How Entrepreneurial New Zealand firms Procure Environmental Technical innovations for the Construction Industry.

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Anne Staal, BENG MA DMS MBA, doctoral researcher & lecturer at Auckland University of Technology (NZ), senior lecturer at Hanze University (NL). *Corresponding author.* astaal@aut.ac.nz. Dr John E. Tookey, MCIOB, MIEEE, Professor in Construction Management at Auckland University of Technology (NZ). Dr Jeff Seadon, senior research fellow at Auckland University of Technology (NZ). Dr Mark P. Mobach, Professor in Facility Management Centre of Research & Innovation for Built Environment Hanze University (NL). Mr Gert H. Walhof MBA, Professor in Purchasing Management Hanze University (NL).

Abstract

Construction industries in New Zealand and abroad have a low track record for successful sustainable innovations. This often has a negative impact on private and government spending, and on quality, society and the environment. This paper posits that the construction industry needs step-change (i.e. architectural, system, radical, modular) environmental technical innovations to make drastic improvements.

Often innovative or small to medium-sized firms at the beginning of supply chains or from other industries will introduce such innovations. These firms will use the innovation capacity of suppliers and of their own organisations to transform and commercialise such innovations into the industry. *However, after an extensive literature review it remains unclear how innovative New Zealand firms procure environmental step-change technical innovations for the construction industry.*

The research focuses on procurement activities within such firms who supply the New Zealand construction industry. These procurement activities interact with (internal and external) innovation activities for an optimal firm performance (in economic and environmental terms) and are affected by clusters of internal and external variables.

The heart of the research consists of two rounds of case studies alternating with two rounds of collaborative focus studies. The research focus is on New Zealand although part of this study will be replicated in the Netherlands. It is part of a doctoral project.

Key words

Construction industry, material suppliers; entrepreneurs, small firms, SMEs; New Zealand; step-change technical innovations; procurement, purchasing; sustainable, environmental.

1. Introduction

Traditionally the construction industry in New Zealand and abroad has a low productivity and a low track record for successful innovations (Fairweather, 2010). The industry also lags in sustainability performance (e.g. NZGBC, 2013; BRANZ 2014, p. 20) when seen from a broader or lifecycle perspective. This has a negative impact on private and government spending, on quality and health/wellbeing, and on the environment. The construction and occupancy of buildings cause between 25% and 35% of the environmental impact (EIPRO, 2006, p. 16). Occupancy during the life-time of buildings constitutes to 25% of the national energy consumption. Construction & demolition landfill waste in New Zealand is approximately 40% of total landfill (BRANZ, Special Report 279, 2013). Nevertheless 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 technologies … without significantly increasing investment costs" (Arnel, 2009, p. 2).

Figure 1 shows a construction supply chain (Pryke, 2009, p. 2). The small dashed oval indicates the primary research area; the large dashed oval the wider research area. The 2nd tier suppliers which are the focus of this research often have no direct client contacts. These include *trade contractors* (supplying services, e.g. plumbers, carpenters); *component suppliers* (supplying systems, e.g. window facades or other off-site

manufactured structures); *material* or *trade suppliers* (supplying commodities e.g. bricks, nails, cladding material); and *specialist services or others* (supplying a range of specialist services or secondary material e.g. machineries or tools).

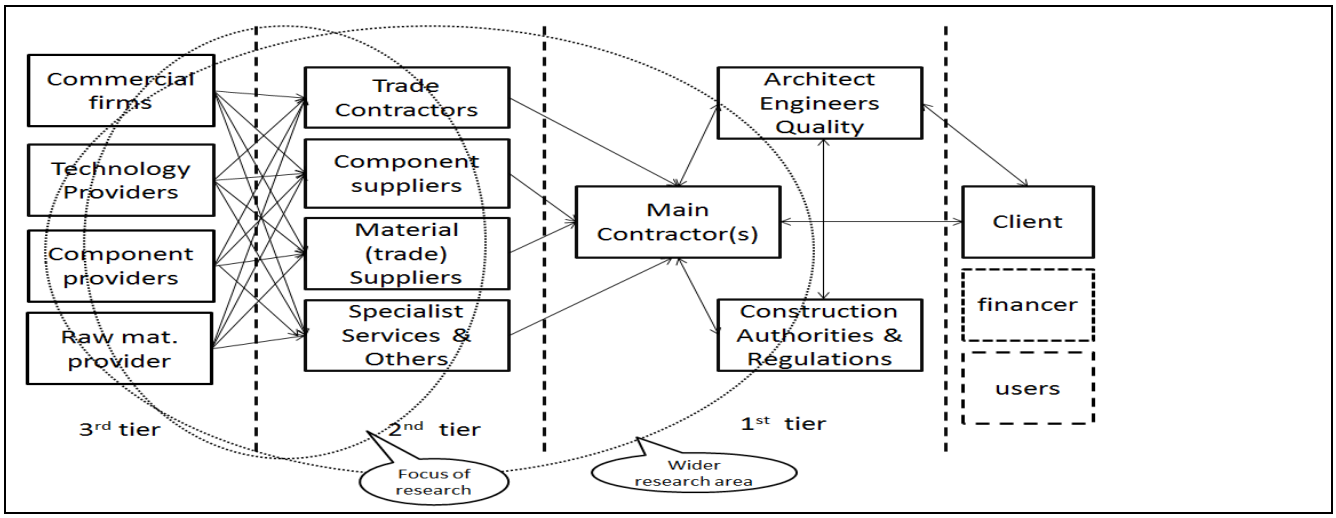

Fig. 1. Actors in a simplified construction supply chain based on Pryke (2009, p.2) & Van Weele (2010, p.15)

The 3rd tier suppliers can offer a variety of goods and services. Based on Van Weele (2010, p. 15) this research distinguishes *commercial firm*s supplying ready-to-sell tangible innovative products and know-how (e.g. machinery or materials); *technology providers* supplying intangible products (competencies/skills or technology know-how); *component providers* supplying tangible innovative (semi-manufactured) products and know-how that must be transformed (processed or built) into a product offering; and *raw material providers.* The downstream client, financer and users are considered less important for this research.

