benefits and higher innovation-satisfaction levels. Marketing-sales experience had *little* effects; procurement, management and overseas experience each had *zero* effects on procurement performance. Literature indicated a positive relation between procurement experience and performance levels; this was not confirmed by the findings. Conversely, 2/11 performance variables seemed *slightly* or *moderately* affected by the company variables.

The conclusion was that only 2/16 company variables (experience levels in NPD and product leadership strategy) slightly or moderately affected 11 procurement performance with innovative suppliers.

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[173] Relations in the data were explored via two measurements (uncoded and recoded) versions for both independent and dependent variables. Most significant relations found in Chapter 7 represented recoded variables. The conclusions below are based on SUM ROW and Sum COLUMN cut-off points ≥15% (§7.8).
[174] See bottom row of Table 100, in §7.8
    Moderate effect: cut-off >20%; slight effects: between 15% and 20%; none-to-little effects: <15%.

9.5.3 Perspective of *Dependent* Performance Variables with Company Variables

Vice versa[175] from this perspective, the innovation-benefits of supplier interaction for the natural environment seemed *slightly* affected by company turnover types.

Satisfaction with marketing-sales with innovative customers seemed *moderately* affected by NPD/innovation experience levels, and by the residual company turnover type variable. (The reason is unknown). Note that satisfaction on procurement or innovation with innovative suppliers seemed *slightly* affected by marketing & sales or BD levels.

Satisfaction on internal innovation activities, seemed *moderately* affected by innovation/NPD experience and the product leadership strategy. However in itself this was *less* relevant to managing innovative suppliers.

The conclusion was that performance variables seemed moderately affected by 1/16 and slightly affected by 2/16 company variables[176]. Performance variables seemed not-to-slightly affected by (13/16) company variables. Conversely, 3/11 performance variables seemed affected by company variables.

9.5.4 Perspective *Independent* Procurement MGMT Variables on Performance

Overall[177], the five types of mediating procurement management variables had *none-to-little effects o*n two <u>output</u>-performance variables. (§2.12.3; §7.3-§7.7). Effects on the other nine <u>process or proxy</u>-performance variables are discussed below.

Priorities in the two procurement phases and most of the supplier types had *none-to-little or slight* effects. In line with literature, the data suggested a slight preference for large, current and domestic suppliers for (somewhat) incremental innovations. Contrary to some literature, the data also suggested a similar preference for (somewhat) radical innovations; with foreign suppliers this also led to higher estimated percentage of turnover levels.

Intensities in supplier relations with innovative suppliers providing services, products, or wholesale-distributions had several *moderate effects* on performance levels. (Notably more intense relations seemed to lead to higher innovation-benefits for the case company and to higher innovation-satisfaction with suppliers). Extant literature would generally suggest that relations with service providers would be more intense (§2.10.2; §2.9.3). Some literature

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[175] See right column of Table 100, in §7.8.
[176] Note, that the company variables that seemed to impact on performance variables differed somewhat from the company variables in §6.5 (§9.3) that seemed to impact procurement variables
[177] See bottom row of Table 101, in §7.8.

also indicated (§2.9.3) that a more intense supplier relation would lead to higher performance. However, this research was unable to detect such statistical differences on <u>output</u>-performance levels.

Developing radical versus incremental innovations with innovative suppliers had *moderate effects* with on <u>process or proxy</u> performance variables. The data suggested that (*N*=28) respondents who were only or mainly involved in radical innovations then reported a significantly higher estimated percentage of turnover from all suppliers over the last three years, higher innovation-satisfaction rates on procurement and innovative suppliers, and higher benefits for the own company. Extant literature (§2.10) suggested that incremental innovations were less risky, but could also equal fewer rewards. However this data suggested that this small group of companies could perform better. The research was unable to find significant effects for developing product versus process innovations with such suppliers.

Literature often indicated a positive relation between entrepreneurial orientation and performance. Entrepreneurial variables, notably innovating, opportunity-seeking, and trust with innovative suppliers had several *moderate* effects with several <u>proxy or process</u> performance variables. Overall, a large part of respondents considered these three orientation variables (very) important. Risk-taking had a *slight-to-moderate* positive, and aggressiveness had almost *zero* but negative effects.

In conclusion: notably three entrepreneurial orientation variables seemed to have moderate effects on performance; also incremental versus radical innovations and relationships with service provider seemed to have moderate effects on performance. The other 15/20 procurement management variables seemed to have slight or zero-to-slight effects.

9.5.5 Perspective of *Dependent* Performance Variables with Procurement Variables

Vice versa[178] from this perspective, notably the following five performance variables: innovation-benefits for own company, for the natural environment, satisfaction with innovation procurement, satisfaction with innovative suppliers, and satisfaction with innovative customers seemed *relatively-strongly* (>35%) affected by several procurement management variables, notably by entrepreneurial orientation variables. These effects seemed stronger than with the company variables above, and also stronger than effects on

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[178] See right column in Table 101, §7.8.

procurement variables with the company variables in §6.5 and §9.4. *The conclusion was that 5/11 performance variables (notably innovation benefits and satisfactions with procurement and innovative suppliers) could be affected by procurement management variables, notably entrepreneurial orientation variables.*

9.5.6 Innovation Procurement Management Options: Managing Innovative Suppliers

As concluded earlier, in many instances the research was unable to find statistically-significant relations. Nevertheless, similar to §9.4.3, case companies seemed to have several company and procurement management options when they managed innovative suppliers to realize procurement performance.

Note that performance variables varied in their sensitivity to company or procurement variables.

Therefore the research concluded that focal companies had several management options in their innovation procurement, i.e. when they managed innovative suppliers for achieving performance. (See also §9.4.3 and §9.7).

This answers RQ7.

NOTES:
1. As explained earlier, variables were analysed in uncoded and recoded versions. (See introductions of Chapter 6 and 7). This research used both versions in the statistical analyses.
2. As explained in §3.5 the research had to be cautious on indicating possible causal relations. Hence the frequent usage of phrases like "seemed".
3. In many instances, the research was *unable to find any statistically-significant difference.* (Indicated by empty cells; §6.8). This was discussed in §10.2.1.
4. Applying cut-offs of ≥15% or ≥20% seemed somewhat arbitrary for determining effects. (Moderate effect cut-off >20%; slight effects between 15% and 20%; none-to-little effects <15%; See also §3.6.4.2).
5. Combined with the literature review, these cut-off could nevertheless reveal *potentially-relevant* relations. Cut-offs also aimed to balance possibilities of Type I and Type II errors.

9.6 Supplier-Innovation Variables on Procurement Practices in Survey II

This Section synthesises finding from descriptive and inferential statistics of Chapter 8. It aims to answer the following empirical research question that was supported by high-level hypothesis H7.

(RQ8) What relations existed between (independent) supplier-innovation variables and (dependent) procurement management best-practises in New Zealand companies that managed innovative suppliers in construction supply chains?

H7: Differences in supplier-innovation variables had significant effects on procurement practices.

Hypothesis H7 was confirmed to a large extent. (See §8.6)

For more details, see the 21 corresponding Section summary-conclusions and the Tables in §8.5. This Survey II had *N*=33 nett respondents, which was sufficient for conducting basic inferential non-parametric tests

The research in Chapter 8 succeeded in identifying 3x4 procurement best-practices that were preferred with nine supplier and innovation types. These best-practices had been suggested from extant literature (§2.11.2), identified in Survey I (notably §5.2.2) and a roundtable discussion (§8.2). Similarly, the research in Chapter 8 succeeded in identifying specific preferences of these best-practices when controlled for supplier-innovation variables.

