An investigation into sub-sector productivity: The New Zealand residential construction industry

A thesis by Mark Kirby

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Abstract

Despite sustained investment, the New Zealand (NZ) residential construction sector exhibits a persistent productivity paradox, constrained by systemic challenges and an estimated annual cost of NZD 2.5 billion attributed to defects and rework. The extant literature exhibits a conceptual divergence, treating quality management (QM) and construction productivity as fragmented. Although seemingly aligned, theoretical foundations and practical approaches are distinct, thereby hindering the development of a holistic solution. This thesis addresses this oversight by rigorously investigating what effect QM has on enhancing productivity in the New Zealand residential construction sub-sector.

Employing a sequential explanatory mixed-methods design, the study utilised an initial survey (N = 106) to empirically rank productivity factors, followed by a diagnostic application of the Theory of Constraints (TOC) model. Quantitative findings were subsequently validated through qualitative semi-structured expert interviews (N=15).

The TOC analysis demonstrated that poor QM is the singular non-physical bottleneck limiting productivity and restricting the system's capacity, driven by an endemic culture that "hyper normalises substandard practices." The analysis establishes QM not as a contributory factor but as the root cause constraint. The study's primary contribution is the development of a synthesised evidence-based QM strategy, (HEM) that resolves the conceptual divergence and provides a framework for sustainable performance.

The research culminates in a proposal for a National Construction, Productivity and Quality Commission (NCPQC), offering policymakers a blueprint for institutionalising systemic national-level reform. The findings move productivity improvement from an aspiration to a viable societal goal, contributing significantly to New Zealand's economic resilience and societal well-being.

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Glossary

Abbreviations and Acronyms

LSS	-Lean Six Sigma
SS	-Six Sigma
TQM	-Total Quality Management
ISO9000	-International Standards for quality management
PDCA	-Plan Do Check Act
LCM	-Lean Construction Methods
CP	-Construction Productivity
TOC	-Theory of Constraints

Definitions of key concepts

This section clarifies the core terminology essential to understanding this thesis, providing precise definitions for key concepts. These definitions establish a shared lexicon, ensuring clarity and consistency in the subsequent chapters.

Universal management strategy:

In this context, a universal management strategy refers to a set of overarching principles, frameworks, or approaches that are posited to be applicable and practical across diverse organisational contexts, cultures, industries, and geographical locations, irrespective of operational or environmental variations. It implies a fundamental adaptability and relevance, suggesting that its core tenet can consistently drive desired outcomes. This suggests that its core principles can reliably lead to improved productivity, quality, and sustainability without requiring significant situational differences. Such a strategy is often characterised by its focus on fundamental human, process, or systemic elements that are believed to transcend specific situational differences, offering a consistent approach to leadership, resource allocation, and operational control.

Quality management:

In this context, it refers to a systematic process and a set of principles employed by an organisation to ensure that its products, services, and operational processes consistently meet or exceed defined quality standards and customer requirements. It aims to maintain a desired level of excellence through encompassing all activities, from planning and control to assurance and improvement. QM is fundamentally about embedding quality considerations throughout an organisation's functions to prevent defects, reduce waste, and continuously enhance overall effectiveness, rather than merely inspecting for quality at the end of a process.

Construction productivity:

In this context, it refers to the efficiency with which inputs (such as labour, materials, equipment, and capital) are converted into outputs (completed construction works or components) within the construction industry**.** It is fundamentally a measure of output relative to input, typically expressed as a ratio (e.g., cubic meters of concrete poured per labour hour, square meters built per week). Enhanced construction productivity implies achieving more output with the same or fewer inputs, or the same output in less time with the same inputs, directly impacting project cost, duration, and overall profitability. It is influenced by a complex interplay of factors, including planning, technology, management practices, labour skills, environmental conditions and culture.

Productivity growth:

Productivity growth, within the context of this research, refers to the sustained increase in the efficiency of converting inputs into outputs over a defined period within the New Zealand residential construction sector. It signifies an improvement in how effectively labour, materials, equipment, and capital are utilised to deliver completed residential projects, leading to greater output per unit of input. In this research, the strategic implementation of quality management principles and practices is directly linked to productivity growth.

Strategic quality management:

In the context of this study, it refers to a holistic and proactive approach to quality that integrates quality principles and practices directly into an organisation's overall strategic planning, decision-making, and operational processes. It moves beyond reactive defect detection or compliance-based tick boxes and establishes QM as a fundamental organisational advantage and a key driver for achieving long-term organisational goals.

The concept of a "strong quality culture":

Cultural contingency is the thesis's foundational claim that organisational culture is the single most critical antecedent condition for the effectiveness of a QM system in the NZ residential sector. It argues that cultural alignment is not merely an important factor (as ISO suggests and TQM philosophises) but a necessary precursor condition that must be satisfied before QMS implementation (structure) can succeed. The contingency element is the outcome (sustainable productivity gains from QM) that is contingent on the existence of a "strong quality culture." Without it system progress will be non-effective. The HEMs cultural contingency adapts classical contingency theory by elevating organisational culture form a situational variable to the dominant, necessary precursor constraint that must be resolved before system deployment.

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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 where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated, and referenced, along with the purpose of use), nor 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."

Name: Mark Kirby Signed: Date: 26/6/2025

Co-authored works and declaration of collaboration

Statement from co-authors confirming the authorship contribution of the PhD candidate:

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Featured article – The Property Foundation

The published manuscript, "A multidimensional analysis of strategies for improving New Zealand residential construction productivity," was featured in the Property Foundation's February 2025 industry newsletter and highlighted on their LinkedIn page, signifying its industry recognition.

The Property Foundation, (2025). New Strategies for improving productivity in residential construction. *The Property Foundation February Newsletter.*https://mailchi.mp/4d0cb03bbd98/the-property-foundation-is-moving-forward-12736710

Chapter 1

Introduction

Overview

This foundational chapter is designed to orient the reader, mapping the scholarly progression of this thesis. It systematically presents the research structure and chosen methodology, starting with an overview of the study and an explanation of the adopted approaches. Furthermore, the chapter establishes a crucial contextual understanding through a critical review of prior empirical studies and identifies areas where knowledge remains incomplete.

The identified gap helps formulate the research problem and demonstrate the study's importance and rationale in local and international settings. Thereafter, the chapter delineates the research aim, objectives, scope, ethical considerations, and overall thesis structure. This structure is designed to ensure a clear and logical progression, allowing the research to effectively address the identified problem and contribute to the existing body of knowledge.

1.2 Study background

Why, despite technological advancements and increased investment, does the construction industry continue to grapple with persistent productivity challenges? This question lies at the heart of a global concern, as the construction industry, a cornerstone of economic development, faces a stark reality. Productivity growth has averaged only 1% annually over the past two decades, significantly lagging behind world economies at 2.8% and manufacturing's 3.6% (McKinsey Global Institute, 2020) impacting project costs, timelines, and efficiency. An alarming statistic that highlights the urgent need to address persistently low construction productivity worldwide (Alaloul et al., 2021). This productivity stagnation is a global concern; however, its severity is disproportionately felt in smaller, fragmented economies where market levers for innovation are limited (OECD, 2023). The challenges identified, such as ageing workforces and low technological adoption are endemic, but the speed of New Zealand’s decline relative to other OECD peers necessitates context specific analysis. Hence, poor productivity is not merely an operational issue; it has cascading effects on societal living standards, housing affordability, and national economies (Alaloul et al., 2021; Martin, 2021; Mischke et al., 2024 p.17).

Systemic challenges characterising the sector inhibit productivity and overall performance. These include a demographic shift marked by an ageing workforce (Australian Constructors Association, 2023; Farmer, 2016) and a deficit in skilled labour resources (Kakitahi et al., 2014; Mustajab & Irawan, 2023). Moreover, there are decreased rates of technological integration (Chowdhury et al., 2019; Egwim et al., 2023), suboptimal procurement, and problematic contractual modalities (Australian Constructors Association, 2023; Helmold, 2023). Furthermore, poor quality, cultural and regulatory nuances regarding protracted consenting processes and a change-resistant industry approach impede industry progress (Elsokhn & Ezeldin, 2022; Vishe, 2024). Nations like Singapore and Hong Kong have offset labour deficits through targeted offsite and prefabrication initiatives (Tam & Hao, 2014). Conversely, the New Zealand residential construction sector is confined by market size, and a profile dominated by micro organisations (Seadon and Tookey, 2019), inhibiting the scalability of industrialised solutions. Notably, these problems persist despite advancements in technological fields, ongoing scholarly inquiry, and the implementation of regulatory policies (Farmer, 2016). Like other nations, New Zealand's construction sector is not immune to these issues.

Reflecting the global landscape, the New Zealand construction sector is crucial to the nation's economy and social well-being, yet it struggles with similar systemic challenges that inhibit productivity and overall performance (Ministry for Building and Construction, 2024). This sector, characterised by mainly change-resistant micro organisations (Seadon & Tookey, 2019), significantly boosts the performance of other industries (Ministry of Business, Innovation & Employment, 2024), creating a beneficial ripple effect. It plays a significant role in the Gross Domestic Product (GDP), generating nearly NZD 100 billion in 2023 (Ministry for Building and Construction, 2024).

However, economic growth has been constrained, with some observers reporting weaker contributions to GDP since late 2022 (Ministry of Business, Innovation & Employment, 2024; Stats NZ, 2024). These recent limitations on economic development, coupled with the inherent challenges of the construction sector and its critical economic significance, highlight an urgent need for effective productivity improvement strategies. This research examines how quality management can strategically enhance productivity in residential construction.

New Zealand's construction productivity has been a growing concern despite its contributions to the industry (Ministry for Building and Construction, 2024; NZIER, 2023; Rosenberg, 2016). The country’s construction sector, particularly its residential segment, presents a complex, enduring and concerning picture of productivity. For instance, as far back as 2014, the New Zealand Productivity Commission report affirmed low productivity and productivity growth at the industry level (Conway et al., 2013). According to de Serres et al. (2014), the productivity issue is worsening, indicating that the disparity between New Zealand and countries with higher productivity is increasing. In 2017, The McKinsey Global Institute examined the root causes of poor productivity growth in New Zealand's construction sector, describing the issue as obstinate and problematic (McKinsey Global Institute, 2017). More recently, Statistics New Zealand further emphasised the enduring problem, confirming that construction productivity declined by 1.7%, and outputs increased by 2.1%. In comparison, labour inputs grew by 3.9%, indicating a persistent long-term trend of increasing labour input against declining hourly outputs. Equally concerning, the Ministry of Building and Construction recently indicated that productivity levels have remained unchanged for around 40 years (Ministry for Building and Construction, 2024). This longevity of stagnation, positioning New Zealand as a significant OECD outlier, suggests that standard policy and economic instruments have failed to address a unique systemic barrier within the New Zealand construction culture. Furthermore, distinguishing New Zealand’s productivity paradox from patterns observed in larger economies (OECD, 2024).

The New Zealand government strives to foster a sustainable construction sector defined by high performance, quality, productivity, and innovation. Hence**, s**ustainability remains a key focus in the New Zealand residential construction sector (Moshood et al., 2024). Conversely, New Zealand's residential construction sector faces notable challenges (BRANZ, 2021; Howden-Chapman et al., 2011; NZIER, 2023; Pricewaterhousecoopers, 2009). The industry faces criticism for generating significant waste, prompting calls to promote waste reduction strategies (Albsoul et al., 2025). Furthermore, for over two decades, the industry has faced consistent challenges in addressing a nationwide housing shortage, particularly in major urban areas (Chowdhury et al., 2019; NZIER, 2023).

Although the shortage has been reduced over time, primarily due to the effects of COVID-19, the sector faces considerable pressure to enhance productivity (NZIER, 2023). With a conservative estimate of a shortfall of around 20,000 dwellings each year, this sector is pivotal in mitigating the nation's acute housing deficit (NZIER, 2023; Ranchhod, 2024; Statistics New Zealand, 2024). For instance, in 2023, the population increased by approximately 145,000 individuals, suggesting the need for around 55,000 additional homes. However, the housing industry produced about 30,000 new homes during that period, highlighting the industry's inability to meet current and ongoing demand (Ranchhod, 2024).

However, existing research efforts have attempted to address the productivity challenges in the New Zealand construction sector, albeit with varying degrees of success. Numerous industry reports, governmental strategies, roadmaps, sector initiatives, frameworks, models and other scholarly efforts to enhance productivity, whilst significant, have remained aspirational at best

(Davis, 2007; Kane, 2012; McKinsey Global Institute, 2017; New Zealand Construction Sector Accord, 2023; New Zealand Productivity Commission, 2023; OECD, 2004, 2024). A confluence of systemic inefficiencies inherent in construction methodologies and the nature of the industry itself exacerbates a supply-demand housing disparity. These factors include a scarcity of skilled labour resources (Ministry of Business, Innovation & Employment, 2024) and a fragmented industry structure (New Zealand Construction Sector Accord, 2023). A demographic profile characterised by an ageing workforce (Ministry of Business, Innovation & Employment, 2024) and an industry profile overrepresented by micro organisations (Seadon & Tookey, 2019). Additionally, a regulatory and cultural environment, all of which contribute to pervasive project delays (Ministry for Building and Construction, 2024), higher material costs, thereby increasing housing affordability pressures (NZIER, 2023).

Compounding these challenges is the substantial economic burden attributable to poor quality (BRANZ, 2021; Love, 2002; Love et al., 2018; Mills et al., 2009). This underscores the critical need for robust quality management strategies, not merely as a reactive measure to address defects but as a proactive and strategic organisational approach to enhance overall productivity. For example, the "leaky building syndrome" has been thoroughly documented from the early 1990s to 2004, highlighting a prevalent problem with weather resistance attributed to inadequate quality, poor design and regulatory standards, subpar materials, and/or flawed construction practices. A 2009 government report estimated that the total cost to repair all leaky homes could reach around NZD 22.9 billion (Pricewaterhousecoopers, 2009) and continue to rise. This indicates significant economic waste and ongoing legacy costs, leading to societal inequalities significantly impacting older homeowners' retirement security and living standards (James et al., 2017; Mosley, 2025).

Another downstream effect of poor-quality housing is evident in societal health. Substandard housing is an enduring societal problem in New Zealand, and its impact on societal health is considerable (Dani et al., 2022; Howden-Chapman et al., 2012). A governmental study between 2018 and 2019 surveyed 12,000 households and found that 34% of New Zealand residents described their homes as occasionally or consistently damp. Meanwhile, 36% reported signs of mould in their residences, affirming the link to poor-quality housing (Riggs et al., 2021; Stats NZ, 2018). Additionally, the economic cost of poor health associated with poor quality housing is approximately NZD 145 million annually (Riggs et al., 2021).