This research relates to sustainable construction technology and subsequent sustainable buildings as a result of such technology. It focusses on a specific subset of sustainability: on *environmental aspects.* This concept in itself is still a broad term with differing interpretations. It originates from the Brundlandt report (1987) and in a construction industry context e.g. relates to the use of raw materials and energy, and the production of physical waste and contamination during the life-cycle of buildings. Literature and practitioners then relate to “eco-efficient buildings” or “green building”. Such buildings and hence the technology innovations of this research (UNEP, 2010, p. 11) will:

1. *Minimise the amount of resources used in relation to the size of the building;*
2. *Maximise the ease with which resources can be refurbished, reused and / or recycled;*
3. *Minimise the amount of resources required to provide thermal comfort and services in a building; and minimize the proportion of resources wasted during construction, refurbishment and demolition.*

In practice such resources often relates to energy efficiency, water efficiency, material efficiency. The notion of Green Buildings (UNEP, 2010, p. 11) additionally takes into account the life-cycle impact on occupants, minimizing pollution and using environmentally-friendly materials or energy systems. This is often covered by rating schemes such as Greenstar, LEED or BREEAM. The research does *not* focus on the social or cultural aspects of sustainability *as such.* Nevertheless, as a second order effect an environmental innovation can also effect social or cultural aspects of sustainability.

In line with Kibert & Grosskopf (2005), Schaltegger & Wagner (2008) and Van den Dobbelsteen (2004) this paper posits that the construction industry needs step-change (*disruptive or discontinuous*) environmental technical innovations to make drastic improvements in sustainability. Such innovations are often procured and (co-) developed by (2nd tier) innovative firms thus introducing such innovations to the innovation superstructure (e.g. Hardie, 2011; Pries & Janszen, 1995; Slaughter, 1998; Winch, 1998) and hence further into the construction industry.

In the New Zealand context such innovative firms will be entrepreneurial Small to Medium-sized Enterprises (SMEs). *However it is unclear how such firms procure step-change environmental technical innovations for the construction industry.*

This paper will now continue with a literature review ($2), leading to a gap in extant research ($3). It will then discuss a conceptual framework ($4), research questions ($5), and briefly discuss the proposed research design ($6). It will end with conclusions and limitations ($7).

2. Literature review on procurement and innovations in construction

This section gives a brief overview from literature. It discusses the concepts of procurement ($2.1) and innovation ($2.2), technology and Intellectual Property ($2.3), aspects of networks and collaboration ($2.4). This section ends with characteristics of the unit-of analysis, the innovative 2nd tier suppliers ($2.5).
Research suggests that the focal firms of the PhD innovative firms are either entrepreneurial or relatively small, or sometimes both. Hence this review discusses literature from these two aspects.
For small construction firms, innovations are a means to survive or make profit (Abbott *et al.* 2006). Chesbrough (2004) coined the concept of 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). This concept is increasingly being used (e.g. Pullen, 2010; Van de Vrande 2009) in small to medium-sized enterprises (SMEs), but its use in construction is unknown. *(For size aspects of the focal firms: SMEs or small firms, please see $2.5).*
There is an on-going debate (Gronum & Verreynne, 2007) on how this concept can be applied in such small firms. There is research on innovation types in the construction industry (Slaughter, 2000 Hardie, 2011). Literature also suggests (e.g. Hardie, ibid, Sheffer & Levitt, 2010) several barriers to adoption of innovations on a *meso* (industry) level or on a *macro* (systemic) level in the construction industry. There is also literature on a *micro* (firm level) on how small firms successfully diffuse (commercialize) step-change environmental innovations in the construction industry (e.g. Hardie, 2013; Sheffer & Levitt, 2010, 2013). Utterback (1994) concluded that these (*in-frequent*) step-change innovations trigger (*more frequent*) process and incremental innovations, and hence can deliver large benefits to stakeholders.
Small firms are not miniature versions of large firms (e.g. Torrès & Julien, 2005) and small firm innovation and procurement processes will differ from those of larger firms (Ramsey, 2007). Processes are likely to be more informal, simplistic and holistic, and centred round the firm-owner, although Meijaard *et al.* (2005) suggested a wider variety of organisational small firm structures including formal and complex structures. In line with Julien (1995), in her French research Reboud e.a. (2011, p. 3) saw a continuum from "SMEs Ordinaires" (traditional small firms) to "SME entrepreneuriales" entrepreneurial firms, with differing characteristics and dynamics. There is also some debate (Ozmen, *et al.* 2014, p. 1) on whether buying behaviour of small firms does include aspects of individual buying behaviour like impulse buying, which are normally not associated with large firm buying behaviour.
There is a wealth of literature on how large organisations procure goods and services but it remains unclear how small firms procure these (e.g. Hagelaar *et al*., 2014; Morrissey, 2011; Paik, 2009). There is some literature on innovation and SMEs. Often (small) entrepreneurial firms from outside the industry or at the beginning of supply chains play an important role in introducing innovations to the industry (e.g. Baumol, 2002; Farschi & Brown, 2011; Johnsen & Philips, 2011; Gambatese & Hallowell, 2011; OECD, 2005, 2010; Pries, 1995, 2005). There is Australian literature (e.g. Hardie, 2006, 2011, 2013) on small firms successfully introducing environmental innovations in the construction industry, but this literature does not reveal (e.g. Hardie 2011, p. 260) supplier relationships of such firms. Likewise, there is a growing body of literature (e.g. Johnsen *et al.*, 2011; Philips *et al*., 2004) on how large organisations procure step-change innovations.
Not all firms are entrepreneurial firms. Entrepreneurial firms (want to) realize substantial growth and renewal (OECD, 2010b). Owners will have a pivotal role (Burns, 2011) and often act as gatekeepers or ambassadors (North & Smallbone, 2000). Their innovation and procurement activities will be determined by their experience and attitude to innovation (Chandler, *et al.*, 2000; Songip, 2013) by their holistic approach to procurement (Quayle, 2002; Pressey *et al*., 2009) and hence by their perceptions on risks, strategies and objectives. Altruistic (social and environmental) motives of firm owners could play a role in the choice of wanting to offer environmental innovations. However it is expected that entrepreneurs are pursuing opportunities (Zortea *et al.*, 2013) and that business objectives (growth, profits, or even continuity) are more important drivers. This is in line with research of Hardy *et al.* (2013, p. 186) on environmental innovative small firms who found that the drivers regulatory climate, industry networks, project-based conditions and