Respondents showed *similar* preferences (56%) on practices for managing radical innovations, existing suppliers, or New Zealand suppliers, or when quality or costs are important. Respondents showed *different* preferences (22%) on practices on green aspects and foreign innovative suppliers. They showed *mixed* preferences (22%) on practices for incremental innovations and for new innovative suppliers. (For an overview, see Tables 112-116 in §8.5). Practices were contextual and could be significant for one supplier-innovation type, but not for another type. The research additionally provided four visualisations (doughnut charts) in Appendix §8.4 based on the respondents' preferences (*N*=33).

Generalisation of practices from Survey II to similar supply chains should be done with care.

In conclusion: findings from Chapter 8 indicated that key supplier-innovation types could significantly affect the preferences for procurement best-practices in the four procurement steps.

This answers RQ8.

9.7 Chapter Summary & Conclusion

The research was able to answer empirical research questions RQ4-RQ8.

(**Chapters 1-3; §9.1**). The focus of the research was on semi-dyadic relations from the perspective of the buying company that managed innovative suppliers. Potentially-relevant variables & practices were discussed and summarised in Tables throughout Chapter 2. The wide array and party-conflicting variables could be explained from the contingency theory and the early lifecycle of the research domain. The research was designed exploratory and descriptive, with limited theory building or testing.

(**Chapter 4; §9.2**). The innovation procurement activities of participants from the exploratory interviews were within their contexts. Practices and variables as discussed with participants were either different or similar with extant literature. The findings reflected the inconclusive results of extant literature.

(**Chapter 5; §9.3**). The descriptive data from Survey I revealed a fine-grained and varied picture. (Summary Table in §5.4). In general, companies provided services, had product leadership strategies, and were equally entrepreneurial toward their innovative customers and suppliers. Companies were innovative and gave suppliers a dominant role in innovations. Companies preferred radical innovations less than incremental innovations, but still more than New Zealand averages. They also had small preferences for new, small, or foreign suppliers for radical innovations, more than for incremental innovations. Innovations with supplier interactions were significantly seen as more beneficial to the company and to the natural environment, than innovations without supplier interactions. Higher company innovation-benefits could equal higher environmental innovation-benefits.

(**Chapter 6; §9.4**). Only in several instances[179] (7/17; 41%), the research was able to find significant differences on procurement variables & practices when controlled for company variable. (See Table 117 below). Levels of trust, and lifestyle and survival company strategies had the highest yet moderate effects on procurement variables & practices. Against expectations, company size (≤99 versus ≥ 250 staff) had limited effect. Procurement variables seemed affected differently, and company variables had different effects. Therefore, companies had several management options on their company variables for their procurement, i.e. when they managed innovative suppliers. Extant literature was frequently inconclusive, and findings were unable to either confirm or reject this extant literature.

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[179] See Table in §6.5

(**Chapter 7; §9.5**). The research could not identify strong correlations among the two output-procurement performance variables. It also could not identify strong correlations of these output-performance variables with the other nine process-performance variables. Hence Chapter 7 analysed effects on all 11 performance variables. (Tables §7.8; cut-off ≥15%).

As again shown in Table 117, the company variables innovation experience and the product leadership strategy had 2/16 (13%) significant effects on procurement performance. Additionally, it seemed that notably company turnover types had an effect on innovation-benefits for the natural environment. The research was unable to find effects for 14/16 (87%) company variables.

A large minority of 8/20 (40%) of procurement management variables affected procurement performance. Notably, entrepreneurial orientation to suppliers affected procurement performance variables, and also the intensity of supplier relations, preferences for working with foreign or domestic suppliers, and developing radical or incremental supplier innovations. The effects were most notable with innovation-benefits for the company and environment, and innovation-satisfaction on procurement and innovative suppliers. The research was unable to find effects for other 12/20 (60%) procurement variables.

Comparing the relative statistically-significant effects in Chapter 6 and 7 led to the following summary Table. It gives an overview of the sensitivity among the independent and dependent variables in relative numbers[180].

Table 117: Summary of significant effects among the variable types

	Company Variables (IV)	Procurement variables & practices (IV)	Source
Procurement management variables (DV)	7/17* [9/21]#		Table 83 in §6.5
Procurement performance variables (DV)	2/16* [3/11]#	8/20 [6/11]#	Tables 100 & 101 in §7.8

* : IV -> DV : How many independent variables seemed affected by dependent variables
\# : DV -> IV : How many dependent variable seemed affected by independent variables

The company variables in 7/17 (41%) instances seemed to affect procurement management variables, but only in a minority (2/16; 13%) seemed to affect procurement performance. However, in 8/20 (40%) instances, the procurement management variables seemed to affect procurement performance. Hence it seemed that most company variables only had an indirect effect on performance. Likewise, in 9/21 (43%) instances, procurement

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[180] Note that the Table of §6.5 in part showed different independent company variables than the Table of §7.8. (§6.5 did not use company turnover type; §7.8 applied entrepreneurial orientation as dependent variables).
This Table 122 compared all variables using a cut-off of ≥15%.

management variables seemed affected by company variables. Only in 3/11 (27%) instances, performance variables seemed affected by these company variables, and in 6/11 (55%) instances these performance variables seemed affected by procurement management variables. Again, case companies had several management options when they managed innovative suppliers to realize procurement performance. Note that these percentages seemed flattered as they ignored the many empty cells where the research could not detect any statistical differences. (See Tables §6.5, §7.8).

(**Chapter 8; §9.6**). Procurement best-practices could be applied for specific supplier or innovation types in similar construction supply chain contexts. Respondents showed similar preferences for procurement practices when they managed radical innovations, existing suppliers, or New Zealand suppliers, or when quality or costs are important. Respondents showed different preferences for green practices and foreign innovative suppliers. They were unclear on practices for incremental innovations and for new innovative suppliers. Generalisation to another context should be done with care.

IN CONCLUSION:

This research explored how New Zealand companies in construction supply chains managed their innovative suppliers. Hence it explored relations between a set of company variables and procurement variables; it also explored relations with these two variable types with procurement performance.

Literature was often inconclusive on variables and practices that were potentially-relevant when companies managed innovative suppliers in New Zealand construction supply chains. Such companies often provided services, had a product leadership strategy and were as entrepreneurial to their innovative customers and suppliers. They were more innovative than the average New Zealand company in construction and gave innovative suppliers a dominant innovation role. Smaller companies reported more supplier innovations, but did not generate more supplier innovation turnover.

The research found several statistically-relevant relations which *could* be causal. In many instances, the research was *unable* to find statistical differences on the effect of company variables on procurement variables. Likewise, the research was often *unable* to find statistical differences on the effect of company or procurement management variables on procurement performance levels. In other instances, the research was able to find statistical differences. Phrased differently, companies seemed to have several management options to realize their procurement performance.

Against expectations, company size seemed to have little effects on preferences in procurement variables & practices nor on procurement performance. An interesting finding was that entrepreneurial orientation towards innovative suppliers had seemed to have significant effects on several procurement performance levels.