Thus, the issue extends beyond just construction sites and organisational offices, affecting the overall well-being of New Zealanders and the nation's economic competitiveness.

However, economic comparisons highlight the potential benefits of improved quality management at the macro level, where countries with higher construction productivity often exhibit more rigorous quality control measures. Additionally, they offer a stronger emphasis on continuous improvement (OECD, 2022). In these contexts, quality management transcends mere compliance tools. It serves as a strategic instrument for boosting organisational efficiency and fostering innovation. Therefore, efficient quality management is a crucial factor affecting productivity. Globally, robust quality management systems have enhanced efficiency, reduced rework, and improved overall project outcomes (Gupta & Khitoliya, 2020; Juran & Godfrey, 1999; Lundkvist et al., 2014; Ruales Guzmán et al., 2019; Small et al., 2021). Conversely, the application and effectiveness of quality management in the New Zealand residential construction sector remain inconsistent. The New Zealand government's research arm (BRANZ) suggests poor quality in the residential construction sector costs the country some NZD 2.5 billion annually (BRANZ, 2021). This implies a reactive approach to managing quality in this sector rather than a more proactive, strategic approach. Poor quality leads to rework, delays, and increased resource use, which significantly hinders productivity and reduces the sector's capacity to deliver projects efficiently and cost-effectively. This may be due to the industry profile, which is predominantly comprised of smaller contractors who often lack the resources or expertise to implement formal quality management systems and processes effectively (Seadon & Tookey, 2019). A disparity that may contribute to poor quality, impacting overall sector productivity as contractors might often rely more on informal pragmatic approaches to quality improvement than formal quality systems, presenting a vast opportunity for organisational and industry-wide improvement (Kirby et al., 2024).

Moreover, previous research efforts in New Zealand have often focused on broader economic factors (Pricewaterhousecoopers, 2016; Riggs et al., 2021; Rosenberg, 2016) or specific operational challenges. For instance, labour shortages (Ministry of Business, Innovation & Employment, 2024), BIM modelling and offsite construction technology (Bakhtiarizadeh et al., 2021; Doan et al., 2020; Mostafa et al., 2018; Shahzad et al., 2023). Additionally, management strategies, productivity factors, models and frameworks (Ghodrati, et al., 2018; Seadon & Tookey, 2019), technology (Chowdhury et al., 2019) and other less holistic approaches. Although quality management is acknowledged as a contributor to improved productivity in academic literature, (Ruales Guzmán et al., 2019; Small et al., 2021) it is frequently overlooked in productivity studies as a primary improvement strategy.

In the context of quality management, existing research has primarily focused on quality assurance, quality systems, quality control, and implementing quality frameworks (Gupta &

Khitoliya, 2020; Han et al., 2023; Luo et al., 2022; Nguyen et al., 2023; Wali & Hamadameen, 2019). Although these efforts are essential, they often lack a comprehensive examination of the interplay between quality management and productivity. This oversight overlooks the importance of a comprehensive, multidimensional approach to quality management that encompasses all stakeholders within the construction process. Predominantly, empirical studies prioritise other factors, frequently examining them in isolation, thereby neglecting the potential of quality as an integrated, organisational strategy for enhancing overall efficiency (Anvari et al., 2013; Dixit et al., 2019; Hasan et al., 2018; Mittal et al., 2022; Nasir et al., 2016; Raj et al., 2023). A growing consensus is that a holistic, integrated approach is imperative to elevate construction productivity (Seadon & Tookey, 2019; Tillmann Böhme et al., 2018).

Furthermore, quality has been considered an isolated factor (Dixit et al., 2019: Seadon & Tookey 2019; Ghodrati et al., 2018). The topic has not yet been explored as part of a comprehensive organisational strategy aimed at enhancing construction productivity in New Zealand residential construction. Consequently, its strategic potential remains largely untapped. While quality has been identified as a contributory factor affecting productivity, it has rarely been explored as the primary approach to enhancing productivity within the New Zealand residential construction sector. This highlights the gap in the existing literature, the need for further research, and the organisational gap in the practical context. This gap is particularly evident in the New Zealand residential construction industry, where a holistic, organisational approach to QM is lacking.

This research is grounded in the Theory of Constraints (TOC), which offers a theoretical framework that increases its academic rigour and relevance. The Theory of Constraints posits that a limited set of critical constraints hinders an organisation's progress (Goldratt, 1984; Rahman, 1998; Vasudevan, 2021). Within the construction industry, poor quality management is a constraint impeding productivity; thus, coupled with the Theory of Constraints, it can improve quality and productivity by systematically addressing constraints (Vasudevan, 2021). The principles of the Theory of Constraints align with the focus of QM on identifying and eliminating bottlenecks and workflow obstacles that hinder quality and productivity.

Through this lens, the research seeks to fill this empirical gap. It aims to determine what effect quality management as a strategic approach has in improving construction productivity in the New Zealand residential sector. Crucially the existing literature reveals a conceptual divergence: while the two bodies of literature (QM and Productivity) are seemingly distinct, but fundamentally convergent, their theoretical foundations and practical applications remain distinct, prohibiting universal resolve. QM literature is often viewed in a holistic, systems-based context, whereas construction productivity studies rely on a fragmented, factor-based analysis (Kirby et al., 2024). This scholarly separation means that QM is consistently relegated to a peripheral, contributory factor, rather than being explored as the primary strategic organisational driver for enhancing productivity. This gap is particularly acute in the New Zealand residential construction sector, where a holistic system level diagnosis of the causal relationship between QM and productivity, a diagnosis that moves beyond mere correlation remains notably absent.

The knowledge gap indicates that, although numerous factors have been discussed in existing literature, quality is often acknowledged as a contributory factor in isolation and yet to be thoroughly examined within the broader strategic context of enhancing New Zealand's residential construction sector productivity. Therefore, this research aims to demonstrate that through construction organisations addressing quality management holistically at every stage of the construction process, improvements to productivity will be a by-product of effective quality management practices, highlighting a significant strategic shift in thinking regarding productivity improvement in the New Zealand residential construction sector.

1.2.1 Study contributions

The research is designed to yield contribution across both theory and practice:

- Theoretical contribution: The thesis resolves the conceptual divergence by empirically proving the causal relationship between QM and productivity through the application of the Theory of Constraints. Thus, establishing QM as the primary bottleneck limiting productivity in the New Zealand residential sector. This offers a new integrated theoretical framework for performance studies in fragmented construction sectors.
- Practical contribution: The findings provide the evidence-based solution necessary to transform the sector performance, culminating in the blueprint for a National Construction Productivity and Quality Commission (NCPQC) offering a strategic pathway for institutionalising sustainable reform.

1.3 Problem statement

Empirical evidence consistently demonstrates that the construction industry struggles with persistent global productivity challenges (Alaloul et al., 2021; Martin, 2021; McKinsey Global Institute, 2020). Despite this recognised crisis, QM has predominately viewed as a secondary contributary factor in performance studies (Dixit, 2021; Ghodrati et al., 2018; Nasir, 2013; Seadon & Tookey, 2019). Consequently its efficacy as a strategic organisational driver for enhancing overall productivity in the construction context remains systematically unverified in the academic literature, presenting a critical gap in knowledge.

The New Zealand residential construction sector is currently confronting a significant productivity paradox (New Zealand Productivity Commission, 2023; OECD, 2024). Despite sustained economic investment and persistent labour input, the sector's output remains suboptimal, as evidenced by its position among the lower echelons of productivity within the Organisation for Economic Co-operation and Development (OECD) economies (OECD, 2022, 2024).

This underperformance manifests in tangible challenges, including an acute housing deficit (NZIER, 2023), escalating construction costs, and frequent project delays. All of which impede the sector's capacity to meet the nation's growing demands (Ministry for Building and Construction, 2024; Ministry of Business, Innovation & Employment, 2024). The extant literature consistently emphasises the pivotal role of productivity in driving socioeconomic development (NZIER, 2023).

As Bahrami et al. (2017) articulated, the initial and most critical step in enhancing construction productivity is the comprehensive identification of its determinants (Green, 2016). At the same time, various factors influencing construction productivity have been extensively explored, including technological adoption, labour dynamics, and procurement practices (Dixit et al., 2019; Hasan et al., 2018; McKinsey Global Institute, 2017). However, the strategic role of quality management at the organisational level remains comparatively under-examined, particularly within the New Zealand residential context (Kirby et al., 2025a).

Although research frequently addresses surface-level issues like skill labour shortages and material expenses, the consequences of inadequate quality control are mostly overlooked (BRANZ, 2021; Kakitahi et al., 2014; Mustajab & Irawan, 2023). This neglect leads to a cycle of inefficiency that begins with frequent rework. Low quality causes defects requiring time-intensive and expensive corrections, ultimately obstructing productivity and worsening labour shortages (Bealing & Morel, 2020; BRANZ, 2021; Montague, 2018). Moreover, rising project costs exert considerable financial pressure on builders and homeowners, impacting housing affordability (NZIER, 2023).

Engaging in substandard work diverts skilled labour from participating in new initiatives, thereby exacerbating the existing skills gap. Furthermore, a reactive approach that emphasises rework restricts opportunities for innovation (Kirby et al., 2024). Evidence shows the industry finds it challenging to escape this cycle; therefore, strategically prioritising quality management within construction firms is essential (BRANZ, 2021). This strategy can reduce the need for rework and associated quality costs, improve resource allocation, and alleviate the inefficiencies linked to substandard quality. Ultimately, it contributes to a more productive and sustainable residential construction industry.

Although quality management is acknowledged as a contributory factor to productivity (Ruales Guzmán et al., 2019), it is often relegated to a secondary consideration in productivity research (Ghodrati et al., 2018; Hasan et al., 2018; Hwang et al., 2020; Nasir et al., 2016; Ofori et al., 2020; Seadon & Tookey, 2019). Studies predominantly focus on discrete factors, neglecting the potential of quality management as an integrated, holistic organisational strategy. Conversely, within the quality management domain, research has primarily concentrated on defect detection (BRANZ, 2021; Georgiou, 2010; Lundkvist et al., 2014; Mills et al., 2009; Park et al., 2012; Rotimi et al., 2015; Sandanayake, 2022). As well as the implementation of quality assurance systems, with limited emphasis on its strategic implications at the organisational level for productivity enhancement (Gupta & Khitoliya, 2020; Han et al., 2023; Luo et al., 2022; Nguyen et al., 2023; Wali & Hamadameen, 2019).

This research argues that the common perspective of quality management as a peripheral element coincides with a view of quality management as a set of activities. Thus, it fails to capture its potential as a strategic organisational driver for enhancing productivity. The economic burden of poor quality (BRANZ, 2021) and its downstream effects, encompassing rework, delays, long-term maintenance costs, and other societal implications, underscores the need for a more robust, systematic, and strategic approach to quality management (BRANZ, 2021; James et al., 2017; Mosley, 2025; Pricewaterhousecoopers, 2009).

Furthermore, the unique challenges faced by the New Zealand residential construction sector, including skilled labour shortages, ageing workforce, supply chain vulnerabilities, regulatory complexities, industry dynamics and political cycles, necessitate a context-specific examination of quality management efficacy. Enhancing productivity in construction offers numerous advantages. On a macro scale, better productivity can stimulate economic growth, reduce inflation, increase wages, and ultimately improve living standards in society (Shoar & Banaitis, 2019). Enhanced productivity at the micro level may reduce organisational costs, improve profits, enhance project performance, and address environmental factors such as embodied carbon and construction waste, all of which directly affect macro-level outputs (Hernández et al., 2023; Pricewaterhousecoopers, 2016; Tran & Tookey, 2011).

Therefore, the central problem addressed by this thesis is: **What effect does quality management have on enhancing New Zealand residential construction productivity?** This research explores the relationship between quality management practices and productivity outcomes. It aims to demonstrate that by strategically integrating quality management into organisational frameworks, productivity improvements will naturally emerge as a by-product of effective management.

Hence, this study offers important insights for policymakers, industry stakeholders, and researchers, thereby contributing to improving the efficiency, sustainability, and quality of the residential construction sector in New Zealand.

1.3.1 Justification for Explanatory Design

Aligned with empirical research (Bowen et al., 2017) this research commenced without a priori statistically testable hypothesis for a number of reasons. The methodological approach is strictly governed by a pragmatic worldview that justifies the use of an explanatory sequential mixed methods design.

The methodological approach begins with a narrative literature review, critically examining two seemingly distinct but fundamentally convergent bodies of literature: QM and construction productivity. The existing literature is characterised by significant conceptual divergence, in which QM is treated holistically within a theoretical context and linked to improved performance (Deming 1986). At the same time, construction productivity literature is studied through a fragmented factor-based lens that defines QM as “just another factor” that contributes to poor productivity (Dixit et al., 2019; Hasan et al., 2018). These divergent results indicate an unknown causal hierarchy of problems in the New Zealand residential construction sector. Committing to a simple hypothesis at the outset would have introduced bias and methodological error. It would limit the scope to a narrow deductive confirmation, bypassing the crucial need to first empirically discover and rank the key factors perceived by New Zealand practitioners (RO2).

Therefore, the research objectives were deliberately structured as a sequence of dependent research questions. This initial factor ranking was essential, as it provided the empirical input required for the rigorous Theory of Constraints analysis in the subsequent diagnostic chapters, guiding the methodological progression toward an evidence-based diagnosis and ensuring that the focus on QM as the bottleneck was proven rather than assumed.

1.4 Research rationale

There is an urgent need to enhance productivity within New Zealand's residential construction sector. Furthermore, providing more affordable housing, achieved through sustainable building practices, helps drive economic growth, highlighting the critical role of the New Zealand residential sector.

As previously articulated, the sector's current state is characterised by a persistent productivity paradox, wherein increased labour input and investment fail to yield commensurate gains in output. Various reports highlight that this underperformance poses significant economic and social challenges, including escalating housing costs, prolonged project timelines, and compromised quality outcomes (Bowen et al., 2017).