client and user influence all ranked substantially higher than the owners' personal motivation. Vörosmarty (2012) found similar drivers for sustainable procurement of Hungarian SMEs.

2.1 On definitions for procurement and procurement performance

This research sees the procurement process related to construction innovations as a part of the wider adoption (diffusion) process of such innovation (see e.g. Hardie, 2005; Weidman *et al.* 2009). Definitions and terms related to *procurement, purchasing, sourcing* or *supply management* vary considerable and are often being used interchangeably (see e.g. Johnsen *et al.*, 2014, p. 10). This research takes a wide approach on procurement and for example includes decisions related to make or buy, to transactional or longer relationships, to choosing high or low risk (value) suppliers. The research uses the following definition for *environmental procurement*:

> is the consideration *of environmental 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 running, maintaining and managing the organisations primary and support activities *in exchange for financial means* provide *economic* and *non-economic* value for this organisation and *environmental* value for other stakeholders.

This definition is an adaptation of Miemczyk's *et al.* (2012) definition on *sustainable* procurement which again was based on definitions of Van Weele (2010) and the Brundtland report (1987). This research additionally incorporates the aspect of *financial means* to delineate procurement activities from non-financial adoption, pre-procurement activities, or partnering or network activities (such as knowledge exchange, or creating joint-ventures). Put briefly: procurement activities will result in an invoice from a supplier (Telgen, 1994). A more popular synonym for "environmental procurement" would be "green procurement" as is also used by the European Union (2011).

Procurement activities lead to procurement performance. In line with Hartmann (2007) and Bos (2010), this research defines *procurement performance* as (1) a change in process performance (i.e. while managing activities in a procurement process) and (2) a change in output performance: i.e. realising *economic firm benefits* (e.g. cost price as a % of sales), realizing *non-economic firm benefits* (e.g. on quality, logistics, exclusivity) and *realising (firm or non-firm) environmental benefits* (for stakeholders: suppliers, employees, society).

2.2 On definitions for innovation and innovation performance

In her research Hardie (2011, p.33) defined an innovation *as an improvement in functionality performance as perceived by the owner of the firm*. The OECD manual described a *technological product innovation* as the implementation and commercialisation of a product with improved characteristics such as to deliver objectively new or improved services to the customer (OECD, 2005).

In this research the focal firm procures innovations and additionally adds value through its own innovation activities. This research hence uses the term *innovation* in three different meanings. The firm's perception of *innovation* relates to (1) an input (from suppliers), (2) a process (internally and with external parties), and (3) an output (for customers and stakeholders).

This *increase in functionality* relates to *technology* or *technical* aspects which can both be seen in *product* and *process* innovations (OECD, 2005, p. 47-49). A *product* innovation is the introduction of a good or a service that is new or significantly improved. A *process* innovation is the implementation of a new or significantly improved production or delivery method. The research focusses on procurement and development of product innovations, which downstream can be used as process innovations.

For this research three further definitions on innovations are relevant:

(1) Innovation is the process through which firms seek to *acquire* and *build upon* their distinctive technological competence, understood as the set of resources a firm possesses and the way in which these are transformed by innovative capabilities (Tidd & Bessant, 2009).

(2) Innovation is the *tool of entrepreneurs*, the means by which they exploit change as an opportunity for a different business or service (Drucker, 1985).
(3) Innovation is the actual use of *nontrivial 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, 1998, 2000).

The innovation objectives are improved results in environmental and economic terms. This research combines the above three definitions and the Hardie definition (2011, p. 33). For this research the focal firm when *innovating*:

> procures technical product or process innovation(s), and through innovation activities is able to produce and commercialise (implement) a *step-change* technical product innovation with significantly improved or new functional performance in economic and environmental terms.

The research focuses on the "step-change" innovations, and excludes incremental innovations or improvements. Hence this research focuses on technical innovations with a higher degree of newness, risks and uncertainties (c.f. Holahan *et al.*, 2014, p. 332). It hence either relates (Slaughter, 2000) to a higher degree of changes in linkages (that is the number of stakeholders involved), or a to higher degree of changes in technology concepts (that is the number of changes of technology or technology components). This is visualised in Figure 2 below.