Chapter 10 discusses conclusions, contributions and limitations of the research.

Chapter 10

General Conclusions, Contributions, and Limitations

> The beginning is the most important part of the work.
> Plato (approx. 427 BC - 347 BC).

Chapter 10

General Conclusions, Contributions, and Limitations

Chapter 9 drew conclusions on the *output* of the research. This last Chapter discusses the *outcome* of the research. The Chapter aims to answer the following concluding research questions:

(RQ10) To what extent did the research achieve the three research objectives?

(RQ11) What are the contributions and implications of the research study for theory and to management practice?

(RQ12) What are the limitations of the research?

This Chapter first discusses the fulfilment of the research objectives (§10.1). It then discusses related contributions (§10.2) and implications (§10.3). The Chapter continues with limitations of the research (§10.4), and ends with personal comments on the PhD journey.

10.1 Fulfilment of the Research Objectives & Self-Assessment

Chapter 9 answered the research questions of this thesis. This Section §10.1 describes how each of the three research objectives (§1.5) were fulfilled during this research. It also assesses the University's requirement for a scholarly study at a doctoral level. The overarching research objective (§1.5) aimed to:

Explore to what extent company variables could affect procurement management variables and practices, and furthermore how these two variable types could affect procurement performance variables in New Zealand companies that managed innovative suppliers in construction supply chains.

10.1.1 Fulfilment of the Research Objectives

In Section §1.5, the overarching research objective was sub-divided into three more manageable objectives.

The first objective (Part I) was (1) to introduce the research topic, (2) to increase a detailed understanding from extant literature on the research topic, and (3) to design an appropriate research methodology to achieve the overarching objective of this research.

This 1ˢᵗ objective was supported by the structuring research questions RQ1-RQ3. Chapter 1 introduced the research topic. The extensive and iterative literature review in Chapter 2 revealed a wide landscape of potentially-relevant articles. Special attention was paid to the fact that companies in New Zealand construction supply chains were small by nature. The literature indicated that this would imply that such companies would exhibit different behaviour when they managed innovative suppliers. With the help of conceptual model I, the review produced a wide range of potentially-relevant variables and practices. Chapter 3 described in detail the conditions and requisites for the design of the research methodology. This Part I successfully contributed to achieving the overarching research objective. (§9.1).

The second objective (Part II) was (1) to identify and explore company variables and procurement management variables & practices, (2) to identify and explore company variables that could affect such procurement management variables & practices, (3) to identify and explore company variables and procurement management variables & practices that could affect procurement performance, and (4) to identify and explore procurement practices that companies would use with specific basic supplier-innovation variables.

This 2ⁿᵈ objective was supported by empirical research questions RQ4-RQ8 which were each supported by one or more high-level hypotheses. The exploratory interviews in Chapter 4 validated conceptual model II and successfully though fragmentarily increased the understanding of the research topic. Chapter 5 described the population of Survey I by applying conceptual model II with three variable constructs. Chapters 6 and 7 provided ample inferential statistics on the relations between these three constructs. With the help of Survey II, Chapter 8 discussed application of 12 procurement practices controlled for a selection of supplier types and innovation types.

This Part II identified and explored variables & practices and their relations, and successfully contributed to achieving the overarching research objective. (§9.2 - §9.6).

The third objective (Part III) was (1) to synthesise research findings and extant literature, (2) to define contributions & implications for specific stakeholders and for the wider industry, (3) to define contributions & implications for research, (4) to define suggestions for future studies, and (5) to define limitations of the research.

This 3rd objective was supported by the concluding research questions RQ9-RQ12. Findings from the research had been confronted with extant literature in Chapters 4-8. For one part, the research findings were unable to confirm or reject extant literature; for another part the findings were new compared to extant literature. The literature review in Chapter 2 had been extensive and thorough. The design of the surveys had been done with care, although the analysis of Survey I results revealed some limitations for statistical analysis. The response rate of Survey I was acceptable though somewhat lower than other relevant studies; the response rate of Survey II also was acceptable as it was reasonable representative for the Survey I population (§10.4.2, §10.4.4).

Chapter 9 synthesised research findings on a Chapter level; Section §10.2 synthesised the contribution of this study in seven areas. Section §10.3 discussed the implications for stakeholders and industry. The research domain and findings were relevant to the construction industry, consequently §10.3 provided suggestions for further research. The thesis ended with limitations and some personal comments.

This Part III succeeded in synthesising the substantial amount of data from this exploratory research, and succeeded in defining contributions and implementations for business and academia.

10.1.2 Self-Assessment on the AUT PhD Graduate Profile

A PhD graduate at AUT is expected to conduct advanced research, to develop his/her academic career, and to make contributions to society. This *doctoral journey* helps scholars to attain:

> *knowledge, values and attributes which allow them to make significant contributions to their professional communities and societies through further high quality research, and developments. (AUT, 2018: 27).*

The AUT Postgrad Handbook (AUT, 2018: 27) mentions 11 competences that the graduate should be able to demonstrate. The following Table provides a brief self-assessment.

Table 118: The Doctor of Philosophy graduate profile (based on AUT, 2018: 27)

Competences of the PhD Graduate Profile	Notably demonstrated in
Advanced specialist/discipline knowledge that makes an original contribution to a particular field of enquiry and as appropriate to local and global communities;	Chapters 9 and 10.
A mastery of a body of knowledge, including a high level of understanding of conceptual and theoretical elements, in the field of study;	Chapter 2, but also Chapters 9 and 10.
A high level of understanding and appreciation of the philosophical basis, methodologies and characteristics of scholarship, research and creative work in their field of study;	Chapter 3.
An advanced ability to analyse information where relevant, using appropriate tools, technologies and methods;	Chapters 2, 4-8.
An advanced capacity for critical appraisal of relevant scholarly literature/knowledge;	Chapters 2, 9, 10.
An advanced ability to initiate, design, conduct, sustain and report research;	Chapters 1, 3, 9, 10.
Personal, professional, intellectual integrity respect, and understanding of the ethical dimensions of research and scholarly activity and where appropriate demonstrate understanding of the Treaty principles in practice.	The AUT Ethics Application 15/237 was considered "very thorough". Field work for the PhD project. Supervision of approx. 50 Dutch bachelor research students within a business environment.
A critical understanding and appreciation of the acquisition of knowledge and professional learning for work practice	Postgraduate teaching and supervision. Executive training courses. Examination of 175+ bachelor reseach theses.
Significant expertise through the research, practice/work, leadership or management roles in their field of study	Business background as a manager and professional on several aspects of the research domain. PhD project @AUT. Research projects @Hanze on sustainable procurement (ISO 20400) and on SME procurement.
An advanced capacity to communicate ideas effectively to a range of audiences inside the field of study or discipline and to the wider community;	Thesis text. Primary or corresponding author of eight peer-reviewed conference papers. Blogs for practitioners on my research interests. Book chapter on procurement negotiations
Confidence and knowledge to make critical commentary on relevant and topical issues in their field of study.	Chapters 9, 10. Supervision and examination of bachelor theses. Peer review on several conference papers. Co-writer on applications for research funds.