Although extensive research has explored various models and factors influencing construction productivity globally, a definitive consensus on universally applicable enhancement strategies, especially within the specific nuances of residential construction, remains elusive. Among the many factors identified for improvement over decades of empirical investigation, QM frequently emerges as a contributing element (Anvari et al., 2013; Dixit et al., 2019; Hasan et al., 2018; Mittal et al., 2022; Nasir et al., 2016; Raj et al., 2023). Likely due to quality management's significant potential to mitigate rework, reduce waste, enhance overall project efficiency, and improve customer satisfaction through improved planning, organisation culture, and communication. However, a comprehensive examination of QM as a strategic management lever for productivity improvement within New Zealand's residential construction sector has been notably absent from the existing body of knowledge (BRANZ, 2021).

Thus, this research posits that the effective implementation of organisational QM systems holds the potential to yield improved productivity as a natural and consequential outcome of standardised operational practices. This research considers that frameworks like ISO 9000 offer a holistic and strategic approach to organisation-wide implementation of QM principles, yielding tangible improvements in construction productivity (Small et al., 2021). This approach departs from conventional productivity studies by adopting a multidimensional perspective. The study acknowledges that QM extends beyond a reactive measure for defect mitigation. Instead, it serves as a proactive organisational strategy aimed at optimising resource utilisation and enhancing project outcomes.

Furthermore, the New Zealand context presents unique challenges that require a localised and context-specific approach (OECD, 2022). The sector relies on a limited pool of skilled labour. A vulnerable sector affected by global supply chain disruptions and sensitivity to economic fluctuations and political cycles requires a nuanced understanding of the factors influencing productivity to enable opportunities to improve it. This research seeks to provide such an understanding by examining the interplay between quality management and productivity within the New Zealand residential construction sector.

This thesis contributes to both academic discourse and practical application by empirically investigating the effect of QM on New Zealand residential construction productivity. The study offers evidence-based insights to guide the formulation of targeted interventions and policies to enhance the residential sector. Ultimately, this research seeks to address the productivity gap in New Zealand's residential construction industry, thereby contributing to the nation's economic resilience, sustainability and social well-being.

1.5 Research questions

The central research aim, to determine the effect of quality management as a strategy on improving NZ residential construction productivity, is addressed through a progression of five sequential research questions.

1. To critically review the characteristics of quality management systems in residential construction organisations
2. What significant factors positively affect construction productivity in the NZ residential construction sub-sector?
3. How effective is the QM based strategy in addressing productivity challenges in residential construction?
4. What insights do industry experts provide regarding the applicability and impact of the proposed QM strategy?
5. What practical QM strategies can be recommended to improve productivity in the residential construction sector?

1.6 Research aim and objectives

1.6.1 Research aim

The primary aim of this research is to determine what effect QM has as a strategic approach for improving New Zealand residential construction productivity. This aim is specifically focused on diagnosing the systemic constraints limiting performance and synthesising an evidence-based framework for sector wide reform.

1.6.2 Research objectives

To systematically address the research questions (RQs) and achieve the research aim, the study is guided by the following sequential research objectives (ROs).

1. To critically review the characteristics of quality management systems in residential construction organisations.

2. To identify and analyse the significant factors that positively influence productivity in the New Zealand residential construction sub-sector

3. To develop and assess a QM-based strategy for improving productivity in residential construction.

4. To validate the developed strategy through expert consultation and assessment.
5. To propose evidence-based recommendations for enhancing residential construction productivity through quality management practices.

Research objective 1 - to define the characteristics of QM systems used by residential construction organisations globally through a critical narrative literature review synthesising knowledge relevant to residential construction productivity. This objective also establishes the key productivity improvement factors for empirical knowledge applicable in the New Zealand residential sector.

Research objective 2 - to identify, through a questionnaire survey informed by global empirical research, the factors perceived by the New Zealand residential construction sector participants as positively affecting local construction productivity. Further, to rank them in order of perceived importance in improving productivity. Expert interviews were used to triangulate quantitative statistical findings.

Research objective 3 - to assess the effectiveness of QM strategies in improving productivity within New Zealand's residential construction sector by analysing primary data from the Phase 1 online questionnaire and triangulating these findings with data from Phase 2 expert interviews. This assessment is applied through the systemic findings derived from the Theory of Constraints diagnosis, focussing the evaluation on resolving the identified QM bottleneck.

Research objective 4 - aims to validate the study's findings by seeking expert assessment from industry professionals. This validation process gathers crucial insights regarding the practical applicability and potential impact of the proposed QM strategies within New Zealand's residential construction sector.

Research objective 5 - to determine QM strategies that can be suggested for improving New Zealand's residential construction productivity through data analysis from the online questionnaire and triangulating findings through expert semi-structured interviews. A holistic implementation strategy based on the synthesised findings is recommended.

Section 1.9, Thesis Outline, features a table that illustrates and clarifies the relationships between the research objectives, research questions, and the research stage.

1.7 Research scope

This research examines the effectiveness of QM as a key lever for enhancing productivity within New Zealand's residential construction sector. This study contributes empirical insights and practical recommendations for improved industry performance though a systematic exploration of established QM frameworks and specific productivity-enhancing factors.

The scope of this research begins with a literature review focused on understanding and improving construction productivity, particularly in New Zealand residential construction. The literature review employed a systematic and comprehensive approach, spanning four decades from the mid-1980s to 2021, with a particular emphasis on the last decade. The primary data collection for this research was conducted throughout 2022, and within the timeframe of this study.

The study utilised reputable search engines, including Emerald Insight, ASCE, ScienceDirect, and Google Scholar, focusing on 'title/abstract/keyword' fields. The selection process was guided by keywords related to construction productivity, improvement, factors, residential construction, and quality management. This research primarily drew from Q1 and Q2 journals, selecting 38 papers. Key journals such as the Journal of Management in Engineering and the International Journal of Production Economics were prioritised due to their scholarly impact and their relevance to the research objectives. Empirical literature is selected systematically, facilitating a comprehensive, quality-oriented review of pertinent literature over an extended timeframe, thereby strengthening the foundation for the study's findings and conclusions.

This study evaluates QM’s pivotal role in enhancing productivity, specifically its effectiveness as an improvement strategy. Thus, various quality management practices, such as checklists, audits, Kaizen methodologies, inspection test plans, and the Conqa quality assurance system, are explored for their potential effect on operational efficiency.

Furthermore, the study investigates the strategic application of established quality management systems, including the ISO 9000 quality management standards, Total Quality Management principles, Deming's Plan-Do-Check-Act model, and Lean construction methods. This is to determine their potential effect on productivity within the unique context of the New Zealand residential construction industry. Moreover, this study identifies key factors for productivity enhancement from global empirical literature and applies them in a local context. Global factors, including communication, supervision, training, QM, and design, are essential for enhancing the local residential construction sector. The research also analyses the perspectives of New Zealand industry professionals on various productivity improvement strategies. This analysis considers the distinct empirical characteristics of the local sector and their perceptions on productivity improvement, providing a more in-depth, comprehensive understanding of the New Zealand residential construction landscape.

The study situates its analysis within the broader global framework, leveraging insights from international contexts to discern potential solutions applicable to New Zealand's residential sector. Notably, this research transcends mere problem identification by offering practical solutions aimed at enhancing productivity. It provides specific recommendations for the implementation of QM systems, with a particular emphasis on the ISO 9000 standards, and proposes actionable strategies to address potential industry resistance in their adoption.

The study also examines the economic implications of achieving improved quality and productivity within New Zealand's residential sector, quantifying the potential benefits to the national economy. While the primary focus remains on enhancing productivity, the research adopts a holistic view by also considering the interplay between other related aspects that influence residential construction productivity in the local sector. These include the cultural context, workforce training, communication strategies, the structure and culture of the industry, and the influence of government policy. An approach that aims to provide clear and actionable understanding of the factors influencing productivity within this important sector.

This research employs a sequential explanatory mixed-methods approach. Data collection starts with a survey questionnaire that undergoes statistical analysis, followed by semi-structured expert interviews to elaborate on the initial findings. The methodological sequencing enabled quantitative results to inform and complement the subsequent qualitative analysis, yielding enriched insights into the initial numerical observations. The study's methodological choices are fundamentally guided by the pragmatic perspective, prioritising the research question and employing the most effective data collection and analysis techniques, notably interviews and questionnaires, to achieve the research objectives.

1.8 Ethical considerations

Maintaining the integrity of scientific inquiry and protecting the rights and well-being of participants are paramount and require strict adherence to stringent research ethics. Prior to data collection, formal ethical approval was obtained from the Auckland University of Technology Ethics Committee (AUTEC).

This measure ensured human participants' privacy, safety, health, social sensitivities, and overall welfare (AUT, 2018). Comprehensive information about the research, including its objectives, the voluntary nature of participation, detailed accounts of interview procedures, strategies for mitigating potential discomfort and risks, anticipated benefits, measures for ensuring privacy, and the recording of interviews, was thoroughly communicated to all participants. The ethical solutions were sought in two stages, as shown in Table 1.1

Table 1.1: Staged Ethics Approvals (Author's work)

#	Title	Ethics application number	Approved by	Date approved
1	An investigation into subsector productivity: The New Zealand residential construction industry	23/83	AUTEC	30 March 2023
2	An investigation into subsector productivity: The New Zealand residential construction industry	24/77	AUTEC	21 June 2024.

1.9 Thesis roadmap and manuscript integration

This thesis is structured as a sequential integrated manuscript designed to address the central problem of poor productivity in NZ's residential construction sector. The structure is guided by the explanatory mixed methods design and the application of the Theory of Constraints model. The chapters are methodically integrated to move the inquiry from broad factor identification to targeted systemic diagnosis and validation, culminating in a synthesised policy solution. Specifically, this thesis follows a three-stage progression.

Table 1.2: Thesis Roadmap (Author's work)

Stage.	Focus and methodological goal	Chapters
1. Foundation an Exploration	Establish the global and NZ contextual crisis **(RO1)** and empirically discover the core factors **(RO2)** to justify the strategic focus.	**Chapter 2.** Narrative literature review **(RO1). Chapter 3**. **Chapter 4**, Quantitative survey and factor ranking (**RO2)**
2. Diagnosis and causal mechanism.	Apply the Theory of Constraints model to the empirical factors to diagnose the systemic root cause -the cultural constraint- to show that poor quality management is the strategic bottleneck **(RO3)**	**Chapter 5.** Demographic factor analysis (**RO2). Chapter 6** Mixed methods analysis and TOC application (**RO3)**
3. Synthesis and solution.	Evaluate and validate the proposed holistic QM strategy **(RO4),** synthesising the evidence into an actionable Holistic Enhancement Model (HEM) **(RO5)**	**Chapter 7** Qualitative interviews for mechanism and model component validation (**RO4, RO5).**
4. Strategic application and conclusion	Apply the validated HEM to a major national priority (sustainability), culminating in the comprehensive discussion, theoretical contribution, and policy recommendations.	**Chapter 8** Strategic application; QM and sustainable productivity. **Chapter 9** Discussion and HEM justification. **Chapter 10** conclusions and recommendations

1.10 Thesis outline and structure

This research adheres to the thesis publication guidelines set by the Auckland University of Technology. The thesis consists of sections corresponding to distinct chapters. In total, ten chapters complete this thesis. Accordingly, chapters three through seven consist of journal articles and conference papers either submitted, under review, or already published. Each chapter includes paper titles that serve as its heading. The remaining four chapters encompass the thesis's introduction, methodology, discussion, and conclusion. Chapters three to seven address five research objectives, each linked to a corresponding research question.

Chapter 1 lays the foundation for the research by outlining the context, defining the research, and explaining the rationale, informed by the research background and the identified problem. Additionally, the chapter presents the research aim, objectives, scope, ethical considerations, overall structure and a thesis roadmap that defines the manuscript integration.

Chapter 2 summarises the research methodology, including the research philosophy, methodological selections and choices, strategies, sampling, data collection, and analytical techniques. It also addresses how this current research maintains validity and reliability.

Chapter 3 investigates the relationship between QM systems and construction productivity in New Zealand’s residential construction industry. This chapter explores the positive link between quality management systems and construction productivity in New Zealand’s residential construction sector. It examines various QM approaches and their potential benefits, while identifying factors that affect productivity. Research advocates for adopting QM as a strategic approach to addressing poor productivity, suggesting that productivity improvements will result from effective management practices.

Chapter 4 investigates the factors influencing productivity in New Zealand’s residential construction sector and details the findings of a comprehensive investigation into critical productivity drivers within the industry. Data is collected through an online questionnaire survey of 106 industry professionals, using a combination of Likert scale, ranked order and open-ended questions to capture nuanced perspectives. Responses are meticulously examined to identify and rank factors influencing productivity in the local sector. The key findings reveal that adequate design, effective communication, robust quality management, proficient supervision and comprehensive organisational training are the top five crucial elements for enhancing productivity. These findings provide valuable insights that underscore the necessity of strategic organisational investments in QM and worker training and advocating for a more holistic approach to productivity improvements in New Zealand residential projects.

Chapter 5 examines the psychosocial factors and investigates the relationships between demographic characteristics and key variables influencing productivity in New Zealand's residential construction sector. The study employs Spearman's Rho correlation analysis on data collected from 106 construction professionals, revealing significant associations between age, industry experience, occupational groups, and factors such as QM practices and productivity strategies. The findings suggest that improving productivity in this sector requires a multifaceted approach, including leveraging experienced personnel, targeted training, fostering a positive organisational culture, and balancing quality, time, and cost considerations while emphasising the strategic value of QM in enhancing overall sector performance.

Chapter 6 rigorously evaluates quality management strategies for productivity enhancement in New Zealand's residential construction sector, providing evidence-based recommendations for industry and policy. This chapter delves into the factors, barriers and effective strategies for achieving sustainable productivity improvements, grounding its analysis in the Theory of Constraints (TOC). Building upon quantitative findings from chapter five, this chapter employs a mixed-methods approach. Data was collected via an online questionnaire survey from 106 industry professionals, utilising two 14-item Likert scales on construction productivity and QM, complemented by three open-ended questions. Quantitative data was analysed using mean value and weighted average methods, while qualitative responses underwent thematic analysis. Key findings strongly underscore the effectiveness of quality-focused strategies in the residential sector. The research reveals that systematically implementing quality management systems, particularly ISO 9000 -aligned standards and industry-wide training, significantly enhances construction productivity and quality. These findings are vital for policymakers, industry experts and organisations, providing evidence-based strategies to address persistent productivity challenges across the sector.