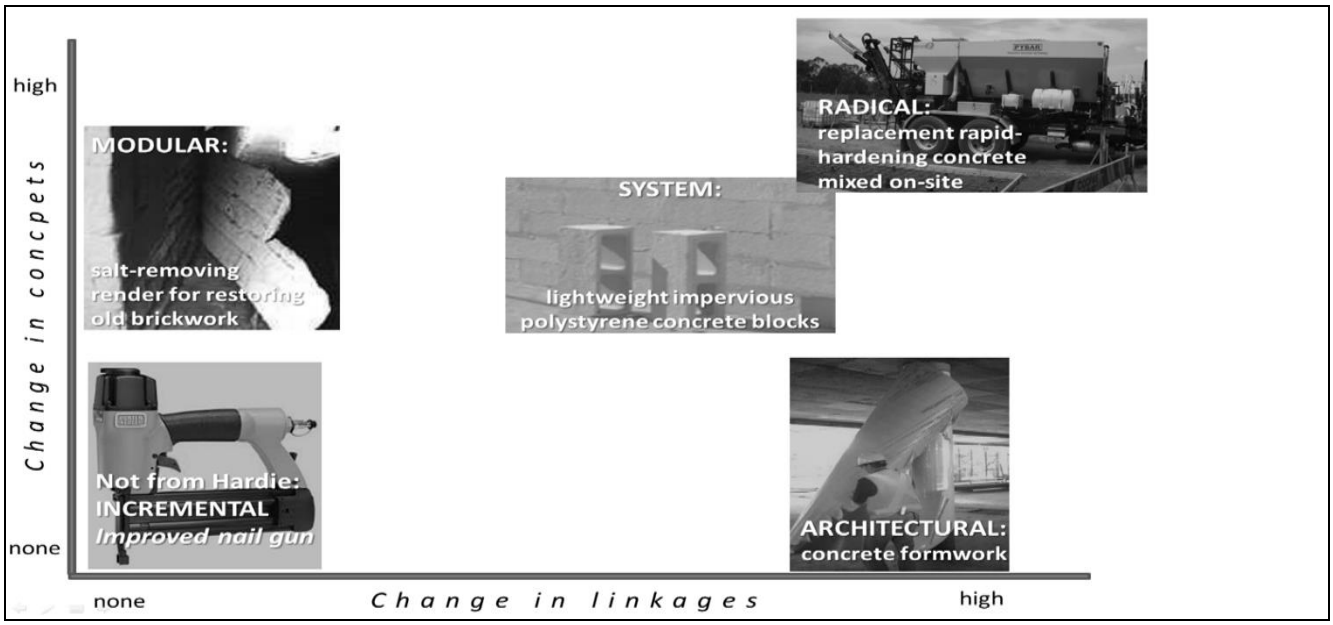

Fig. 2. Construction innovation typology as used in Hardie (2011) and based on Slaughter (2000)

In line with seminal work of Henderson & Clark (1990, p. 12), incremental innovations and improvements must be seen as *reinforcing* the current status whereas the step-change innovation of this research will *change* the current status of either technology (concepts) or actors or firms (linkages). Slaughter (1998, 2000; see Table 1) saw a relationship between the types of innovation and supplier involvement. Slaughter (2000, p. 4-13) suggested a relationship between the type of innovation, the phase of implementation and the type of company. She suggested that contractors may be good sources for *architectural* and *system* innovations, whereas suppliers may be good sources for *modular* innovations. *Radical* innovations will often originate from R&D or engineering research. Wynstra & Pierick (2000, p. 51) discussed that such relationships will depend the development risk versus the responsibility held by the supplier. Similarly, Cousins (2002) discussed that such relationships will change with the level of trust (confidence) in the supplier versus the level of dependency, whereas Kraljics (1983) discussed that such relationships will depend on the economic balance of power and the availability of alternatives.

Mlecnik (2013) adopted the Slaughter taxonomy in his research on 2nd tier SME suppliers on construction innovation (Table 1). His research found that innovative suppliers (in his case suppliers of main contractors) have a broader vision on innovation and use a wide network in the construction chain. Such suppliers can for instance start with what seems an incremental innovation but through collaboration with other players change this into a step-change innovation (Mlecnik, 2013, p. 109).
The related construct *innovation performance* relates to (1) managing innovation activities (processes) in several innovation phases, and (2) the change in output performance with the product innovation. This performance relates to realising financial firm benefits (e.g. cost price as a % of sales), realizing non-financial firm benefits (e.g. quality, logistics, flexibility, use of material & energy, market share, brand image), and realising non-firm environmental benefits (for stakeholders: suppliers, society, employees). This reasoning is in line with the OECD manual (2008, p. 46 and p. 108) and Cooper (2012).

Table 1. Categories of construction innovation (Mlecnik, 2013, p. 106) based on Slaughter (1998; p. 228-230)

	impacts	source	phase
Incremental	Improvement of current practice; minimal impact of components & systems	Companies with knowledge base (can be all parties in SC)	Any time
Modular	Significant improvement in concept; no changes in other components or systems	Companies responsible for a module, or new entrants	Design / selection
Architec-tural	Small improvement on concept; major change on other component or systems	In the field (eg general or specialty contractors)	Design to implementation
System	Complementary innovations with new attributes	Companies with no vested interests; coordinators	Conceptual design
Radical	Completely new concept; often renders a previous concept obsolete	Outside existing industry; based on R&D; new venture	Technical feasibility