Section summary-conclusion

1. *The research succeeded in achieving the research objectives. The researcher demonstrated to have acquired the graduate profile competences in Doctor of Philosophy from the Auckland University of Technology.*

10.2 Contributions of this Study

Chapter 9 produced detailed conclusions on the literature review and the empirical research. This Section synthesises contributions from this study related to the overall research aim from §1.4 (see also §10.1.1):

> *to learn how New Zealand companies in construction supply chains procured innovations from such suppliers.*

10.2.1 Increased Understanding: How Companies Manage Innovative Suppliers

This study added to an increased understanding (see §1.4, §1.5; §9.7) on how companies managed innovative suppliers in New Zealand construction supply chains. Notable contributions in this respect are:

− Case companies were entrepreneurial with an open and cooperative approach (Chapter 4; §5.2.2) to managing innovative suppliers. Findings indicated an entrepreneurial orientation towards suppliers which was not studied in SME procurement (§2.3.3; §2.7; see §10.2.2). Differences in entrepreneurial orientation towards innovative suppliers had some effects on procurement management variables (§6.2.6). Moreover, the research also revealed effects on procurement performance when controlled for entrepreneurial orientation towards suppliers. (§7.7).

− Findings indicated a positive correlation between the extent of entrepreneurial orientation to innovative customers and to innovative suppliers. Trust, innovating, and opportunity-seeking were seen as most important (§7.7.6). Aggressiveness to innovative customers or suppliers was seen as least important. These findings were in stark contrast of the distrust, short-term and aggressive cost-focus that was prevalent in New Zealand and other construction supply chains (§5.1.2, §5.2.6; §10.2.2).

− Case companies perceived most innovation-benefits for their own companies, but also for the natural environment (§5.3; §7.8). The reported innovation-benefits with supplier interaction were larger than without supplier interactions. Also, benefits for the environment *with* supplier interaction were larger than benefits for the company *without* supplier interactions. Instead of being a trade-off, supplier innovations could at the same time be beneficial for the company and for the environment. This was an important finding for the construction industry and for policy makers.

− Most case companies had an entrepreneurial strategy, and also a customer strategy focused on product leadership or customer intimacy (§5.1.3, §5.1.7). Some literature suggested that procurement with these strategies could be different from lifestyle or operational excellence (cost-focused) strategies (§2.8). Procurement management variables & practices varied controlled for lifestyle and survival strategies (§6.4.7). However, procurement performance levels seemed not markedly affected by these strategy types (§7.2.7). Consequently this research was unable to confirm extant literature.

− Case companies were engaged in incremental supplier innovations (§5.2.5). However a subset of companies reported they were successful in radical supplier innovations. Although

the notions of radical and incremental innovations were intersubjective, the reported innovation performance indicated that case companies were more innovation active than the average companies (§7.6). Intensity with supplier relations had an effect on performance (§7.5). In line with extant literature, the case companies had slight preferences for current, domestic and large suppliers (§5.2.3). Companies seemed generally loyal to their existing innovative suppliers. However literature and research findings also indicated that it could be beneficial to cooperate with new, foreign, or small suppliers to realize cost savings, improve quality, accelerate innovations or realize radical innovations (§7.4).

These insights were relevant to the industry and policy makers (§10.3), and are a clear contribution of this research.

10.2.2 Entrepreneurial Orientation Construct: Measure Behaviour to Suppliers

The entrepreneurial orientation construct based on Covin & Slevin (1989) appeared to have some effects on procurement management practices & variables, and also effects on procurement performance. Findings were discussed in §6.2 (also in §6.1.6, §6.3.6, §6.4.6) and in §7.7. Findings were visualised in §6.5.1 and §7.8.1.

In essence, the entrepreneurial orientation construct posits that organisations, groups or individuals exhibit an attitude and behaviour to look for opportunities, take risks, are aggressive in their markets, and conduct innovating activities (Lumpkin & Dess, 1996). This construct had been validated in numerous academic studies. A potential contribution of this research is that the entrepreneurial orientation construct seemed also applicable towards innovative suppliers in construction supply chains. So far, such application of this construct to suppliers was not discussed integrally in extant research. Wu *et al.* (2009) discussed this construct in supply chains, but only from the sellers' perspective. Marshall *et al.* (2015: 20) discussed how this construct could drive the adoption of sustainable supply chain practices. However they did not analyse effects on procurement variables & practices and on procurement performance as was systematically done in this thesis. In fact, one of their suggestions (ibid: 23) was to "focus on one supply chain or a specific sector to provide further insight in managerial decision making". *In this thesis, the entrepreneurial orientation was successfully applied on supplier innovations within the context of construction supply chains which is a clear contribution to research.*

The clear benefit of applying this construct in procurement, is that it would help to measure and understand the mindset and behaviour of companies towards innovative supply

markets. (See also §10.2.6). Pursuing supplier innovations in construction supply chains is risky. Eshima & Anderson (2017: 770) defined entrepreneurial orientation as:

> the joint *exhibition* of innovative and proactive entrepreneurial *behaviours*, and a managerial *willingness* to pursue opportunities with uncertain outcomes. (*Italics added*).

Especially the companies in the exploratory interviews, but also the data from Survey I confirmed this combination of *behaviour* and managerial *willingness*. For example: (1) SME case company #4 was able to establish a partnership with a large and foreign innovative material supplier (Chapter 4). The entrepreneurial perspective would explain this from opportunity seeking, innovative activities, and possibly trust. (2) SME #5 was able to establish a long-term partnership with a raw material supplier by co-locating production sites (Chapter 4). Similarly, an entrepreneurial perspective would explain this from risk-taking, trust, and opportunity-seeking. (3) SMEs can be successful in radical supplier innovations. Again, this behaviour could be explained from the perspective of entrepreneurial theories (Chapter 7)[181]. *The explanation of this behaviour with entrepreneurial theories demonstrates a clear contribution of this research.*

10.2.3 Company Size and other Company Variables: Produced limited Effects

Based on the literature review, the research had posited (§2.1.2; §2.3.3) that company size would have an effect on procurement. However, the effects on procurement management variables & practices controlled for company size were limited as was discussed in §6.1 and visualised in §6.5. Likewise, the effects of company size on procurement performance was limited as was discussed in §7.2.1 and visualised in §7.8. Extant literature was inconclusive on the exact effects of company size for this research topic. This became particularly clear from the extensive literature in the Appendices of §2.3.3 and §2.3.6, and from the discussion on company size effects in §6.1. Empirical findings contradicted and confirmed effects of several of such variables. *It appeared that the effects of company size were ambiguous, which is a clear contribution of this research.*

Although not investigated to the same level of detail, effects from other company variables on procurement management (§6.2-§6.4) and on procurement performance (§7.2) varied

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[181] Ad1, ad 2: Small companies would normally have difficulties in forming such a partnership. Ad 2: This type of process innovation would be normal with automotive or pharmaceutical industries, but less so within low-tech industries. Ad 3: SMEs in low-tech industries as construction would be less inclined to engage in radical innovations. These three examples however could be explained by the constructs of entrepreneurial orientation on suppliers: opportunity-seeking, innovative activities, higher risk profiles.

and to a large part were also limited. Combined insights from literature and the empirical data suggested that the effects of company variables was context-based. Furthermore, as discussed in §2.5, known or unknown variables could separately or conjointly have moderating or confounding effects on procurement variables & practices and on procurement performance. This was in line with the early lifecycle of this research domain (§3.2; Langerak 2014, Wallace, 1971). *Therefore, extracting and generalising best-practices from extant research, or generalising best-practices from this research to other areas should be done with care. This is a clear contribution of this research.*

It must be noted that the company variables in this research were also used to apply a segmentation strategy on the data. Segmentation is done to distinguish groups with company characteristics, different procurement behaviour or performance. Traditionally, segmentation was often done on company size or on industry type (§2.3.3; see e.g. De Jong & Vermeulen, 2006; see Paik, 2009, 2011; see Adams 2004). However this research (though fairly unsuccessfully) tried and analysed several obvious segmentation variables. (See §5.1; §6.1-§6.4; §7.2). *Apparently, defining effective segmentation variables in this research domain is not easy. This is a clear contribution of this research and could also be valid for extant research.*

10.2.4 Significant Performance Effects: Limited and Complex to Measure

The design and execution of Survey I was unable to confirm (or reject) a majority of hypothesised effects from the extensive literature review. This became apparent from the absence of large significant effects of company variables and procurement management variables & practices on dependant procurement performance variables.