Chapter 7 builds upon chapters 4-6 and seeks to validate previous research findings by further examining the effectiveness of QM as a strategy for enhancing productivity in New Zealand's residential construction sector. Data collection employs a qualitative approach using semi-structured interviews with 15 industry experts. Data analysis is by way of thematic analysis, which is used to explore the deeper latent meanings and determine the validity of previous research findings. The findings reveal a strong consensus among experts regarding the critical role of QM in enhancing productivity. Specifically, the ISO 9000 QM system emerged as a potentially effective tool when integrated with other strategies, such as lean construction or the Plan-Do-Check-Act (PDCA) model. The research has far-reaching implications for society and industry. It emphasises the need for a holistic, integrated approach that addresses cultural, human capital, policy, and technological factors to realise the full potential of QM in boosting productivity within the unique context of New Zealand's residential construction industry.

Chapter 8 presented as a completed conference paper, expands on the strategic implications of the research by focussing on sustainable productivity. This chapter details a qualitative inquiry that definitively confirms QM as a pivotal strategy for simultaneously improving New Zealand residential construction productivity and contributing to national sustainability objectives, directly aligning with the United Nations Sustainable Development Goals

(UNSDG's). A key finding of this research is the established crucial link between the QM implementation gap and the sectors environmental performance. It demonstrated that by resolving the cultural constraint (identified via TOC in chapter 6) and prioritising quality, organisations directly mitigate material waste and reduce embodied carbon, thus providing a mechanism for the industry to meet its climate change obligations.

This chapters strategic contributions lie in its ability to formally integrate the sustainability dimension into the core thesis argument, thereby validating the Holistic Enhancement Model (HEM) as a unified solution to the nations dual challenge of economic efficiency and environmental stewardship.

Chapter 9 provides a comprehensive critical discussion and interpretation of the empirical results, moving beyond mere reporting to synthesise the findings. This chapter critically examines the effectiveness of QM by applying the Theory of Constraints diagnostic lens to the data, formally identifying the cultural constraint as the root cause of the QM paradox. The discussion then culminates in the development and theoretical justification of the Holistic Enhancement Model (HEM). This chapter establishes the thesis dual theoretical contribution, extending TOC and QM contingency theory, thereby providing the necessary foundation for the final conclusions and recommendations.

Chapter 10 concludes the thesis by providing a comprehensive synthesis of all findings. This chapter first formally demonstrates how each research objective was achieved. Decisively answering the overarching aim that QM has a profoundly positive effect on NZ residential construction productivity, but only when strategically implemented through the culturally focused Holistic Enhancement Model framework. The chapter then outlines the studies original theoretical contributions, including the HEM and the extension of TOC and QM contingency theory, as well as its practical and societal contributions. Finally, this chapter provides specific recommendations for stakeholders. Discuss is the studies limitations and presents suggestions for future research. Table 1.3 further outlines the various research objectives and questions related to each chapter of this Thesis.

Table 1.3: Thesis outline (Author's work)

Chapter	Publication	Research objectives addressed	Research questions posed
3	An investigation into quality management systems and factors affecting construction productivity: The New Zealand residential construction industry	*RO1 - To define the characteristics of quality management systems used in residential construction organisations through a critical literature review*	RQ1 - What quality management systems do residential construction organisations use to improve construction productivity?
	(Published conference paper)	*RO2 - To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector.*	RQ2 - What are the common factors that positively affect construction productivity in the New Zealand residential sub-sector?
4	Factors for improving productivity in the New Zealand residential construction sector (Published Journal Article)	*RO2 - To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector.*	RQ2 - What are the common factors that positively affect construction productivity in the New Zealand residential sub-sector?
5	Exploring the interrelations between demographic factors and key variables influencing productivity in New Zealand (Accepted conference paper)	*RO2 - To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector.*	RQ2 - What are the common factors that positively affect construction productivity in the New Zealand residential sub-sector?
		RO5 - To suggest ways to improve construction productivity through quality management strategies.	RQ5 - What quality management strategies can be suggested for improving productivity within construction residential
6	A multidimensional analysis of strategies for improving New Zealand residential construction productivity	*RO3 - To evaluate the effectiveness of a developed strategy for quality management in residential construction*	RQ3 - How effective is the developed strategy for quality management in the residential construction sector?
	(Published Journal Article)	*RO5 - To suggest ways to improve construction productivity through quality management strategies.*	RQ5 - What quality management strategies can be suggested for improving productivity within construction residential
7	Unlocking productivity: The power of a quality culture in New Zealand housing (Submitted) Journal of Construction Economics and Building	*RO2 - To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector.*	RQ2 - What are the common factors that positively affect construction productivity in the New Zealand residential sub-sector?
		RO3 - To evaluate the effectiveness of a developed strategy for quality management in residential construction	RQ3 - How effective is the developed strategy for quality management in the residential construction sector?
		RO4 - To validate the findings through expert assessments	RQ4 - What insights do industry experts provide regarding the applicability and impact of the proposed quality management strategy on residential construction practices?
		RO5 - To suggest ways to improve construction productivity through quality management strategies.	RQ5 - What quality management strategies can be suggested for improving productivity within construction residential
8	Sustainable productivity in New Zealand residential construction: Role of QM	*RO5 - To suggest ways to improve construction productivity through quality management strategies*	RQ5- contributes to the strategic application of QM

1.11 Chapter conclusion

This introductory chapter has established the foundation for a thorough investigation into the efficacy of QM as a productivity improvement strategy within the NZ residential construction sector. The research aim, objectives, and guiding research questions have been clearly articulated, alongside a preliminary exploration of the significance of this study within the context of industry challenges and the pursuit of sustainable construction practices. A thesis road map is provided to clarify the integration of ROs, chapters and manuscripts according to each phase of research. The next chapter outlines the methodological framework used to address the research objectives. It details the specific approaches, data collection methods, and analytical techniques utilised to gather and interpret the evidence presented in the subsequent chapters.

Chapter 2

Research Methodology

Overview

Having established the research aim, objectives, and the existing body of knowledge in the preceding chapters, this chapter now turns its focus to the methodological framework that underpins this investigation. The effectiveness of QM as a strategy to improve productivity within the New Zealand residential construction sector necessitates a rigorous and well-defined approach to data collection and analysis. This chapter will detail the specific research design, outlining the rationale for the chosen mixed-methods approach, the selection of participants, the instruments and procedures employed for data collection, and the analytical techniques used to interpret the findings. By clearly articulating the methodological choices made, this chapter aims to provide transparency and ensure the credibility and rigour of the research undertaken to address the research questions posed in the introductory chapter.

2.1 Introduction

An in-depth analysis of the empirical literature on construction productivity and QM indicates that the New Zealand residential sector struggles with the adverse effects of poor quality management practices and enduring construction productivity issues . This continues despite decades of research and governmental efforts. Nevertheless, a review of empirical research confirms that quality management is often regarded as a secondary factor in enhancing productivity, yet its benefits are widely acknowledged. One commonality is that QM is usually considered in isolation and rarely seen as the primary approach for productivity improvement in the residential construction sector, highlighting a research gap.

Underpinned by a pragmatic research paradigm, this study uses a sequential explanatory mixed methods approach combining a survey questionnaire, semi-structured interviews, and stratified probability sampling to comprehensively address this gap identified in Chapters 3-7 of this thesis.

This chapter details the methodological choices used in this study to address the research gap and outlines the purpose statement and research questions. It also discusses the theoretical foundations, the guiding worldview, methodological choices, sampling selection, data collection and analysis techniques, and triangulation strategies related to this research. The chosen methodology is appropriate for addressing the research questions and filling the identified gap due to its comprehensive approach, context-specific focus, and alignment with a pragmatic worldview. The mixed methods approach, triangulation, and industry representation ensure robust and valid findings, while the explanatory nature and theoretical grounding allow for deeper insights and practical recommendations.

2.2 Defining research

Research is a multifaceted endeavour deeply rooted in philosophical inquiry and human curiosity. Its origins trace back to 1620 and ancient intellectual traditions, notably articulated by thinkers like Francis Bacon, who emphasised empirical methods and inductive reasoning as foundational to pursuing knowledge (Bacon, 1902). Implying that seeking knowledge is a "voyage of discovery" likely to provide some form of future advancement (Fellows & Liu, 2021). This evolutionary thinking has led to systematic approaches that address the societal needs and challenges of the modern world (Creswell, 2014). In the context of this research, which aims to examine the effectiveness of QM in improving residential construction productivity, a systematic and methodical approach is essential to ensure reliable and valid findings.

Many definitions of the term exist, broadly centring around drawing conclusions, developing theories, gathering information, conducting systematic inquiry, and creating or discovering new knowledge. Thomas Kuhn described research as a scientific activity influenced by a paradigm, a conceptual framework that includes formal theories, classic experiments, and established methods (Kuhn, 1962). Collins English Dictionary (2024) defines research as "a systematic investigation to establish facts or principles or to collect information about a subject." This research is guided by Creswell (2012), who succinctly defines research as the methodical collection and analysis of information to enhance the understanding of a topic or phenomenon. A commonality among definitions suggests that research is a purposeful and organised formal process tailored to meet the needs of a particular investigation. However, any future discovery is influenced by the research design, questions, chosen methods, and analysis techniques related to the topic. This research is grounded in a pragmatic worldview, which emphasises the importance of finding solutions that work in practice. This paradigm acknowledges that multiple realities exist and that the most effective approach is often the best way to address the research problem.

Conversely, although research is valuable for advancing knowledge, solving problems, and fostering innovation, it also presents inherent weaknesses and limitations that must be recognised and addressed, including biases and ethical factors (Guba & Lincoln, 1994; Rosenberg & McIntyre, 2019). Examining these dynamics enhances comprehension of how research influences societal developments, guiding individuals toward informed decision-making and fostering a deeper understanding of the complexities of life (Smith & Osborn, 2008). The following section describes the research design used in this study from beginning to end.

2.3 Research purpose

This study is an investigative inquiry. It aims to determine the effectiveness of QM as a strategy for improving New Zealand residential construction productivity. The research questions are formulated based on a review of the extant construction productivity and QM research spanning over forty years, combining attributes from two well-researched theoretical perspectives: construction productivity and QM. Existing literature was utilised to identify the gap the research questions aim to answer. The research design methodology used to answer the research questions is discussed beyond the presentation of the research questions.

The study explores the potential of QM as a strategic approach to enhance productivity in New Zealand's residential construction sector. The investigation is firmly grounded in the Theory of Constraints and bridges two well-established theoretical domains (construction productivity and QM) by synthesising over four decades of research. The research questions emerge from a comprehensive literature review, which identifies the existing knowledge gap and provides a solid foundation for the study's objectives. This inquiry seeks to uncover the intricate relationship between QM practices and construction productivity, specifically within New Zealand's residential building industry.

The research design methodology is carefully selected to address the research questions through rigorous data collection and analysis, and extends beyond simple descriptive presentation. This approach ensures a robust data collection, analysis, and interpretation framework, allowing for a thorough examination of the effectiveness of QM strategies in improving residential construction productivity. By adopting this comprehensive methodology, the study aims to provide valuable insights that transform industry practices, optimise approaches to construction, improve productivity, and ultimately enhance overall performance and efficiency in New Zealand's residential construction sector.

2.4 Research design

2.4.1 Research plan conceptualisation

This study utilises a narrative literature review as the foundation for its conceptual framework, seeking to integrate various viewpoints, highlight essential themes and trends, and reveal deficiencies in current knowledge. This method informs the research direction and establishes a robust foundation for the investigation by explicitly delineating the primary concepts and variables being examined. This strategy is designed to provide a comprehensive overview of the topic, focusing on high-quality, relevant sources while capturing the field's historical development over the past four decades. Table 2.1 provides an overview of the specific strategy used for the narrative review in this research.

Table 0.1: Narrative Review Strategy (Author's work)

Parameters	Methods
Search Engines	Emerald Insight, ASCE, ScienceDirect, Google Scholar
Search Parameters	Title/Abstract/Keyword
Keywords	Construction productivity, improvement, factors, residential construction, QM
Journal Selection	Mixture of Q1 and Q2 journals relevant to research objectives
Time Span	40 years (mid-1980s to 2021), with emphasis on the last 10 years
Paper Selection	38 papers

Search Engines- The authors selected Emerald Insight, ASCE, ScienceDirect, and Google Scholar as their sources. This choice aligns with the research methodology proposed by Tranfield et al. (2003) indicate these are reliable platforms for academic literature within the research domain. Keywords used include 'Construction productivity, improvement, factors, residential construction, quality, Construction management, Policy. ' These terms are closely linked to the study's primary aim of exploring how QM systems affect construction productivity in the residential sector. Specific journals were chosen due to their relevance to the research objectives. These included journals focused on management in engineering, production economics, QM, administrative science, construction management, productivity and architectural management. Papers were selected, spanning from the early 1980s to 2021, with a more significant representation from the last decade. This choice was made to capture the historical context and the most recent developments in the field, as the topic has become more globally prolific in recent years.

2.4.2 Key concepts and variables

- **Quality management** encompasses the processes and activities organisations employ to ensure the quality of their products or services (Gupta & Khitoliya, 2020; Juran & Godfrey, 1999). In the context of this research, quality management refers explicitly to the strategic and proactive approaches undertaken by residential construction companies in NZ to manage and enhance the quality of their construction processes and outputs. This strategic interpretation departs from the reactive defect mitigation (BRANZ, 2021) and aligns with the concept of QM as an integrated, organisational lever for improving overall efficiency and project outcomes (Lundkvist et al., 2014; Small et al., 2021) These include, but are not limited to, the implementation of QM systems (e.g., ISO 9000), continuous improvement initiatives, and quality control and assurance mechanisms throughout the project lifecycle.

- **Productivity,** broadly defined as the ratio of outputs to inputs, has been a subject of extensive scholarly inquiry across various economic sectors (McKinsey and Company, 2022; Rosenberg, 2016). In the construction context, this research considers that productivity is not merely a matter of resource utilisation efficiency (Conway et al., 2013) but also the quality, timeliness, completeness, and overall value delivered to stakeholders (Alaloul et al., 2021; Martin, 2021; Seadon & Tookey, 2019). This definition acknowledges the cascading effects of poor quality on rework and resource inefficiency, thereby setting the stage for QM to be treated as a strategic driver of performance (Love et al., 2018). Relative to this research, productivity refers to the efficiency of residential construction processes in New Zealand, measured in output per input unit (e.g., labour, materials, time and completeness to standard. To operationalise productivity, this research utilises broad indicators, such as project completion time in months, industry reports, and official metrics on sector-level costs of quality, as well as Statistics New Zealand's industry productivity analysis and contributions to GDP. Data for these metrics will be collected through interviews and questionnaires with industry professionals and desktop research methods.
- **Strategic implementation** refers to the deliberate and planned integration of QM principles and practices into residential construction companies' overall organisational strategy and operations. It involves a proactive approach to quality, where QM is not merely a reactive response to defects but a core element of the business strategy to enhance overall performance and efficiency (Gupta & Khitoliya, 2020; Juran & Godfrey, 1999). This perspective aligns with established frameworks such as the ISO 9000, which advocate for organisational wide strategic integration of quality principles (Small et al., 2021), directly mitigating the economic burden and rework associated with the reactive approach to quality typically observed in the sector (BRANZ, 2021; Love et al., 2018).