2.3 Technology and intellectual property
The innovation definition mentioned above in $2.3 relates to technology. This research focuses on *technical, technological,* or *technology* innovations. These terms seem to be used somewhat interchangeable to denote the same constructs. Hardie (2011, p. 33) uses the phrase "*technical* innovations with significantly improved functional performance". Afuah (2003), BRANZ (2014) and OECD (2005, 2010b) use the phrase "*technological* innovation". Sexton & Barret for example use the phrase "*technology* innovation".
In general the adjective "*technical*" is defined by the Merriam-Webster dictionary as "the *practical use* of machines or science in industry". The adjective "*technological*" is defined by Merriam-Webster as "relating to technology; resulting from improvements in technical processes that increase productivity of machines". The Merriam-Webster dictionary defines *technology* as "the *use* of science in industry, engineering, etc., to invent useful things or to solve problems, or a machine, piece of equipment or method that is created by technology". Following this reasoning, this would include innovations out of research & development (R&D). In extant research the term "*technology*" furthermore seems to relates to intangible assets *per sé*, hence the focal firm (see Figure 1) can procure know-how, prototypes, and intellectual property rights such as patents, trademarks or software (OECD, 2005). Others (Afuah, 2003) see a broader scope in that it also focuses on innovations that *apply* such intangibles for solving technical problems. Hence the focal firm can also procure (see Figure 1) innovative components or raw materials, or ready-to-sell innovative products. These need not originate from science or from R&D.
This research hence has a slight preference for the phrase "technical innovations". It focuses on procurement of *technical product or process* innovations which the focal firm (via innovation processes) then transforms into a step-change *technical product* innovation for its customers.
A well-established means to protect technical innovations is using patents and other forms of intellectual property such as trade secrets, copyrights, brands, trademarks or database protection (Jell, 2011). Holgesson (2012) found that small or entrepreneurial firms use patents to attract financial means and customers and less for protection. In the New Zealand context Deakins (2013) found that patenting can be a good albeit expensive and imperfect strategy for small innovative firms. In their research Manley (2008) and Hardie

(2011) found that a large part of innovative construction small firms (subcontractors and manufacturers) use patents as a means of protecting their technical innovations. (In a survey among innovative small firms Hardie (2011, p. 107) found that 67% of innovations had been patented). Koebel (2008, p. 47) saw patenting relevant for (3rd and 2nd tier) manufacturing and supplying firms but not for innovative home builders as they could not extract value from their suppliers' patents. Brochner (2013) concluded that patents are relevant for small construction service firms in industry-university R&D interactions and for their intellectual property strategies.
A search in the online database of Espacenet[1] and IPONZ revealed approximately 100 New Zealand patent owners (patentees) with national construction patents but *also* with related patents in Europe or the United States. The existence of such European and US patents indicate that these patent owners are prepared to invest (or have invested) in their patents. Furthermore (following e.g. reasoning of Holgersson, 2012) such patent owners see commercial or strategic value in their patented innovations and their related complementary assets (e.g. Burgelman *et al.*, 2009, p. 33). At the same time the two patent databases revealed approximately 100 European or American patent owners with valid construction patents in New Zealand. This would indicate that overseas companies see commercial potential for their patented innovations. A broader patent search indicated 300 New Zealand construction patents filed abroad, and 700 foreign construction patents filed in New Zealand. However as is generally the case, these patents may commercially be less relevant, allowed to lapse or declared invalid. Espacenet indicated that 45 of these (1000) patents were explicitly related to climate change, but probably more will have a (intended) positive environmental impact.

2.4 Networks and collaboration
It must be noted that technology protection is not the only strategy that firms use although the above discussion shows it can be an important one. Firms can also use their upstream networks of suppliers and their downstream networks of customers to create an environmental value proposition (Gambatese, 2011, p. 508; Treacy & Wiersema, 1997; OECD, 2010a). Finally firms can use marketing strategies like early-time-to-market or joint innovation strategies with customers (Fairweather, 2010) to gain a competitive advantage. In all these instances upstream and downstream networking and collaboration capacities are crucial for successful innovations. (e.g. Chesbrough, 2004; Gronum *et al.*, 2012; De Jong, 2005).
In this respect it should be noted that the simplified construction supply chain of Figure 1 actually relates to a dynamic network with potential partners and suppliers, rather than a static one. Additionally Fig. 1 shows a simplified innovation-related network. The total network of a focal firm from distant (loose) end-customers to distant (loose) 4th or 5th tier suppliers could easily include tens to hundreds of existing and potential network partners (De Jong, 2005). This research will only investigate procurement activities with current or potential 3rd tier suppliers.

2.5 New Zealand innovative firms supplying the construction industry – the unit of analysis
This research focuses on innovative firms within the context of the construction industry. In the New Zealand context, such firms are relatively large (probably between 6 – 150 employees) and will have entrepreneurial traits. Literature interchangeably uses terms such as *entrepreneurs*, *small firms, small business*, *small company* or *SMEs,* and definitions vary over countries or regions. According to the New Zealand definition, SMEs have between 1 – 19 employees and are also called *small businesses* or *small enterprises* (www.stats.govt.nz). European Union (2003/361) defines SMEs as autonomous companies that have less than 250 employees. This paper prefers to use the term SME (or SMEs) and for an international comparison follows the European definition. In these focal firms separated innovation and procurement activities can be discerned.

[1] www.espacenet.com; www.iponz.co.nz. Brief patent search in IPC-class E04, with NZ priorities or Non-NZ priorities. (Data 20 May 2013; updated 28 February 2015). See also Brochner (2013 p. 415, p. 417) for technology classifications (IP & US classes). Espacenet uses classes Y02 & Y04 for 'climate change' patents.