The research posited earlier that SME performance indicators would also be applicable for large organisations. Some extant SME literature was straight-forward with proposing performance measures. A comparison (§2.12) of similar research however demonstrated a wide variety of measures. Other literature discussed the complexity of measuring performance (Van Donk & Van der Vaart, 2005; Paik, 2011). This research used a total of 11 intersubjective performance variables for Survey I. Two standard output-variables were taken from the Oslo Manual on innovation data collection (OECD, 2005); two sets of performance process or proxy-variables (on perceived innovation-benefits, and on perceived innovation-satisfaction rates) were based on common literature (§2.12.3).

As shown in §7.8, the effects on the two <u>output</u>-performance variables when controlled for the relevant mediating or independent variables could not be convincingly established. Nevertheless, the companies of Survey I reported relatively high numbers or innovations and percentage of innovation turnover (§5.3). The research succeeded to identify several independent variables that would affect <u>process or proxy</u>-performance variables (again, §7.8).

The data analysis (§7.1.3) was also unable to indicate major (strong) statistically-significant differences and correlations for the two output-performance variables when controlled for the nine process-performance variables. Hence, respondents with relatively high versus low innovation numbers and estimated percentage innovation turnover in several instances did *not* significantly differ in their perceived benefits or satisfaction-rates. The research discussed several possible reasons for this (§7.1.3).

A clear contribution of this research is the observation not to rely on obvious performance measures, but to add other performance measures.

10.2.5 Limited significant Effects: But satisfied with Procurement & Performance

The research analysed and selected a large number of potentially-relevant variables in Chapter 2. At first sight, the summary Tables at the end of Chapters 6 and 7 (see also §9.7) showed low amounts of statistically-significant differences, although respondents seemed to have several procurement management options.

As discussed above, respondents also reported relatively high innovation numbers and related percentages of turnover (§5.3.1), positive innovation-benefits, and were neutral-to-satisfied on their company's internal and external innovating activities (§5.3.2, §5.3.3). Furthermore, most companies had existed for >10 years (§5.1.5) and must have witnessed several economic upturns and downturns.

This would lead to conclude that a few statistically-significant differences could have an effect in the business reality of the focal companies. Moreover, literature would confirm that small differences in a sample could have real-life effects on the performance of focal companies. (Kjaergaard, 2016; Bettis & Hitt, 1995: 12). Finally, performance would also be affected by unknown moderating variables, and within SMEs is not always straight-forward (Schillo, 2011; Wiklund & Shepard, 2005; Davidson *et al.* 2005).

The insight that a small number of known variables and an unknown number of moderating variables seemed to affect procurement behaviour and performance in construction supply chains is a clear contribution of the research.

10.2.6 Entrepreneurship: An applicable Management Theory

Chapter 3 discussed several management theories that could be applicable to the research topic of (mainly) SMEs that managed innovative suppliers. As the research domain was immature (§3.2.4; Langerak, 2014; Wallace, 1971; Edmondson & McManus, 2007), the research chose to be "eclectic" (Davidson, 2016: viii) and analysed literature from the domains of procurement, open innovation, innovation, small business, and entrepreneurship (§3.4). Several theories from the entrepreneurship or small business domain (§3.4) seemed suitable to better understand the procurement behaviour of case companies when they managed innovative suppliers. (See also §10.2.2). The following Table illustrates this with examples from the empirical research.

Table 119: Procurement behaviour explained by entrepreneurship or small business theories

Management theory	How it could help to understand procurement behaviour
The Effectuation Theory posits that entrepreneurs start with means available to them, instead of starting with defining company (or innovation) objectives. Companies would favour partnerships and leverage on contingencies or unexpected situations (Sarasvathy, 2001; §3.4).	This was demonstrated in several of the exploratory interviews, where respondents discussed how they compensated for company weaknesses or threats in the way they managed relations with their innovative suppliers. SMEs in Survey I appeared to manage higher innovation risk levels, and achieve similar (or better) performance levels with supplier innovations than large companies. They considered innovative suppliers important for achieving company objectives.
Small Business Theories describe SMEs as being funded, owned, and managed by one owner or a small number of people. The personality of the owner-manager plays an important role. The company is seen as flexible and various key business functions are conducted by limited numbers of staff. The company is scarce on resources (people, financial, equipment) and either has a lifestyle strategy or a growth / entrepreneurial strategy (Storey, 2016; Burns, 2000; §3.4).	Respondents from SMEs in Survey I had several roles and broad experience levels, whereas respondents from large companies had narrower experience levels. Results from Survey I indicated that smaller companies had less resources e.g. to manage relations or negotiate-contracts with innovative suppliers. Respondents often reported entrepreneurial (growth) strategies. Research participants from the exploratory interviews worked at top management level and demonstrated a broad knowlegde base and experience.
Entrepreneurship according to Shane & Venkataraman (2000) involves the discovery, evaluation, and exploitation of opportunities to introduce new goods and services as not previously achieved. (See also §2.7).	In this research, the case companies would meet customer demands with supplier innovations. Survey I respondents used procurement (viz. open innovations) processes to explore and exploit innovations from suppliers. Practices were holistic and focused at collaboration to realize innovations. Survey II indicated that companies would use different procurement practices for different innovation and supplier types to achieve their objectives. This included the use of new or foreign suppliers, and incremental or radical innovations. Some companies successfully used suppliers for radical innovations.

A more traditional match with procurement theories (for example transaction cost theory, or research based-view) or innovation theories could explain this procurement behaviour with innovative suppliers to some extent (§3.4). Additionally, Ozmen (2012) or for example Pressey *et al*. (2009) would explain some behaviour based on personal attributes of staff involved in managing innovative suppliers. (See bottom row Table in §2.6.3). However, applying the perspective of entrepreneurial theories was more appropriate for this research domain considering the uncertain and often complex context in which case companies managed their innovative suppliers. As mentioned in Subsection §10.2.2, the application of entrepreneurial theory in procurement is limited, although some recent (yet unpublished) IPSERA 2018 papers discussed *intra*preneurial orientation in larger procurement organisations. Sustainability improvements in supply chains would need an entrepreneurial approach (Marshall *et al.*, 2015). *Similarly, this research indicated that an entrepreneurial approach could also help to manage supplier innovations. This understanding is a clear contribution of this research.*

10.2.7 When Companies Manage Innovative Suppliers: Procurement Best-Practices

The data from Survey II revealed a set of best-practices for specific supplier types or innovation types that companies could use when they managed innovative suppliers (§8.3; §8.5; §8.6; see also §10.2.3). *Although academia or management should interpret such procurement practices within the context of a specific organisation, this is a clear contribution of the research.*

Section summary-conclusion

2. *The overall aim of the research was to increase the understanding how New Zealand companies in construction supply chains managed innovative suppliers. This Section discussed six Sub-sections with multiple and clear contributions to industry practice and academia.*

10.3 Implications for Business & Research

Doctoral theses would often distinguish between implications for research and implications for industry practice. This research domain was relevant to different stakeholders (§1.3) and had a clear business relevance., i.e. learn how companies managed innovative suppliers (§1.4, §1.5). Therefore in §10.3.1 the implications for research and industry are discussed

from the perspective of stakeholders in the construction supply chain. (§1.3; §2.1.2). Section §10.3.2 then lists suggestions for related further research.