2.4.3 Interrelation of concepts within the research framework

This research posits that the strategic organisational implementation of QM strategies is a key driver of improved productivity in the New Zealand residential construction sector. The conceptual framework guiding this research is based on the premise that by proactively managing quality organisationally throughout the construction process, companies can minimise rework, reduce waste, optimise resource allocation, and enhance overall quality and project efficiency, ultimately leading to increased productivity.

2.4.4 Operationalisation of concepts

To ensure clarity and measurability, the key concepts will be operationalised as follows:

- **QM:** Measured through indicators such as the presence and effectiveness of QM systems (e.g., ISO 9000 certification), the extent of employee training and understanding of QM in related areas, and the implementation of specific quality assurance and control practices (e.g., inspections, audits, continuous improvement), reworks and quality costs.
- **Productivity** can be measured using several metrics, such as project completion durations, cost performance metrics, earned value metrics, defect rates, resource utilisation efficiency, quality of work, timeliness, completeness in relation to acceptable industry standards, and overall value provided to stakeholders. To operationalise productivity, this research utilises broad indicators, such as project completion time in months, industry reports and official metrics on sector-level costs of quality, Statistics New Zealand on industry productivity analysis and contributions to GDP. This data will be collected through interviews, questionnaires and desktop research methods.
- **Strategic implementation** can be evaluated through qualitative analysis with key personnel to determine the extent to which QM is embedded in the organisational strategy and culture policies and procedures.

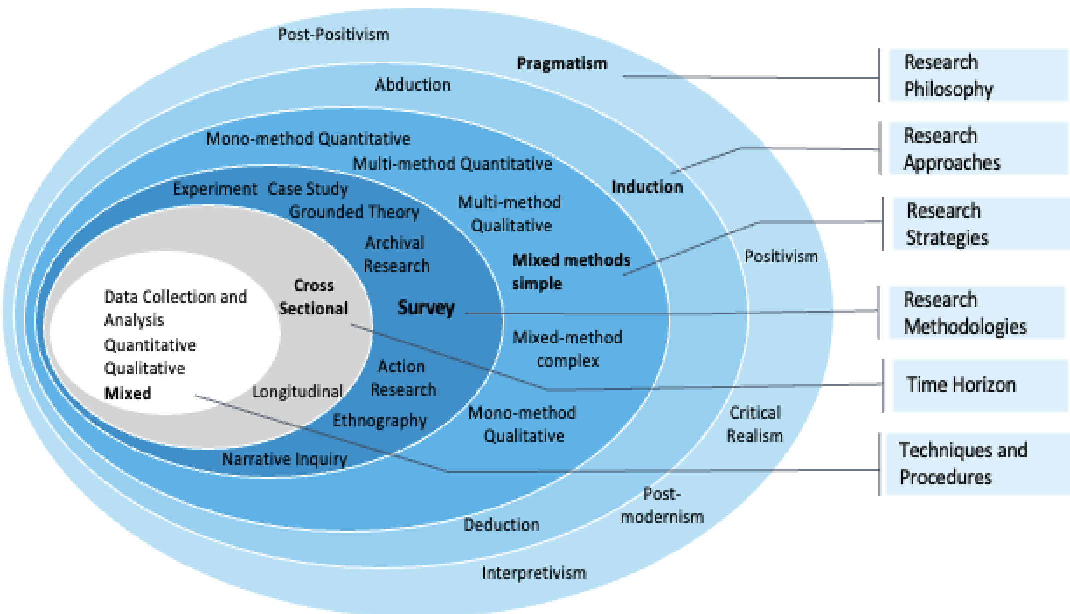
2.4.5 The narrative literature review

The narrative literature review refined these conceptual definitions and operationalisation strategies. By critically analysing the existing literature, the review identified diverse perspectives on QM and productivity, uncovered established measurement approaches, and informed the selection of appropriate indicators and metrics for this research.

By clearly defining and operationalising the key concepts and variables, this research aims to provide a robust and transparent framework for investigating the relationship between QM and productivity in the New Zealand residential construction sector. This approach ensures the research is grounded in a clear conceptual understanding and enables rigorous and meaningful data analysis.

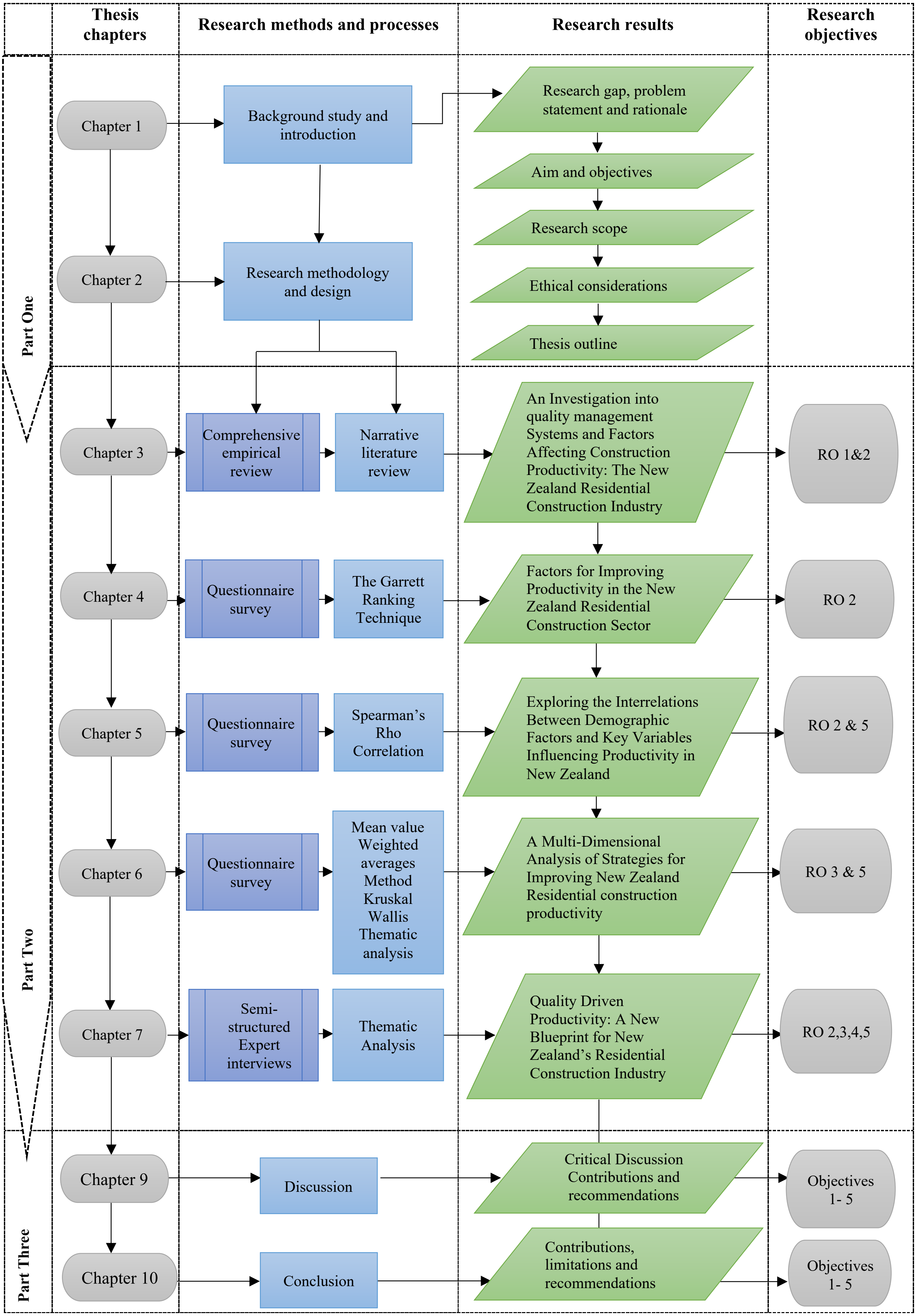
The following sections provide an overview of the research design and outline the chosen methodology relative to the previously presented purpose statement and research questions. Additionally, it discusses the philosophical paradigm, participant selection, data collection, data analysis, validation and triangulation as they relate to both phases of this research. The research design is detailed through the "onion model" introduced by Saunders et al. (2019). Figure 2.1 incorporates six layers: philosophies, approaches, methodological choices, strategies, time horizons, and techniques. This study aligns with the six-layer framework proposed by Saunders et al. (2019).

Figure 0.1: The research onion model (Saunders et al., 2019)



Building upon the foundational layers of the 'Research Onion' model (Saunders et al., 2019) , which delineated the philosophical assumptions, methodological choices, and data collection techniques underpinning this study, the research design flowchart (Figure 2.2) was designed. This provides a visual representation of the sequential and interconnected steps undertaken to achieve the research objectives. This flowchart serves as a pragmatic roadmap, illustrating how the chosen methods, research processes, and deliverables align to address the research questions and contribute to enhancing QM and productivity in the New Zealand residential construction sector.

Figure 0.2:Thesis overview (Author's work)



2.5 Research questions

The aim of this research is to critically examine the impact of QM strategies at the organisational level on enhancing productivity, particularly within the New Zealand residential construction sector. By identifying key QM practices and their relationship with productivity metrics, this study seeks to provide insights that can inform best practices and drive performance improvements in the industry.

Fisher et al. (1995) assert that a clear and relevant research question is the study's foundation. It provides direction for methodological choices, ensuring that it makes a meaningful contribution to the field of construction management (Willis, 2023). The central question driving this research is: **What effect do QM strategies at the organisational level have on improving construction productivity in the New Zealand residential construction sector?** This question is formulated based on a critical review of the current productivity and QM literature, which reveals a significant commonality: earlier approaches to boosting productivity, while often statistically validated, are frequently viewed as standalone factors and lack contextual applicability within the specific nuances of the New Zealand residential construction context (Böhme et al., 2018; Carson & Abbott, 2012; Hwang et al., 2020). Specifically, previous studies often fail to account for the unique characteristics of the New Zealand residential sector, such as its reliance on micro-organisations and specific regulatory requirements combined with a lack of skilled labour and an ageing workforce.

While global research has established a connection between QM and increased productivity (Ruales Guzmán et al., 2019; Small et al., 2021). The effectiveness and potential benefits of this approach within the New Zealand residential construction industry remain under-investigated (Hwang et al., 2020).

This research seeks to address this gap by examining QM not as an isolated factor but as a holistic, organisational-level strategy. To comprehensively address the central research question, this study will further investigate the following sub-questions:

RQ1. What QM systems do residential construction organisations use to improve productivity? This question seeks to establish a baseline understanding of the current state of the New Zealand residential construction sector. This sub-question comprehensively investigates the implementation and utilisation of QM systems, and productivity improvement factors and how they are applied to enhance productivity. This investigation will thus define the foundational context for QM strategies and productivity improvement factors.

RQ2. What common factors positively affect construction productivity in the New Zealand residential construction sector? This research sub-question utilises empirical knowledge of global productivity factors to inform the specific New Zealand residential construction context, aligning the research with the broader international literature. The approach provides a solid benchmark for local interpretation and analysis.

RQ3. How effective is the developed strategy for QM in the residential construction sector? This sub-question evaluates the effectiveness of specific QM strategies developed (existing) or proposed within the New Zealand residential construction context This research will identify existing practices and potentially introduce or refine a QM strategy and assess its impact in the local context.

RQ4. What insights do industry experts provide regarding the applicability and impact of the proposed QM strategy on residential construction practices? This sub-question serves to validate the practical applicability and potential impact of a proposed QM strategy by gathering crucial insights directly from experienced industry experts. Their perspectives provide essential real-world context, confirming the relevance and feasibility of the research findings for improving residential construction productivity in New Zealand.

RQ5. What QM strategies can be suggested for improving productivity within the New Zealand residential construction sector? This forward-looking sub-question seeks to generate practical and relevant recommendations for enhancing QM practices to boost productivity within the New Zealand residential construction industry. This research will go beyond analysing existing practices and contribute to developing strategies suitable for organisational and industry-wide implementation.

By systematically addressing these research questions, we can gain an in-depth and nuanced understanding of the relationship between QM strategies and construction productivity within the specific context of the New Zealand residential construction sector.

2.6 Research philosophy

2.6.1 Introduction

Existing literature discusses the notion that a paradigm represents the broader, accepted principles and standards that guide researchers within a specific field (Feilzer, 2010). It encompasses the assumptions through which we create and filter knowledge (Kuhn, 1962; Lincoln & Guba, 2000) and is the fundamental lens that shapes the research approach, influencing subsequent observations. Therefore, underlying philosophical perspectives intrinsically inform research, precisely the ontological, epistemological, and axiological viewpoints (Creswell & Clark, 2017).

Empirical research suggests that philosophical foundations help shape the researcher's ideological system, thereby guiding the researcher's assumptions throughout the research process (Creswell & Creswell, 2018; Denzin, & Lincoln, 2011). Thus, Tranfield et al. (2003) emphasise the importance of examining interconnected research philosophies as a key component of a consistent research process.

The pragmatic paradigm aptly navigates the limitations of purely positivist approaches, which often present rigid, measurable, deterministic, and reductionist realities (Creswell & Clark, 2017). This worldview prioritises practicality and seeks solutions to real-world issues, directly guiding the research approach proposed here (Cherryholmes, 1992). Its flexibility is highlighted when compared to other post-positivist and constructivist approaches by acknowledging that multiple truths exist (Cherryholmes, 1992; Creswell & Clark, 2017; Dewey, 1958) and that complex phenomena require flexibility in philosophical perspectives. Hence, it is considered imperative for this study (Feilzer, 2010).

A pragmatic worldview is employed to gain a comprehensive understanding of how QM strategies affect construction productivity in the New Zealand residential sector.