The Australian and New Zealand Standard Industrial Classifications (ANZSIC) distinguishes (MBIE, 2015) between *construction firms*[2] or *firms supplying* to such construction firms. The focus of this research (Fig 1) is on the latter category and ANZSIC defines such firms as providing services (engineers and architects) or conducting "manufacture, wholesaling and retailing of construction materials".
In general 92% of construction firms in New Zealand are micro firms and have less than 5 employees (Page, 2013, p. 16). They will work on smaller construction projects. Firms with more than 5 employees are more often involved in bigger or more complex construction projects (Fairweather, 2009). Micro firms will probably not be innovative and if they are, it will be difficult to distinguish procurement from innovation activities. This means that the research focusses on the remaining 8% of firms working in the construction industry.
The research focusses on innovative firms and as stated earlier these firms will have entrepreneurial characteristics. However, only a minority of entrepreneurial firms will have a sustained entrepreneurial orientation *and* also create substantial growth. An international OECD study (2010a, p. 24) found that high-growth enterprises account for 2% to 8% of the total firm population. Keijzers & Bos (2006, p. 28) were somewhat milder in stating that although only 2% of (Dutch) SMEs can be considered innovative front-runners conducting own R&D another 28% can be seen as innovation adopters. Still they found that 60% of SMEs do not have innovation as part of their business.
When taking into account (1) New Zealand's moderate position in the Global Innovative Index (Cornell, 2015) and (2) the relative low innovation rate in construction industry (e.g. Page, 2011) the percentage of innovative firms in the New Zealand construction could be lower. From a quantitative international comparison of entrepreneurship and performance Frederik & Monsen (2011; p. 202) concluded that "current Kiwi *entrepreneurial disequilibrium* of high entrepreneurial activity but lower economic development comes from a singular constellations of events that disfavour *creative destruction* in the Schumpeterian sense" (original italics from the authors). They found that that several macro factors (e.g. lack of adequate governmental interventions) hindered the creation of wealth from entrepreneurial activities. Deakins (2013, p. 3) cited a New Zealand treasury report stating that competitive forces are generally relatively low due to the size of the domestic market (Deakins, ibid). Following the reasoning of Schumpeter (1942) this would imply low innovation or improvement rates. This however would contradict general opinion that 2nd tier construction firms experience fierce competition on lowest-price contracts (e.g. Bemelmans, 2012; Hinton, 2013). When using 2010 New Zealand Statistics data Deakins concluded that a lack of investment in business R&D hindered adoption of innovations. Rinne & Fairweather (2011, p. 77) concluded that cultural attitudes like the tally-poppy-syndrome, individualism and a focus on lifestyle can limit implementation of innovation. Basnet *et al*. (2010, p. 476, 480) found similar inhibitors for supply chain management in New Zealand and for example mentioned: limited knowledge, independent managerial mindset, uncompetitive local market, and small organisation size.
For defining entrepreneurs the OECD (2010a, p. 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 (2003, as cited in Hardie, 2011, p. 29) also linked entrepreneurship to innovation and defined this as an activity that "involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services as not previously achieved". Entrepreneurship will include characteristics of *pro-active to innovation and risk, competitive aggressiveness, autonomy opportunity recognition, growth ambitions, and organisational learning* (Lumpkin & Dess; 1996), as used in Zortea, 2012, p. 147-148) to which this research adds *a longer term vision on how to achieve this growth* (e.g. based on Burns, 2001). It can be expected that such firms will be members of industry associations that foster or stimulate entrepreneurship. In the context of this research such associations could for example be PrefabNZ or New Zealand Green Building Council (NZGBC).

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

As argued above, micro firms with less than 6 employees probably have too simplistic structures (Meijaard *et al.*, 2005). This research *à priori* does not exclude firms with more than 150 employees although (a) in the New Zealand context these firms will probably behave as mature and large firms, and (b) the theory of innovation and procurement activities for such firms has been more developed. Although Koebel & Cavell (2006) concluded otherwise it is also expected that such larger firms have a less distinct entrepreneurial and innovative approach (see e.g. Verreynne & Meyer, 2010). This is supported by an OECD report (2010, p. 16) that found that small firms *(AS: probably with less than 100 employees)* are more active than large firms in "breakthrough innovations […] not just as knowledge exploiters but also as knowledge sources".
In conclusion, this research has a unit-of-analysis of innovative firms supplying the construction industry with a minimum of 6 and a maximum of 150 employees.

3. Gap in extant research

The literature review reveals *a lack of knowledge on New Zealand innovative firms procuring step-change environmental technical innovations with the intent of supplying the construction industry.* In more detail it is unclear:

(1) What interacting procurement activities such firms conduct when they innovate and procure innovations.
(2) How such firms react (deal with) or use external variables in managing these interactions.
(3) How firms deal with the variables of the innovations in managing these interactions.
(4) How such firms use their variables (characteristics) in managing these interactions.
(5) What the procurement performance is as result of these interactions.
(6) What the innovation performance is as a result of these interactions.
(7) What the combined firm performance is as a result of these interactions.

There is a considerable research gap on how procurement activities interact with innovation activities and literature mentions a wide number of (potentially dominant) variables that can affect such activities. Hence the industry practice of the focal firms can also exhibit a variety in such interaction activities. This research will be able to identify firm performance from such interacting activities, but seeing the state of the current extant research, will *not* be able to generate best practices for the industry.