10.3.1 Relevance for the Stakeholders in the Supply Chain
The Figure below gives an overview of stakeholders in the construction supply chain.
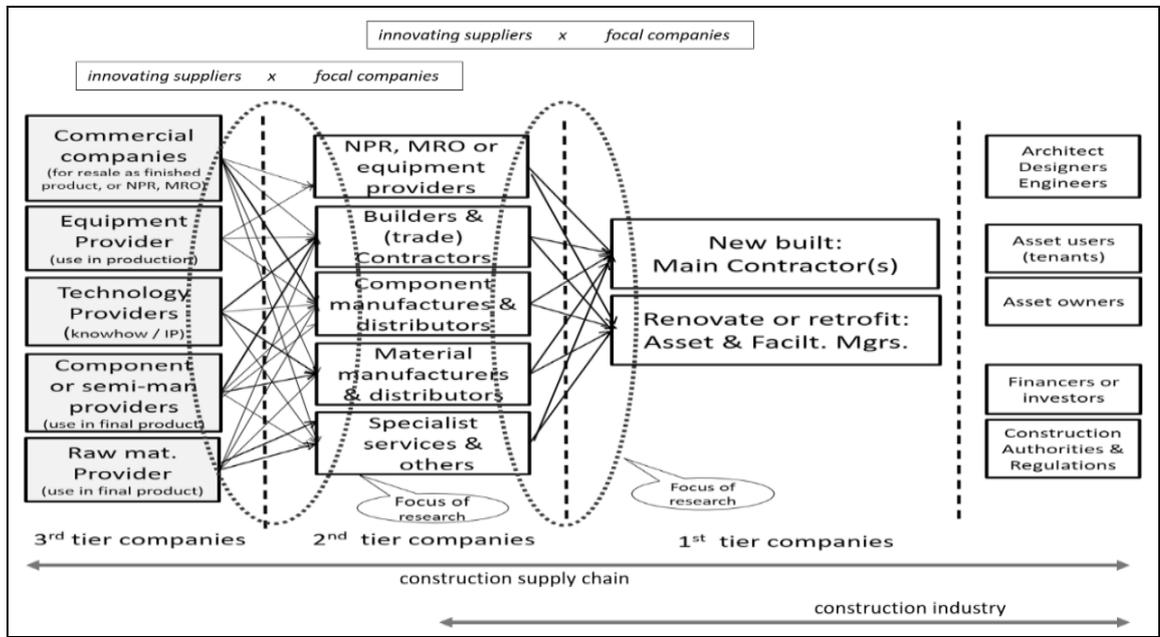
Figure 60: Construction supply chain with the focal 1st and 2nd tier companies (Copy Figure 9)

Starting from the right: <u>asset users and asset owners</u> need innovative solutions which are handed-down in (technical or functional) specifications to <u>1st tier companies</u>. With the conclusions of this thesis, 1st tier companies could gain an improved understanding on how to manage their 2nd tier innovative suppliers. Alternatively, <u>2nd tier companies</u> gain an understanding on how to manage 3rd tier innovative suppliers. (Moreover, asset users, asset owners and 1st tier companies could gain an understanding on how 2nd tier companies manage their innovative 3rd tier companies).

Starting from the left as observed from the sellers' perspective: 3rd or 2nd tier companies as <u>innovative suppliers</u> could gain an improved understanding on the behaviour of their (in)direct customers. This could increase their chances of success in bid management, joint development or innovation pilots.

A wider circle of stakeholders could also benefit. <u>Industry associations</u> could help to stimulate innovations in their industry sector. They could create an eco-system and industry players would behave friendly, innovative and cooperative during the idea or develop phase. Following the innovation cycle, players would be more competitive during the business

phase. Associations could influence this process with networking, joint education or pilots via project organisations. Innovations could be incremental with current players, but could turn more radical (hence more profitable) with new players.

Educational institutions should continue teaching construction procurement and supply chains, and extend this with supplier innovation management and sustainability in supply chains. This could include an awareness of the innovative quality of small suppliers, and of the particularities on managing such suppliers. There could be a need for a textbook on entrepreneurship procurement, but this thesis and extant research would only offer general guidelines and practices. Likewise, consultants should be more aware of contingency aspects and the upwards potential of supplier innovations.

The natural environment. Even when case companies had a focus on their innovation benefits, interaction with innovative suppliers could yield substantial benefits for the natural environment. Moreover, standardisation guidelines are said to stimulate incremental sustainable innovations. Radical innovations could have a bigger positive effect on the natural environment, and findings showed that several companies were successful in realising radical supplier innovations.

Policy makers on increasing construction efficiency, on stimulating entrepreneurship, and on sustainability programmes could benefit from an increased understanding on managing innovative suppliers. Construction is often driven by high competition and lowest costs. Stimulating entrepreneurship in managing innovative suppliers in construction supply chains could help to achieve objectives in all three areas. Consequently, the procurement function within large and small organisations would not only help to contain costs and manage logistics, but would help to stimulate supplier innovations and improve sustainability at the same time. This trend that procurement can add value on several business drivers (for example Van Weele, 2018, Johnsen *et al.*, 2014) is visible in many industries, but so far hardly in construction.

As explained earlier, the research field was wide an immature. Hence depending on stakeholder interests, the contributions (§10.2) and limitations (§10.4) offer opportunities for future research.

10.3.2 Suggestions for further Research
This research is relevant to industry and academia. The contributions (§10.2), implications (§10.3) and limitations (§10.4) provide ample suggestions for further research. The exact

avenue will be impacted by the relevant stakeholders. Further research should consider insights from Edmondson & McManus (2007), Van Aken (2004) or Langerak (2014) (see §3.2.4) for defining perspectives, research objectives and methodology (§3.3). Some specific and overlapping suggestions:

1. Conduct structural equation modelling (SEM) and/or advanced factor analyses (FA) to investigate in more detail correlations & causations among promising variables. (The current data set is too small; §10.2.1).

2. Conduct a meta-analysis on extant relevant research (see Appendices §2.3.3, §2.3.6) that applied SEM and FA. Investigate contingency factors in such research. Replicate relevant parts of extant and this research in other relevant contexts. (§10.2.1).

3. Analyse the effects of company or customer strategies on procurement management and procurement performance with innovative suppliers. (10.2.1).