It uses a “what works” approach to address the research problem rather than adhering to a single philosophical stance; thus, integrating subjective and objective data provides critical insights. The pragmatic approach is particularly suitable for this research, as it enables the validation of survey data with interview data and the creation of actionable knowledge for the construction industry.

2.6.2 Axiology

Axiology, the study of value and worth, examines the importance of moral considerations and plays a vital role in knowledge development by considering the ethical implications and practical applications of research (Merriam & Grenier, 2019). It influences how research is conducted across the spectrum, from positivism to constructivism-interpretivism (Ponterotto, 2005), suggesting its applicability across diverse methodological approaches, from objective to subjective. Construction management research identifies axiology as a potentially beneficial area for project research (Biedenbach & Jacobsson, 2016). Integrating value theory and axiology into construction management research can enhance the understanding of stakeholder values and improve project outcomes (Zhang & El-Gohary, 2015).

In this study, which adopts a practical approach to understanding reality, axiology plays a key role in helping the researcher acknowledge and appreciate the values that construction professionals hold about QM and productivity (Alaloul, et al., 2023). This perspective enables a more critical understanding of how these values shape quality and productivity practices and industry culture, which necessitates an understanding of how our perceptions of quality influence its management (Biedenbach & Jacobsson, 2016; Alaloul, et al., 2023). Highlighting a more inclusive and value driven analysis for construction management research that enables researchers to garner a deeper understanding of their tangible effects within the construction industry (Biedenbach & Jacobsson, 2016; Zhang & El-Gohary, 2015).

2.6.3 Ontology

Ontology, the study of being, explores the nature of reality and what exists within it (Creswell & Creswell, 2018 p.12). Moon & Blackman (2014), describe ontology as the foundation of our ideas and beliefs about what exists and how we interact with the social world. This branch of philosophy is concerned with the nature of reality and its legitimacy, often employing scientific objectivity to define a knowable and logical reality (Creswell & Creswell, 2018). At the same time, ontological explorations encompass assumptions regarding the fundamental nature of existence and reality, which are crucial in expanding human knowledge about the universe and the empirical sciences (Ylönen & Aven, 2023). Research on ontological perspectives highlights the extremes of objectivism and subjectivism, which help define research viewpoints (Crotty, 1998; Cunliffe, 2010). Objectivism posits that social phenomena and their significance exist autonomously from social actors, suggesting that reality is external and objective (Rosida et al., 2023).

According to some researchers (Rosida et al., 2023; Saunders et al., 2019), this ontological worldview posits that a separation exists between what is real and human perception, implying a predetermined outcome that is independent of emotions and individual beliefs.

In contrast, subjectivism proposes that reality is moulded or determined by our perceptions, beliefs, or feelings (Saunders et al., 2019) through personal experiences, interpretations, and perceptions. Adherents of subjectivism maintain that reality is subjective and that knowledge and truth are contingent upon individual viewpoints (Rosida et al., 2023; Saunders et al., 2019). Construction management studies highlight the importance of ontological perspectives in shaping research methods and outcomes (Biedenbach & Müller, 2011; Zhou et al., 2016).

Ontology-based approaches are extensively employed in construction research to address various issues (Zhou et al., 2016). The diversity of stakeholders in the construction sector presents challenges that the ontological view seeks to address through a shared understanding of concepts and their interrelationships. Thus, comprehending how industry professionals understand the critical relationship between QM and construction productivity is a key ontological consideration for this study.

The practicality of the pragmatic approach emphasises beneficial consequences, acknowledging that individuals may perceive reality differently based on their experiences and perspectives. While recognising the potential for multiple realities, this study also seeks to identify common patterns and practical insights that can inform QM strategies in the New Zealand residential construction sector (Creswell & Creswell, 2018 p.12).

2.6.4 Epistemology

Epistemology is the philosophical branch concerned with the theory of knowledge. Epistemologists investigate the nature, origin, limits, and validity of knowledge, as well as the methods that generate knowledge, including the relationship between the observer and the observed (Hesse-Biber & Leavy, 2011). Epistemology examines rational, intuitive and empirical knowledge domains. Several authors explore the foundations of our understanding of the world, focusing on how we acquire knowledge (Beebe & Monaghan, 2018; Bishop & Trout, 2005; Gerken, 2017). In the realm of epistemology, contrasting viewpoints on the nature of knowledge and reality often emerge in opposition (Saunders et al., 2019). According to Saunders et al. (2019), objectivity influences our perspective on knowledge, suggesting that knowledge is separate from human standpoints. Furthermore, the acquisition of knowledge is through observation and measurement as well as the scientific method, implying the possibility of absolute truth.

Conversely, the second perspective affirms the subjective perspective. It emphasises that knowledge arises from individual experiences and interpretations, leading to diverse narratives and understandings that suggest reality is constructed through our personal experiences, implying a lack of objective truth.

An understanding of epistemology is crucial in the context of construction management research (Smyth & Morris, 2007). Researchers in this field must consider the nature of knowledge and how it is acquired when developing research questions, designing methodologies, and interpreting findings (Rosida et al., 2023). A weak epistemological foundation in construction management research can lead to underdeveloped theoretical models, highlighting limitations in advancing knowledge that can severely limit progress in the construction sector (Iroha et al., 2024; Moshood et al., 2024).

Hence, the pragmatic paradigm is a valuable approach in construction management research for understanding knowledge creation and attainment by considering both subjective and objective measures (Boamah et al., 2021; Yepes & López, 2021). Several pragmatic approach studies recognise the subjectivity within the construction management domain and emphasise the integration of multiple epistemological perspectives to maximise practical outcomes (Krohn, 2017; Tariq, 2024). Hence, researchers may benefit from a more holistic approach where practical outcomes can evolve from balancing philosophical perspectives (Feilzer, 2010; Kelly & Cordeiro, 2020). Indeed, empirical literature highlights the crucial role of philosophical doctrines, such as axiology, epistemology, and ontology, in determining research methodologies. The pragmatic approach asserts its strength and versatility through its integrative framework, which emphasises the synthesis of these philosophical doctrines (Creswell & Clark, 2017; Kelly & Cordeiro, 2020; Maarouf, 2019).

This section discusses the various philosophical perspectives and their foundational role in construction management research.

Creswell & Clark (2017) affirms that the critical role of philosophical foundations in research, highlighting the necessity for researchers to adhere to specific principles to establish a robust philosophical structure, which enhances the credibility and dependability of their findings (Creswell & Clark, 2017; Frechette et al., 2020; Urcia, 2021).

Creswell & Creswell (2018 p.12) present a summary of the paradigmatic components, helping researchers align their methodological approaches (Figure 2.3).

Figure 0.3: Paradigmatic components (Creswell, 2018, p12)

2.7 The philosophical paradigms

2.7.1 Overview

Researchers adopt a variety of philosophical positions relative to their worldview. Research paradigms and worldviews significantly influence how researchers approach their studies, interpret data, and draw conclusions. Commonly identified paradigms in research include positivism, post-positivism, interpretivism, critical theory, and constructivism (Guido et al., 2010).

Positivism assumes a reality that is objective and measurable (Hesse-Biber & Leavy, 2011), while interpretivism views reality as socially constructed (Creswell & Creswell, 2018). Critical theory focuses on power dynamics and social change (Ryan, 2018), while constructivism emphasises individual perspectives in creating knowledge (Petit & Huault, 2008).

More recently, paradigms such as constructivist interpretivism, critical realism, and pragmatism have gained prominence. Constructivist interpretivism combines elements of constructivism and interpretivism, emphasising the role of individual experiences and social interactions in shaping reality (Appleton & King, 2002). Critical realism acknowledges an objective reality while recognising that social and cultural factors shape our understanding of it, even if not directly observed (Frederiksen & Kringelum, 2020). Conversely, pragmatism focuses on practical consequences and problem-solving rather than a specific philosophical stance (Morgan, 2014). Nørreklit et al. (2016) highlights how actors shape organised reality through a pragmatic constructivist lens (Frederiksen & Kringelum, 2020).

Notably, these paradigms are not entirely mutually exclusive, enabling researchers to incorporate elements from various paradigmatic positions (Cherryholmes, 1992). Research indicates that varied paradigms provide researchers with different perspectives for analysing respondent data, with paradigm selection typically depending on philosophical perspectives, the nature of the research, and the area of study (Ryan, 2018). Diversity in methodological paradigms allows researchers to tailor approaches to the specific context and objectives of their inquiry (Aguzzoli et al., 2024; Ponterotto, 2005).

The following section provides an in-depth analysis of various paradigmatic views, identifying the benefits of pragmatism for this research's overarching paradigm. While addressing the complex interplay between QM practices and construction productivity, relevant to the local residential construction sector.

Prioritising practical and solution-oriented outcomes is key to this research. Pragmatism allows for the seamless integration of both objective and subjective data and is a key consideration of this research endeavour, aligning with the pragmatic worldview principles. For example, the pragmatic approach facilitates the incorporation of survey findings with interview data, ultimately contributing to the generation of actionable insights for the construction industry.

2.7.2 The positivist paradigm

Positivism, a foundational research paradigm, is concerned with what is real and the legitimacy therein and uses scientific objectivity to help define a knowable and logical reality (Creswell, 2018). Positivists adopt an objectivist epistemology, wherein researchers act as impartial observers, examining phenomena that exist independently of their influence, ensuring that their presence does not alter the studied subjects (Rehman & Alharthi, 2016). Positivism is rooted in the realist ontological perspective. This asserts that the social world operates according to cause-and-effect principles similar to those in the natural sciences, allowing for reliable predictions of future events (Ellaway et al., 2020; Lincoln & Guba, 1989). However, positivism has been criticised, particularly regarding its application to social phenomena (Richards, 2003 p.37). While objective and scientific methods are appropriate for studying natural objects, they are less successful for social phenomena involving human behaviours or actions (Richards, 2003 p.37). The singular reality promoted by the positivist paradigm is often deemed impractical as an overarching worldview in the social sciences.

Despite these criticisms, positivism remains relevant in mixed-methods research, often engaging positivist forms of analysis (Hesse-Biber & Leavy, 2011). While positivism has been a dominant paradigm in management research, it has faced challenges from alternate paradigms such as interpretivism, critical theory, and post-positivism (Clark, 1998; Henderson, 2011; Ryan, 2018). These alternative approaches often emphasise the socially constructed nature of knowledge and the complexity of organisational phenomena. Aspects that positivist methods may not fully capture (Petit & Huault, 2008) fuel the ongoing debate about the most appropriate methods for studying complex management issues (Aliyu et al., 2014; Wiltshire, 2018).

The strengths and limitations of complex social constructs are broadly acknowledged as fundamental aspects of construction management research (Ajirotutu et al., 2024; Ciuciuc et al., 2025). Although positivism has led to a robust framework for understanding social phenomena, its limitations have led to the exploration of other alternative paradigms offering more specific insights into the social world (Wiltshire, 2018). Hence, pragmatism emerges as a flexible and comprehensive framework for addressing the research question.

2.7.3 The post-positivist paradigm

Post-positivism emerged as a research paradigm in response to the limitations of logical positivism in scientific inquiry. The post-positivist approach, an evolution of positivism, incorporates qualitative data while acknowledging the significance of subjective reality, but still adheres to the principles of traditional positivism (Samdahl & Kelly, 1999). It advocates for methodological pluralism and acknowledges the complexity of social phenomena (Henderson, 2011; Wildemuth, 1993). Post-positivism retains many virtues of the scientific method while incorporating epistemological concerns that animate its work in various fields (Cochran, 2002). Thus, the rise of alternative paradigms and the shift toward post-positivism reflect a move away from the rigid positivist structures toward a more flexible and inclusive understanding of research problems (Aguzzoli et al., 2024; Clark, 1998).

Post-positivism, despite its widespread application, faces criticism for its perceived rigidity in addressing research objectives, particularly in contrast to alternative paradigms, that offer greater flexibility. This critique arises primarily from post-positivisms' strong emphasis on methodological pluralism (Corry et al., 2018; Wildemuth, 1993). However, this investigation requires a paradigm that incorporates both subjective and objective data while emphasising the production of actionable knowledge. Conversely, the pragmatic approach addresses concerns and offers distinct advantages over post-positivism, particularly in studies that require a flexible and comprehensive framework, enabling greater methodological choice in addressing complex research problems. Although paradigmatically, post-positivism acknowledges these complexities (Clark, 1998; Corry et al., 2018), it lacks alignment with the research aim. Thus, this research is best viewed through the flexibility of the pragmatic lens.

2.7.4 Critical realism

Critical realism offers a viable philosophical framework for social science research, providing a distinct perspective in contrast to the positivist and interpretivist approaches. It melds a realist ontology with a relativist epistemology, embracing a form of "robust" relativism (Mcevoy & Richards, 2003; Wynn & Williams, 2012). Critical realism, initially proposed by Roy Bhaskar in the 1970s, views reality as layered and aims to explore the causative mechanisms behind what is experienced and observed (Hu, 2018; Schiller, 2015; Walsh & Evans, 2013).

Critical realism acknowledges the distinct causal influences of agents and structures, making it suitable for examining the causal connections between social conditions, urban spatial structures and agents' actions (Hu, 2018; Næss, 2015). Critical realism is increasingly recognised as a philosophical worldview that comprehensively supports investigations by integrating multiple research methods (Hu, 2018; Walsh & Evans, 2013). While critical realism offers valuable insights aimed at uncovering causal mechanisms, pragmatism emerges as the preferred research approach for this study, which focuses on practical solutions for the construction industry. Pragmatism emphasises problem-solving, methodological flexibility, and prioritisation of research questions, aligning closely with the study's objectives.

2.7.5 Interpretivism

Interpretivism emerged from Western researchers who began studying different cultures, aiming to understand the social customs and belief systems within these societies (Pulla & Carter, 2018). A qualitative research methodology with roots dating back to the 19th century, this approach is grounded in epistemological assumptions. It encourages researchers to examine the underlying meaning of human actions and social phenomena, and providing a subjective perspective on individuals' lived experiences (Pulla & Carter, 2018).

In social work research, interpretivism plays an essential role by highlighting the importance of understanding individuals' feelings and the meaning they attach to their daily experiences (Pulla & Carter, 2018). Focusing on the subjective experiences and layered meanings individuals ascribe to their lives and interactions (Reeves et al., 2008; Williamson, 2006).