4. Conceptual framework and variables

The conceptual framework for this research (Figure 3) shows two (dependant) constructs of interacting procurement activities (1a) and (internal and external) innovation activities (1b) of the innovative New Zealand firm. It furthermore shows clusters of variables and performance indicators found in extant literature which for the sake of brevity are not discussed in this paper. (These can be found in Figure 3).
The procurement activities and innovation activities will lead to interdependent procurement performance (5a) and innovation performance (5b). The resulting entrepreneurial firm performance (6) is the dependant construct. These constructs are affected by five (extraneous) constructs which describe the firm's macro (2a) and meso (2b) environment, the characteristics of the innovation (3), the characteristics of the owner and the innovative firm (4a), and the firm's strategy and business model (4b). The dotted squares around some constructs indicate possible relationships that will be tested early in the empirical research. These relationships follow reasoning of the holistic and integrated nature of the firm and thinking of the entrepreneur (Hagelaar *et al.*, 2014). However, as this research wants to examine the *interaction* between procurement (1a) and innovation (1b) activities and the effects of several extraneous variables, it *à priori* wants to separate constructs. Furthermore, as this research wants to determine (isolate) value-adding procurement activities, it also wants to distinguish the performance types (5a, 5b, 6).
For classifying the procurement activities (1a) this research analysed the validated procurement process framework of Van Weele (1988, 2010), which is used extensively in industry and for example also used in Pressey *et al.* (2009) in his SME research. It is also used in a recent text book (Johnson *et al.* (2014) for sustainable procurement. For simplicity reasons this research proposes the modified (4 phase) framework as used by Pressey *et al.* (2009) and by Staal & Walhof (2015) which combines the three post-contractual

phases into one phase for managing the supplier relations. It must be noted that these phases need not follow a strict-step approach starting with *specifying wants* and ending with *managing suppliers*. The procurement phases can be iterative. For example in line with best value procurement thinking, the focal firm could start with selecting a trustworthy supplier and proceed from there (Kashiwagi, 2002).
For classifying the (internal and external) innovation activities (1b) this research analysed several classification methods (Slaughter, 2000, p. 4; Rogers, 1970; Gambatese & Hallowell and Cooper & Kleinschmidt, 2001; p. 40). It proposes the validated framework stage-gate process of Cooper & Kleinschmidt (ibid). In his later work Cooper (2013, p. 3-4) emphasised that his stage-gate process need not only focus on financial estimates but also on qualitative (subjective) measures. Especially with step-change innovations and within SMEs the process phases of both frameworks will most likely not follow a linear or sequential pattern but may be "iterative and messy" (Compare Sexton & Barrett, 2003, p. 630; compare also Bocken *et al.*, 2014).

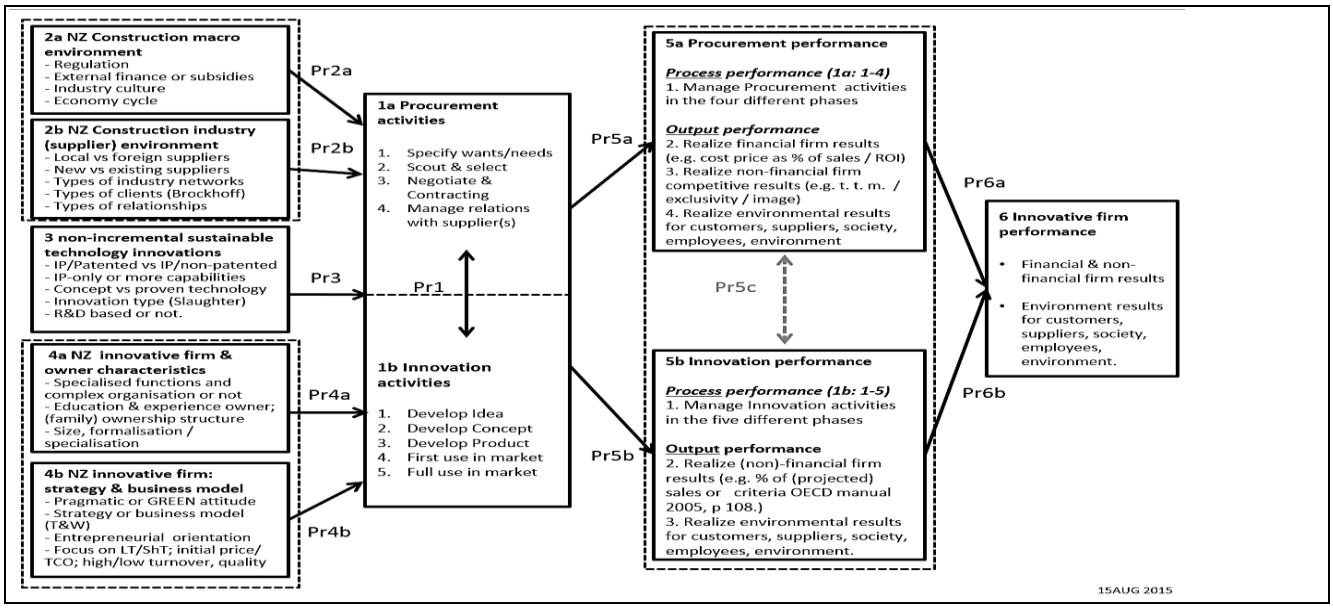

Fig. 3. Conceptual framework, with variables (2a-4b) and performance indicators (5a, 5b, 6) found in literature

Both frameworks are on a sufficient high level to account for informal and iterating procurement and innovation activities *interacting* within innovative firms (Table 3 below). During the empirical research the phases of both frameworks can be modified or subdivided into several sub-phases. Koen *et al.* (2001) for example developed an innovation process model for the "fuzzy" (i.e. unstructured and with high-uncertainties) ideation phase into five sub-phases. (See also Philips *et al.*, 2006). In Hagelaar *et al.* (2015) the four procurement process phases were subdivided into eight phases for a better apprehension of procurement in small firms. Hence the empirical research starts with high-level process phases and in the empery can adjust accordingly.