4. Analyse the effects of (individual or company level) entrepreneurial orientation on procurement management and procurement performance with innovative suppliers. (§10.2.1; §10.2.2). Could this support step-changes in construction innovations or sustainable procurement?

5. Analyse the effect of company size on procurement management and performance, for instance contrasting companies with <10-20 staff versus with >100 staff. (§10.2.3). Analyse effects of any mediating or confounding variables.

6. Conduct research into more effective SME segmentation criteria (§10.2.3) for research on SME procurement and SME procurement performance with innovative suppliers. (Cf. Julien, 1995; Keijzers *et al.* 2007; Meijaard *et al.* 2005: 91; Reboud *et al.* (2011: 3), Torres & Julien, 2005).

7. Analyse other promising SME company characteristics and their procurement management in relation with procurement performance with innovative suppliers in other industries or countries. (§10.2.3).

8. Analyse relevant (SME) procurement performance criteria with innovative suppliers and analyse to what extent and why (SME) companies are satisfied with such performances (§10.2.4; §10.2.5).

9. Analyse the use of procurement practices on supplier or innovation types in different countries or industries (§10.2.7). Investigate whether these practices could be modelled into a maturity model (§2.6.2). This comparative research would need larger sample sizes on best-practices for specific supplier–innovation types to reveal more solid statistical

relations including size-effects, and the research on the effects of specific moderating or mediating variables.

10. Analyse in extant literature (see Appendices §2.3.3, §2.3.6) or in new research to what extent entrepreneurial management theories could help explain procurement behaviour. (§10.2.6).

11. Analyse management of innovative suppliers from the other semi-dyadic perspective, hence from the perspective of the innovative supplier. (cf. Rigby, 2013).

Section summary-conclusion

3. *The research domain is relevant for the construction industry. Findings are beneficial for industry practice.*

4. *Implications for business can be communicated to New Zealand stakeholders in several ways: interactive breakfast sessions, articles in e.g. the Build magazine, or publications and promotion via industry associations.*

5. *Participants of this research will receive an update on the results.*

6. *Implications for research would imply re-writing key aspects of this thesis into articles for peer-reviewed journal papers.*

7. *The contributions (§10.2) and limitations (§10.4) offer opportunities for future research.*

10.4 Limitations on Execution of the Research

The previous Sections discussed contributions and implications of this study. Section §3.7 discussed rigour and limitations on the research design. This Section discusses limitations on the execution of the literature review and of the empirical research methods in Chapter 4–8. These limitations relate to achieving the research aim of learning how companies procured construction innovations from innovative suppliers. (See §1.5).

10.4.1 On the Literature Review (Chapter 2)

The literature review produced a large number of variables & practices that were potentially-relevant for the research. The literature covered the research domain but was unable to provide extant research that could univocally support the selection or the analysis of such potentially-relevant variables & practices. In part this could be explained by the contingency theory and the immature research domain. (§2.5; §3.2.4). *Hence the research was designed exploratory and multi-mode.*

10.4.2 On the Exploratory Interviews (Chapter 4)

Although the interviews had been designed to cover the classification model from §2.10.3, the interviews were unable to discuss each process step extensively. Similarly, the information on other aspects produced fragmentary evidence on the relevant variables. *This was expected and had been taken into consideration in the research design.*

10.4.3 On the Sample Size and Response Rate of Survey I (Chapters 5-7)

The nett invitations to N=1,097 companies and the sample size of n=112 companies resulted in a nett response rate of 10.2%. (See §3.6.4).

Literature generally prefer a minimum response rate of 12%. (Bassioni *et al.,* 2005; Kumar, 2012; Saunders *et al.,* 2009). This research found lower and higher numbers from comparable research. These rates were weighted W=11.5%; unweighted U=13.6%. Considering context, guidelines and relevant literature, the Survey I response rate was acceptable, also considering that the design of the research. (See corresponding Appendix).

Furthermore, the fact that findings turned out to have $p \leq .05$ with a confidence interval of 95% would not à priori imply practical significance or "substance" (Muller *et al.*, 2009: 302). For example Field (2009:58, 59) and Cramer & Howitt (2004: 55) therefore suggested to calculate effect sizes. As discussed in Part II, sample sizes were too small, most of the data were non-normal and hence often not suitable for calculating effect sizes. (Sullivan & Feinn, 2012: 217; Lavery, 2015: 28). Where relevant, the research did determine effect sizes. It must also be emphasised that calculating more effect sizes would go beyond the means of this PhD.

As the research was exploratory, is was designed comprehensively. Hence the research systematically analysed plausible relations from conceptual models II and III, and duly reported significant and non-significant effects. Where relevant, it additionally analysed correlations. Significant and non-significant results were given equal attention[182]. Suggested correlations or causations were based on validated conceptual models, were presented cautiously (§3.5), and were not an attempt to 'just try and find some results'. The extensive literature review and the extensive statistical analyses are proof of this structured approach. Moreover, statistically-significant results were always related to the total amount of results (See §5.2.2, see introductions of Chapters 6, 7). Additionally, the fact that the research

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[182] It must be noted that this differed from what statisticians sometimes call "p-hacking", "selective reporting", or data-dredging"' (Head et al., 2015: 1; Simonsohn et al., 2014: 670).

applied "uncoded" and "recoded" variables to explore for potentially-relevant significant results (see introduction of Chapters 6-7) was done deliberately and again only used to counterbalance limitations in the data (VanVoorhis & Morgan, 2007: 46-47).

And finally, literature frequently reported conflicting findings. In several instances, research findings were confirmed by extant literature; in other instances they were contradicted by extant literature. This was expected and inevitable in this exploratory research (§10.2.4). *In conclusion: the execution of survey I and data analysis was done with care and yielded appropriate statistical results.*

10.4.4 On the Validity and Generalisability of Survey I (Chapters 5-7)

Respondents could have a higher interest or more experience in the research topic than non-respondents; this could give skewed impressions on the target-population. Likewise, aspects that were not measured in the survey, misunderstood by respondents (bias), influenced by personal attributes (see also §3.2.3), or proved not-significant from the findings could get inaccurate attention in the analysis. Results could furthermore remain superficial as surveys tend to simplify and compress the complexities of case companies. (Forza, 2002: 162).

Entrepreneurial orientations can occur on an individual and organisational level. It must be noted that Survey I measured this orientation (and all other variables) via a single respondent. In part their companies appeared large and fairly old. (See §5.11; §5.1.5). Literature found that entrepreneurial orientation is often related to smaller and younger companies. Consequently, there could be an individual respondent-bias on the reported entrepreneurial orientation on the company level.

Another possible limitation was the selection of variables & practices. In part this was unavoidable as was discussed in §3.2.4. Mullen *et al.* (2009: 29) mentioned as a drawback the necessity to measure and control for "background variables" (hence moderating and confounding variables). This research applied a comprehensive approach as it included several of such variables. It succeeded in consistently analysing a higher number of variables & practices than in extant relevant research.