Interpretivism is often integrated with other methodological approaches, such as positivism, to enhance the understanding of meaning behind social interactions and human behaviours (Lawler & Waldner, 2023; Roth & Mehta, 2002).

In the context of this research, which adopts a pragmatic worldview, interpretivism, while valuable in providing rich insights into subjective experiences and social contexts, does not fully align with the practical demands of the construction industry (Bandara et al., 2023; Sarvari et al., 2024). The pragmatic method in research emphasises practical outcomes and solutions by blending multiple methodologies to address the research question (Maarouf, 2019). While interpretivism excels at exploring subjective meanings, pragmatism prioritises the research question and uses 'what works' to address it (Kelly & Cordeiro, 2020). This strategy aligns with the pragmatic paradigm's emphasis on employing the most effective research methods to address the research questions and produce tangible, practical solutions and insights for the New Zealand residential construction sector. Achieving practical outcomes through the integration of a range of methodologies is more effective when adopting a pragmatic approach. Nevertheless, interpretivism is employed in this research to analyse the interview data as a complementary approach rather than the central paradigm guiding this research.

2.7.6 Critical theory

Critical theory emphasises the examination of societal structures and how various social, political, cultural, ethnic and gender factors influence disciplines including construction management (Baqui et al., 2021; Paradis et al., 2020; Verma, 2023). This paradigm challenges the notion of a single, absolute truth, advocating for more nuanced interpretations. It prioritises inductive methods rather than deductive and employs critical theory to inform research projects and analyse data (Caingcoy, 2023). Several studies have explored critical theory as a paradigm in construction management research, offering different perspectives on traditional approaches (Gioia & Pitre, 1990; Volker, 2019).

This study adopts a pragmatic worldview, suggesting that critical theory insights into power dynamics and social structures, while valuable, do not fully address the research's primary objective of developing practical solutions for the construction industry (Wickramanayake et al., 2024). The pragmatic approach, emphasising practical outcomes and problem solving, offers greater flexibility in integrating various methodologies. Although critical theory excels in analysing social structures and power relationships, the pragmatic paradigm prioritises the effectiveness of research methods.

This investigation necessitates a framework capable of incorporating both quantitative and qualitative data while prioritising the generation of implementable insights for New Zealand's residential construction sector. The core aspects of pragmatism revolve around action-oriented practices and the synthesis of diverse methodologies; therefore, it is more appropriate for achieving this objective. Critical theory, while valuable, is not suited as the central paradigm that guides this research, as the study aims to provide practical solutions for industry.

2.7.7 The constructivist worldview

The constructivist approach presents a crucial aspect of the ongoing discourse in research philosophy through focusing on the process of knowledge creation, highlighting the epistemological question of how we acquire understanding (Hesse-Biber & Leavy, 2011).

As an approach to inquiry, constructivism has garnered considerable interest across multiple disciplines, including construction management (Nørreklit et al., 2016; Petit & Huault, 2008). The paradigms that focus on knowledge construction align with the second major viewpoint in the longstanding debate on research approaches, which emphasises the epistemological dimension of inquiry (Dawadi et al., 2021; Hesse-Biber & Leavy, 2011), concerning itself with how we create knowledge.

Hesse-Biber and Leavy (2011) affirm that recognising the relationship between the researcher and respondents is a key aspect of this belief system. Constructivists believe multiple explanations of reality exist, engaging in social research through an inductive approach. They use data to explain reasoning and consider the historical and cultural norms formed through social interaction (Dainty, 2008). Qualitative researchers who adopt an epistemological perspective develop methodologies grounded in multiple disciplines, rejecting positivism and focusing on comprehending human behaviour (Dainty, 2008). The researcher's preferences intertwine with the researcher in this field (Dörnyei, 2007), highlighting the fundamental differences between the methods (Creswell & Creswell, 2017).

In construction management research, constructivism implicitly reinforces existing industry attitudes that hinder cultural progress and change (Green et al., 2006; Rooke et al., 2004), suggesting that the research culture must also evolve to effectively influence the industry's culture. At the same time, Scalcau (2021) states that the researchers' subjectivity raises questions about this method.

Nørreklit et al. (2016) present the paradigm of pragmatic constructivism, highlighting how actors shape organised reality. This approach offers benefits in fields often divided between the 'realist' scientific mainstream and social constructivist critiques. Nørreklit et al. (2016) suggest that pragmatic constructivism provides a middle ground that preserves realism as the practical measure of success for organisational actors' creations. (Morgan, 2007). Furthermore, it highlights the distinctions between quantitative and qualitative methods, as well as the rigidity each imposes on the proposed research through its respective paradigm (Gillespie et al., 2024).

Constructivism provides value in understanding subjective realities; however, does not fully align with the research's focus on generating practical solutions for the construction industry.

Pragmatism facilitates an approach that emphasises practical consequences and problem-solving and facilitates a more adaptive integration of varied methodologies. While constructivism excels at exploring subjective meanings, the pragmatic paradigm focuses on the utility of research methods. It selects those that are most conducive to answering the research questions and generating valuable results and actionable insights for the NZ residential construction sector. With its core tenet of selecting research strategies based on their effectiveness in addressing the research questions and yielding actionable outcomes, pragmatism is better suited to achieve this goal.

2.7.8 The pragmatic paradigm

Construction management research originates from both the social and natural sciences, with choices typically guided by the theoretical or philosophical foundation of the study (Dainty, 2008). In this context, the pragmatic approach offers a valuable alternative between the subjective (qualitative) and objective (quantitative) realities (Johnson & Onwuegbuzie, 2004; Scalcau, 2021). The pragmatic worldview originated in late 19th- and early 20th-century American philosophy and social sciences and is shaped by key figures such as Pierce, James Dewey and Rorty. Contemporary philosopher Hilary Putnam emphasises that pragmatism is a way of thinking that promotes interconnected conceptual and philosophical perspectives rather than strictly defined doctrines (Putnam, 1994, p.152).

Concerning the connection between data and theory, Feilzer (2010) confirm pragmatism highlights the role of abductive reasoning, which seamlessly transitions between induction (qualitative) and deduction (quantitative). This method aims to clarify observations via theory and to evaluate theory through action, representing a widely recognised form of the abductive process frequently employed in mixed methods research. Crucially, the pragmatic perspective highlights the research problem over the method, allowing maximum flexibility in combining approaches to ensure a comprehensive understanding of the problem (Creswell & Clark, 2017; Creswell & Creswell, 2018). This aligns with the pragmatist focus on using optimal methods to address research questions and generate practical solutions for real world problems (Cherryholmes, 1992). Moreover, the pragmatic approach allows a researcher greater flexibility in choosing from established post-positivist and constructivist paradigms (Feilzer, 2010).

While mixed methods research frequently cites pragmatism as its philosophical underpinning (Maarouf, 2019), this approach faces scrutiny regarding its adequacy as a comprehensive intellectual framework to justify the integration of diverse approaches (Gillespie et al., 2024; Maarouf, 2019. However, by enabling the integration of diverse research methodologies, the pragmatic paradigm answers its critics. Specifically, the utility of this approach in the current study is demonstrated by enabling the validation of survey data with interview data, resulting in actionable knowledge for the construction industry (Creswell & Clark, 2017; Creswell & Tashakkori, 2007; Howe, 1988; Johnson & Onwuegbuzie, 2004; Morgan, 2007).

2.7.9 The paradigmatic choice

The study identifies with the pragmatic paradigm following an in-depth analysis of various philosophical viewpoints (Cherryholmes, 1992; Johnson & Onwuegbuzie, 2004). The epistemological stance adopted is that of the pragmatic worldview, recognising that knowledge is not static (Dewey, 1958; Putnam, 1994). Consequently this research emphasises the practical application of knowledge, moving away from purely theoretical considerations, such that what counts as knowledge is what is effective in any given context (Cherryholmes, 1992; James, 1907). Ontologically, a pluralistic or contextual ontology is adopted, acknowledging that any given problem may have multiple realities or ways of understanding the world relevant to the problem (Creswell & Clark, 2017; Maarouf, 2019). Therefore, this study aligns with the pragmatic approach, understanding that it is less concerned with defining one 'true' reality (positivist) and more concerned with understanding how reality is perceived and interpreted. This implies a focus on the utility of knowledge rather than absolute truths (Dewey, 1958).

Axiologically, this research maintains a strong connection to the moral and value based perspectives of the research, employing a pragmatic approach that emphasises moral considerations in actions and ideas, viewing value judgements based on their practical implications (Hamada et al., 2020; Kelly & Cordeiro, 2020; Maarouf, 2019). This suggests that pragmatic considerations in moral judgments are flexible and context-dependent. The study acknowledges that the researcher's values shape the research questions, methodological choices, and the interpretation of results. Moreover, aligning with the notion that 'good' is often evaluated based on the practical benefits it confers in tackling specific challenges (Kelly & Cordeiro, 2020; Maarouf, 2019). Therefore, while values can introduce bias, efforts must be actively made to minimise errors by maintaining objectivity (Kelly & Cordeiro, 2020).

Pragmatism serves as a philosophical bridge connecting ontology, epistemology and axiology, by emphasising their interdependence. This philosophical approach suggests that our perceptions of reality, our knowledge acquisition processes, and our value systems are inherently linked and shaped by practical implications and real-world consequences. Such integration aids in addressing the theory-practice gap and connects academic and practitioner interests by focusing on the impact of ideas and actions (Hothersall, 2018; Korte & Mercurio, 2017). The pragmatic paradigm offers a versatile and accommodating research methodology, allowing investigators to employ diverse viewpoints and techniques as needed. At its core, pragmatism establishes a conceptual structure for comprehending how our practical engagements with the real world shape our understanding of knowledge, values and reality. (Heelan & Schulkin, 1998; Li et al., 2024).

The central question, "**What effect do QM strategies at the organisation level have on improving construction productivity in the NZ residential construction sector,"** necessitates this approach. While its focus on causality and measurement align with the post-positivist pursuit of objective knowledge, the investigation into implementation, context and participant values leans toward the interpretivist worldview. This combined need for both objective measurement and contextual understanding affirms that overarching pragmatism is the most suitable philosophical framework for achieving the research aims and objectives.

Epistemologically, the phrase starts with "What affect," which suggests a desire to establish a causal relationship. While acknowledging the potential complexities, the research aims to establish a measurable and demonstrable link between QM and productivity. Although the phrase "at the organisational level" indicates a consideration of context, the core of the question seeks to identify a generalisable effect, which borders on a post-positivist pursuit of objective knowledge. "What effect" implies a quantitative measurement of productivity. However, "QM strategies at the organisational level" suggests a need to understand the implementation and context, which the researcher explores through qualitative interpretivist methods. Thus, through this lens, a mixed methods approach is suitable for this research.

The question assumes that "QM strategies" and "construction productivity" are tangible, measurable concepts from the researcher's perspective. It emphasises the connection between these concepts, assuming that this connection can be observed and quantified. By mentioning the "New Zealand residential construction sector," the question suggests a belief in a distinct, observable reality within this field.

In terms of values, axiologically, the question values increased productivity in the construction sector. The value of QM is highlighted through a means to achieve this desired outcome. The research intent aligns with both economic value (e.g., cost-effectiveness) and societal values (e.g., improved housing). The question suggests a desire to generate knowledge that both industry and academia can apply to improve real-world outcomes in the construction sector.

The research question's focus on causality and measurement aligns with the post-positivist paradigm. However, deeper investigations of social interactions in terms of how participants value QM and its effect on construction productivity lean towards the interpretivist worldview. Hence, the combined mixed methods approach and practical orientation of the research suggest that overarching pragmatism is most capable of answering the research objectives.

The following section focuses on the 2nd layer of the research onion (Saunders et al., 2019). It guides this research format, providing an overview of various research approaches, including induction, deduction, and abduction, as they relate to this research.

2.8 Research approaches

2.8.1 Abductive, deductive, inductive

Research methodology is fundamentally underpinned by distinct logical reasoning approaches, namely deductive, inductive and abductive reasoning that guide the inquiry process. While each approach possesses unique characteristics and applications, they are often employed in combination to comprehensively address complex research questions, particularly in applied fields such as construction management. Understanding these approaches is crucial for justifying methodological choices and interpreting findings (Fathalizadeh et al., 2021; Yau & Yang, 1998).

Deductive reasoning commences with a well-established theory, hypothesis, or general principle, which is then tested through specific observations or empirical data. It moves from the general to the particular, aiming to verify or falsify propositions (Belzen et al., 2021). In construction management research, deductive principles have been employed to examine barriers to lean construction techniques (Jiang et al., 2020) and to integrate with ontological perspectives for enhancing decision-making processes (Su et al., 2019). The strength of this approach lies in its structured ability to confirm and refute existing theories with empirical evidence, thereby providing clear, testable outcomes (Belzen et al., 2021; Fife & Gossner, 2024), which enhances the reliability and scientific rigour of research findings (Prado et al., 2011).

Conversely, inductive reasoning proceeds from specific observations or empirical data to derive broader generalisations, patterns or new theories (Jiang et al., 2020; Su et al., 2019).

This approach moved from the particular to the general, aiming to formulate or build propositions and insights (Jiang et al., 2020). In construction management research, induction is an essential methodological approach for formulating hypotheses and developing theories based on observed patterns and data analysis (Su et al., 2019). Contemporary studies underscore the value and increased use of inductive approaches in this field for exploring novel phenomena, developing rich contextual understandings, and generating new theoretical insights directly from empirical observations (Blismas & Dainty, 2003; Jiang et al., 2020). This fosters innovative solutions and improvements by leveraging existing knowledge and data patterns within the domain (Jiang et al., 2020; Su et al., 2019).

Research within the field has employed an interpretivist and pragmatist philosophical stance, using inductive reasoning to critically analyse existing literature, thereby enhancing traditional reasoning approaches (Posillico et al., 2022). Overall, inductive reasoning in construction management research fosters innovative solutions and improvements by leveraging existing knowledge and data patterns (Jiang et al., 2020; Su et al., 2019). Additionally, inductive methods combined with other approaches such as deductive reasoning offer comprehensive tools for analysing complex qualitative data. Helping synthesise empirical observations to form holistic understandings of construction management phenomena (Azungah, 2018).