Table 3. Interaction matrix on possible innovation activities (*vertical*) & procurement activities (*horizontal*)

	Specify wants or needs	Scout & Select suppliers	Negotiate contracts	Manage supplier relations
Ideation				
Concept				
Develop product				
First use in market				
Full use in market				

The phrase "interaction" in this research is broadly defined as an *interactive* process (that is a set of interactive activities) between procurement and innovation. This "*interaction*" implies collaborative activities and interdependencies for ultimate firm performance and would imply "involvement" which Wynstra (1998, 2004) described as joint *prioritising, mobilising, co-ordinating, and timing.* This PhD research would add the aspect of *joint decision making* as one of the key aspects of management. Similar phrases found in other research include the "*role*" or "*involvement*" of procurement (Johnsen, 2012). Others used "*contribution*" of procurement (e.g. Hartmann, 2007) when relating to the outcome of such involvement. Van Echtelt (2004, p. 10, p. 28) used the phrase "*effective integration*" when discussing multi-functional project teams in large organisations consisting of both procurement and innovation experts. This PhD research prefers the phrase *interaction* (and related phrases like *interactive* or *interacting*) as it à priori implies a more equal process (with regards to activities, interdependencies and output) than the single-sided dependency in phrases such as "involvement" or "contribution".

5. Research question and objectives of this research

The overarching research question is: *How do innovative New Zealand firms procure environmental step-change technical innovations for the construction industry?* Related research objectives are to:

(1) Determine how procurement activities and innovation activities (i.e. related to environmental step-change technical innovations) interact within the focal firms.
(2) Determine the effects of dominant (internal and external) variables with said interactions.
(3) Determine dominant procurement activities in economic and environmental terms (within the focal firms) when interacting with innovation activities.
(4) Develop & communicate new insights to the firms and other participants involved in this research, and via academic journals or conferences. Provide recommendations on further research.

6. On the research design

Answering the research questions in the previous Section would need exploratory, descriptive and to a limited extent explanatory research (Kumar, 2005) and hence need a qualitative and flexible research design. "Beauty is in the eye of the beholder" (Hungerford, 1855-1897). In part the researched phenomena are social constructs i.e. subjective and individual perceptions and social interactions (e.g. Zhou *et al.*, 2014, p. 138). Interpreting these will develop subjective meaning and knowledge. This relates both to the perceptions of dominant variables and the perceptions of performance.

Variables. The appreciation (see also Vickers, 2010) whether an innovation is indeed a *step-change environmental innovation* will vary with the *position* in the construction supply chain and the *particular interests* of stakeholders. This appreciation will also vary with *time* and with the *geographical place* or *specific industry*. For the stakeholders involved in this research *step-change* will be related to their perception of *non-trivial change.*

Performance. Innovation or procurement activities will lead to value via innovation or procurement performance. This value may relate to economic or environmental performance. Such performance can have *a realised value* or a *potential value* which is not yet or ultimately will not be realised. Similarly, a value may have been realised in other New Zealand industries or in overseas construction industries, but not (yet) within the context of the New Zealand construction industry. This research will comprehend such value from the position of the focal firm, its suppliers, and its customers and other stakeholders, taking into account these aspects of time, industry and geographical position. The perceived added-value within the three performance constructs will hence be measured via qualitative and subjective means (Rose & Manley, 2012, 2014).

In brief, the research uses the following methods:

(1) Ongoing literature review, exploring interviews and collaboration with researchers on closely related research questions. This will enable the researcher to continually contrast and compare his findings in order to develop his knowledge on the research topic and design.
(2) Two rounds of explorative and descriptive multiple case studies (Eisenhardt, 1989). The first round will use classic case study methodology. The second round could also include elements of action research

(Seuring, 2008). This will enable the researcher to generate findings on dominant variables and dominant procurement activities.

(3) Two rounds of research world café sessions (Schiele, 2012). This collaborative focus method (Latham, 2008) is based on the world café of Tan & Brown (2005) It differs from traditional focus group methods[3] as academics and practitioners both have the role of co-researchers and both generate, refine and test knowledge (Schiele, 2014). This will enable the researcher to better appreciate the complexity of the subject matter and to strengthen and validate his findings.

The two rounds of case studies and two research world café sessions will be conducted in alternating rounds. In line with Eisenhardt (1989) as cited in Manley (2008), it is expected that two rounds totalling 6 - 10 case studies will suffice to obtain sufficient rich data with effective cross comparison. Hoffmann (2011) and Schiele (2014) find that the research world café sessions each need 10 - 15 participants. Depending on the intermediate research outcomes, the 2nd round of case studies could be replaced or supplemented by a survey. Likewise the 2nd round of world café sessions could be designed differently. The selection of participants and case study companies will be done carefully to fit the research objectives and safeguard the validity (Dubois & Araujo; 2007; Swanborn, 2010).

7. In conclusion

(1) This research wants to increase knowledge on the role of procurement in innovative New Zealand firms supplying the construction industry when procuring step-change environmental technical innovations. It has established a knowledge gap in extant literature.

(2) To bridge this gap this paper has developed a conceptual framework with dominant variables which will be tested in empirical research.

(3) The empirical research exploring interviews, two rounds of case studies alternating with two world research cafés sessions (round-table discussions).

(4) By nature of the research problem, this research is explorative, descriptive and to a limited extend explanatory. The research will increase the understanding of procurement during innovation activities and the resulting firm performance from such activities, but seeing the state of the current extant research and contingencies, will *not* be able to generate best practices for the industry.

(5) The research outcomes will be beneficial to innovating construction firms and their business partners, to owners and occupants of buildings, and to the wider environment. Hence it has a scientific and business relevance, and a social and environmental relevance.

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[3] This research will use the term "*round-table discussions*" to adhere closer to participants' expectations.

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