Finally, Survey I produced a heterogenous sample of company respondents from the New Zealand construction industry. De Jong & Vermeulen (2006: 604) noted that a focus on one single industry would be "hard to generalize". This was inevitable but findings were

compared with literature. *In conclusion: the careful design and execution of Survey I and triangulation with other research methods helped decrease limitations.*

10.4.5 On the Focus-Group Research (Chapter 8)

The roundtable discussion partially validated the supplier-innovations types and practices for Survey II. Roundtable participants could be more interested than the average target-population which could lead to a bias. Triangulation helped to compensate this. The research had initially designed two sessions, but had to cancel one session due to a lack of interest caused by a holiday period. The two rounds for procurement steps specify-needs and find-select suppliers were more qualitative. The two rounds for the steps negotiate-contract and manage-relations were more quantitative. These latter approach proved more valuable to the research. *Findings were fragmentary but satisfactorily validated model III for Survey II.*

10.4.6 On the Sample Size and Response Rate of Survey II (Chapter 8)

The same arguments apply as with Survey I. (§10.4.3). Additionally, as could be expected, the sample size of Survey II (N=33) was considerably lower than of Survey I (N=112). The sample size was considered large enough for Chi-Square tests (§8.1). The respondents came from the same sampled population (N_{tot}=1,097; see §3.6.4.1, Figure 28). Three questions were either *identical* or *similar* in Survey I versus Survey II, and produced comparable results. *Hence findings from Survey II could be considered fairly representative for Survey I.*

10.4.7 On the Validity and Generalisability of Survey II (Chapter 8)

The same arguments apply as with Survey I. (§10.4.4). Additionally, the small sample size, the variety of respondents, and the basic survey structure would limit generalisation to the target-population. *However as the Survey II population was fairly representative for Survey I (§10.4.6), this indirectly enabled a generalisation to the target-population.*

10.4.8 Conclusions on the Limitations

Extant literature (§1.7) had already suggested that this research on managing innovative suppliers would be a hard research topic (Ramsey, 2007; Hardie, 2011b, Urbina *et al.* (2012: 174). Indeed, the execution of the research was confronted with several limitations.

Additionally, in several occasions the research was unable to confirm or reject (inconclusive) findings from extant literature. *Two partly conflicting conclusions could be drawn.*

Assume, there were no confounding variables, and that the conceptual models, the survey data, and the statistical tests were perfectly reliable and valid. A comparison of the empirical results with the literature review from Chapter 2 would then lead to the conclusion that the results were repeatedly different from extant literature.

Otherwise assume, that confounding variables had an undetermined impact, and furthermore that the conceptual models, survey data, and statistical tests were less valid and reliable. (This is always the more plausible scenario). The design and execution of the research was nevertheless done carefully and diligently, and the interpretation of research findings was done consistently and with caution. The triangulation with the mixed-mode approach (Edwards & Holt, 2010; §3.7) increased validity. Although with less accuracy, the overall conclusion would <u>still</u> be that results were repeatedly different from extant literature and yielded a deeper understanding of the research topic.

Additionally, results of this research suggested that the <u>context</u> within extant research (see also §2.5) could be more important than generally assumed. Hence also the generalisability of <u>extant</u> research could be less easy than generally assumed.

The comparison of inconclusive findings with extant literature in Part II <u>did not </u>disqualify the exploratory research design and execution. It <u>merely demonstrated the need </u>for future research (cf. Langerak, 2014; Edmondson & McManus, 2007).

Section summary-conclusion:

8. *The survey sample sizes and the response rates in this research were acceptable. The external validity and generalisation of survey results was strengthened with triangulation from an extensive review of literature and from the mix of carefully designed and executed research methods.*

9. *The context of extant relevant research (§2.5) could be more important than generally assumed. Hence the generalisability of extant research could be less easy than generally assumed.*

10. *Results of this research should be interpreted with care. Future research (§10.3.2) preferably needs larger sample sizes on best-practices for specific supplier–innovation types to reveal more solid statistical relations including size-effects, and the research on the effects of specific moderating or mediating variables.*

10.5 Some Personal Comments – Looking back on the Journey

This PhD project was initially designed on the basis of a rational-goal model (Cameron & Quinn, 2011). The project would analyse the emerging fields of SME procurement and of SME inbound open innovation. Understanding these bodies of literature would help to understand how companies managed innovative suppliers in New Zealand construction supply chains. The extensive body of literature covered in Chapter 2, gradually disclosed gaps and inconsistencies in literature. Conceptual model II tried to capture potentially-relevant variables. The research was broad in design due to the exploratory nature.

Then more in line with the effectuation theory (Sarasvathy, 2004), the research approach shifted from causation to effectuation[183]. Although the research was neatly designed (see §3.3), analysing the substantial data from the interviews and the two surveys equalled more an inductive "journey" towards an unknown destination, than a deductive "travel" from position A to B. (Swieringa & Wierdsma, 1992: 162). The quantitative research strategies were "crafted" instead of merely being planned (Mintzberg, 1990: 2; Rozemeijer, 2000: 209).

First analyses in SPSS were difficult but gradually my knowledge and skills on statistics and on the software grew to a competent level. YouTube tutorials from several academics and notably the SPPS handbook by Field (2009) supported this part of the PhD journey. First inferential findings were disappointing and appeared inconsistent with dominant extant literature.

Going back into the literature made me realise that extant procurement and innovation management in SMEs was described in their contexts. It seemed that this context was more dominant than I previously assumed; several moderating and confounding variables could have an impact. To avoid passive scepticism on the extant knowledge, the researcher began to appreciate the findings in a more positive mode of scepticism. Hence in an investigation mode with a deferred judgement[184].

This contingency or contextual approach (§2.5) found e.g. support with remarks by De Jong & Vermeulen (2006), who concluded in their SME research that it was difficult to compare results over different supply chains or industries. Conclusions on the research confirmed that the choice for a broad design (De Waal, 2011) was correct. They also confirmed the

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[183] Notably the principles of the bird in the hand, and the pilot in the plane.
[184] Oxford dictionaries only mentioned negative connotations with scepticism. The Stanford Encyclopaedia of Philosophy discusses the ancient sceptics who suspended their judgment. (Accessed 3 August 2018).

notion from §3.2.4 that this research area was young and immature (Langerak, 2014; Edmondson & McManus, 2007), and therefore that results could a certain extent contradict each other.

The PhD journey was beneficial for me in several ways. It enabled me to conduct research at the Auckland University of Technology in New Zealand. The ensuing interactions with many knowledgeable and friendly academics honed my skills as an academic. Furthermore, the various industry contacts and interesting discussions enabled me to hone my skills as a pracademic. Finally, the numerous analyses and many writing hours during the project helped me to sharpen my knowledge. This included the awareness that the academic value it is not the knowledge of a domain per se, but the demonstration to apply advanced academic tools to advance or challenge that knowledge base.

Generalisation of the thesis findings to procurement practices in other industries or supply chains is tempting but could be limited (§10.4). Indeed, other extant research in this area could have limited potential (!) for generalisation. Nonetheless, SME and large companies and their direct and indirect stakeholders will benefit from an increased understanding on innovation procurement. In construction and in other industries. There still is a dearth of knowledge in this area.

I hope this thesis expands our knowledge on the topic. Additionally, I hope academics, pracademics and business practitioners will enjoy studying the thesis. You are very welcome to discuss suggestions for improvement and for further research.

Section summary-conclusion:

11. Yeah! This doctoral journey in New Zealand has been worthwhile!

10.6 Chapter Summary & Conclusions

The Summary-conclusions from the five Sections lead to conclude that this doctoral research achieved ambitious research objectives, successfully defined relevant contributions and implications, aptly managed the inherent limitations, and proposed suggestions for further research.

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