Abductive reasoning, as another approach is often considered an inferential bridge between induction and deduction. It begins with an observed anomaly or puzzling phenomenon and seeks the most plausible explanation or "best guess" that accounts for the observations (Jang & Park, 2011; Mishra et al., 2023). It is an iterative process, and while categorised by a non-linear and non-monotonic nature that can lead to multiple, often contradictory hypotheses

(Jang & Park, 2011; Mishra et al., 2023). This approach is particularly relevant in the dynamic and uncertain environment of a project-based setting, where traditional inductive and deductive methods may fall short (Haig, 2005; Mishra et al., 2023). Abductive reasoning facilitates innovation and problem-solving, enabling the exploration of novel solutions that are not immediately apparent through more traditional methods (Biradar et al., 2024; Haig, 2005). Its ability to integrate theoretical insights with practical application makes research findings more relevant to industry practices (Jang & Park, 2011; Mishra et al., 2023).

In the context of this research, a hybrid inductive and deductive approach was predominantly employed, particularly for the thematic analysis of qualitative data gathered through expert interviews (Kirby et al., 2025c). This methodological choice was strategic, recognising that while the initial literature review (Kirby et al., 2022) and a subsequent quantitative survey (Kirby et al., 2024) provides a foundational deductive element by testing established factors and relationships. The qualitative investigation (Kirby et al., 2025c) aims to explore nuances, validate findings, and generate richer, context-specific insights. The thematic analysis commenced with an initial deductive framework, informed by key themes and concepts derived from the preceding literature review and quantitative findings, specifically QM systems and productivity factors. Simultaneously, an inductive approach was rigorously applied, allowing for the emergence of novel themes, unexpected relationships and deeper conceptual understandings directly from participants' experiences. This dual approach ensured that the analysis was both theoretically grounded and empirically emergent, offering a robust and comprehensive interpretation of QM strategies and systems for productivity improvement in the New Zealand residential construction sector, thereby directly addressing the research objectives and the overarching aim.

2.9 Research strategies

2.9.1 Quantitative methods

Building upon the preceding discussion, research approaches can be broadly categorised as quantitative and qualitative (Queirós et al., 2017). The quantitative method emphasises measurable facts and aims to establish cause-and-effect relationships (Choy, 2014).

Creswell & Hirose (2019) assert that research techniques using the quantitative method encompass experiments, surveys, and archival techniques. Thus, the quantitative method is grounded in theoretical principles and employs statistical analysis to quantify viewpoints and opinions within a study (Carr, 1994). These methods typically involve larger sample sizes and require less data collection time than qualitative approaches (Rahman, 2016)

Choy (2014) indicates that the quantitative approach commences with topic selection and narrows to a specific research question (Queirós et al., 2017). Quantitative research methods, while widely employed across disciplines for numerical data analysis , have both strengths and limitations in academic studies (Dainty, 2008). These methods, including experiments, surveys and archival techniques, offer a snapshot of the phenomena but may not fully capture the deeper latent meanings or experiences (Henry et al., 2015; Killian et al., 2019). Thus, contemporary studies have emphasised the need for more flexibility in research approaches, confirming the limitations (Killian et al., 2019). Quantitative methods are often historically entwined with ethical considerations, suggesting that all research methods are inherently value-laden (Levitt et al., 2022; Zyphur & Pierides, 2019), fuelling the enduring debate around objectivity within the quantitative approaches (Levitt et al., 2022). Indeed, some researchers challenge the traditional positivist assumptions and purist perspectives, arguing that research cannot be truly value-free or apolitical (Griffin & Phoenix, 1994).

2.9.2 Experiments

Experiments represent a rigorous quantitative research methodology that is primarily designed to establish definitive cause-and-effect relationships between variables (Rahman, 2016). It involves the use of controlled environments to systematically manipulate independent variables to observe their precise impact on a dependent variable (Rahman, 2016). These approaches offer several advantages, such as larger sample sizes, standardised data collection methods and the capacity to generalise findings (Hampton, 2017; Rahman, 2016). While offering unparalleled internal validity and the potential for high generalisability under ideal conditions (Walker, 2005) the application of true experimental designs in complex, dynamic fields like construction management research is often constrained by practical and ethical considerations. Consequently, their use in construction management research is typically limited to highly specific, often simulated or laboratory-based contexts, or through quasi-experimental designs where full control is not feasible. However, the method has proven useful in construction engineering and management by enhancing collaborative efforts between academia and industry, thereby solving practical problems (Azhar et al., 2009).

Hence, contemporary research confirms the importance of experimental techniques in the field of construction research, emphasising their ability to precisely test theoretical propositions and empirical evidence, despite certain limitations, potentially contributing to theoretical knowledge (Azhar et al., 2009).

2.9.3 Surveys

Survey research is a foundational quantitative method that systematically collects data from a sample of a target population. Typically via structured questionnaires or interviews which allows researchers to garner information regarding participant behaviours and opinions (Rose et al., 2019).

It is widely employed for descriptive and explanatory research, quantifying perceptions, attitudes, practices or characteristics of a group. In construction management, surveys frequently assess industry-wide practices, stakeholder perceptions of QM, or the prevalence of productivity factors (Keusch, 2015; Lee et al., 2011). Its primary strengths include efficiently gathering data from large samples, enabling statistical analysis and the generalisation of findings to broader populations (Keusch, 2015; Lee et al., 2011. However, key limitations involve reliance on self-reported data, potential for response bias, the inherent "snapshot in time" nature of data, and its ability to establish definitive cause and effect relationships, thus distinguishing it from experimental designs (Lekan et al., 2021). The popularity of electronic surveys continues to grow in research due to their cost-effectiveness and ease of analysis (McPeake et al., 2014). However, empirical data highlights a reduced response rate for electronic surveys compared to more traditional methods (McPeake et al., 2014). Thus, researchers can employ personalisation, easily accessible survey links, and transparency about survey length to improve response rates (McPeake et al., 2014).

Recent studies highlight the effectiveness of integrating surveys with qualitative data to create mixed-methods designs (Copeland & Agosto, 2012). This facilitates data triangulation and improves internal consistency strengthening academic rigour (Creswell & Hirose, 2019).

2.9.4 Archival research

Archival research offers unique strengths, such as the ability to study phenomena over extended periods and access large, diverse datasets (Barnes et al., 2015). These methods differ in their approach, data collection processes, and analytical techniques; however, studies have been increasingly valuable in construction management research (Rahi, 2022; Sapeciay et al., 2017; Zhu et al., 2020). These studies typically involve the analysis of historical documents, records and various artefacts to garner more profound insights into past events, processes or phenomena (Sapeciay et al., 2017; Zhu et al., 2020), further enhancing research efforts (Das et al., 2018). Comparative methods applied across time and space have been shown to improve research practices (Buckley, 2016). While typically linked to qualitative methods, quantitative analysis can also be utilised for historical data (Simonton, 2002).

Having outlined the diverse methodological research strategies, it is evident that the survey approach represents the most appropriate quantitative methodological choice for phase one of this study. The quantitative methods employed in this research are discussed further in “Section 3.5, Data Analysis.” The following section provides an in-depth overview of qualitative methods, highlighting the appropriate qualitative methods for this research.

2.10 Qualitative methods

Qualitative research, on the other hand, starts with the researcher's self-reflection and adopts a more open-ended approach (Mwita, 2022). Qualitative research is an overarching term for diverse methodologies based on different epistemological foundations (Petty et al., 2012).

Qualitative methods offer flexibility, provide in-depth and detailed information, and allow for the use of multiple data collection techniques (Mwita, 2022). They are cost-effective and beneficial for understanding complex realities and the meaning of actions in specific contexts (Queirós et al., 2017). Qualitative approaches can provide deeper insights into human behaviours, perceptions, and experiences (Rahman, 2016). However, they are prone to researcher subjectivity, involve complex data analysis, and have limited generalisability (Mwita, 2022). Reproducing findings can be complex, and the researcher's biases may affect the outcomes (Dainty, 2008).

Qualitative research strategies include narrative studies, case studies, ethnography and phenomenology, and grounded theory (Creswell & Poth, 2016). These approaches differ in their historical development, data collection methods, and analytical techniques (Petty et al., 2012). Grounded theory focuses on developing theories from data, while case studies provide in-depth analysis of specific instances. Phenomenology explores lived experiences, ethnography examines cultural phenomena, and narrative research investigates stories and personal accounts (Petty et al., 2012; Rana et al., 2023).

Each methodology has unique strengths and applications in different research contexts, which are further defined below.

2.10.1 Grounded theory

Grounded theory was developed by Glasser and Strauss in the 1960s and is rooted in sociology (Stough & Lee, 2021). Petty et al. (2012) assert that grounded theory focuses on developing theories from data, seeking to generate a theory that explains a social process, action, or interaction based on data collected from participants who have experienced the phenomenon under study. Commonalities, such as interviews with other approaches, have led researchers to explore the integration of grounded theory with other approaches. Including hermeneutic phenomenology (Annells, 2006) and ethnography (Elsbach & Kramer, 2016). However, the uniqueness of grounded theory is demonstrated through its epistemological underpinnings, which distinguish it from other qualitative methods (Wimpenny & Gass, 2000). These variations reflect the evolution of grounded theory methodology since its introduction, with different iterations and variants emerging over time.

2.10.2 Case studies

Case studies of qualitative research methodologies originate from the human and social sciences as well as evaluative research (Creswell & Tashakkori, 2007). Case types may consist of people, institutions, policy, clinic, process or systems, however, emphasising the specific aspects of a case is a key element of case study research, regardless of case types (Stake, 1995). Their ability to capture detailed information on the comprehensive nature of the complexity of real-world problems ensure popularity and prominence in construction management research (Barrett & Sutrisna, 2009). The flexibility of data analysis techniques ensures they can be tailored to the specific inquiries, highlighting their methodological versatility, leading to a more insightful understanding of the research problem (Yin, 2018).

2.10.3 Narrative Studies

Elliott, (2005) confirms that narrative research is a qualitative methodology from the humanities and social sciences. It focuses on exploring detailed stories of life experiences of individuals, typically involving a small number of participants (Elliott, 2005). This approach can be used for both qualitative and quantitative studies. Data collection can involve various methods, including observation, participant diaries, letters, documentation, interviews, artefacts and photographs. These diverse sources help provide a detailed, contextualised story of the participant experience (Petty et al., 2012; Rana et al., 2023). Qualitative research methods that focus on the narrative approach offer a valuable opportunity to investigate the intricacies found within personal experiences deeply (Muylaert et al., 2014). These methods could be adapted to construction management research; however, they require careful prior consideration (Wiles et al., 2011).

2.10.4 Phenomenology

Phenomenology, a qualitative methodology, originates in early 20th-century German thought. Psychology and philosophy are key tenets of this method and are evident through its association with influential thinkers like Heidegger, Gadamer, and Satre (Mapp, 2008).

Klinke & Fernandez (2022) assert the strength of the phenomenological method lies in its ability to capture and understand individuals' perceptions of a phenomenon within their distinct environments, highlighting its methodological value (Boer & Zeiler, 2024).

Contemporary studies have explored the application of phenomenology in construction management research, seeking to capture industry professionals lived experiences, highlighting its utility in understanding complex industry challenges (Prakash & Ambekar, 2020). To extract the core meaning, researchers set aside their perspectives (bracketing) of the phenomenon to enhance their understanding (Cudjoe, 2023). This notion of researcher detachment bears similarities to the concept of objectivity in post-positivism (Cudjoe, 2023; Mapp, 2008).

However, the method is not without constraints, often considered as overly prescriptive and dogmatic, implying the need for more flexible approaches (Stilwell & Harman, 2021).

2.10.5 Ethnography

Ethnography is a branch of comparative cultural anthropology that began in the early 20th century. During the 1920s, sociologists utilised it to examine cultural groups in the United States (Wolcott, 1994). Ethnography provides a deep contextualised understanding of the cultural groups, making it valuable for studying various aspects of society (Creswell et al., 2007). Wolcott (1994) asserts that primary data collection is through observations, which may often require extended periods. Its main focus is on examining shared behaviours, language and belief systems within a cultural group, where the researcher immerses themselves in the culture seeking to observe, interview and develop a deeper understanding (Creswell et al., 2007). This suggests the value provided by qualitative methods regarding human experiences.

To further explore the diverse landscape of qualitative research, Table 2.2 provides a concise overview of the five prominent qualitative methods, their primary applications among researchers, and their underlying philosophical assumptions.

Table 0.2: A comparative analysis and overview of qualitative methods (Author's work)

Method	Focus	Data collection	Analysis approach	Philosophical underpinnings	Source
Ethnography	Examines shred patterns of behaviours, beliefs and language within a cultural group	Primarily uses participant observation over extended periods	Describes and interprets behaviour language and interaction	Can follow positivist, realist or critical approaches	(Atkinson, 2007; Atkinson et al., 2000; Creswell et al., 2007; Wolcott, 1994)
Phenomenology	Explores the unique lived experiences of	Most often involves	Seeks to uncover the	Rooted in psychology	(Moustakas, 1994; Osborn &

	individuals and the meaning of the phenomenon	individual interviews	essence of the phenomenon	and philosophy.	Smith, 2008; van Manen, 1990)
Case studies	Aims to understand what is distinctive about a specific case	Uses a variety of methods including interviews, observation, and document analysis	No specific method researcher chooses based on the focus of the study	Can follow positivist or interpretivist approaches	(Hancock et al., 2021; Stake, 1995; Yin, 2018)
Narrative studies	Focuses on detailed stories or life experiences of individuals	Employs a wide range of methods including diaries, letters, interviews and artefacts	Reorganises stories chronologically an identifies key aspects	Can incorporate various theoretical lenses	(Clandinin et al., 2016; Elliott, 2005b; Petty et al., 2012)
Grounded theory	Aims to generate a theory that explains a social process, action or interaction	Typically involves interviews and may also include observation and documentary data	Uses constant comparative method and coding to develop theory	Can follow positivist or interpretivist approaches	(Charmaz, 2006; Glaser & Strauss, 2017; Morse et al., 2016; Stough & Lee, 2021)

Although quantitative and qualitative methods are essential in various fields, mixed-methods approaches are increasingly acknowledged, as they integrate techniques to thoroughly tackle complex research questions (Creswell & Clark, 2017). Several researchers suggest combining both approaches through mixed methods, as this approach compensates for the divergent techniques and offers a more comprehensive understanding of the research topic (Choy, 2014; Kelle, 2006). Regardless, the choice between methods should be influenced by the research questions and objectives (Kelle, 2006) as well as the overarching paradigm.

Table 2.3 facilitates informed decision-making regarding methodological options, identifying the main methodological distinctions (Amaratunga et al., 2002; Dainty, 2008).

Table 0.3: Comparisons of positivist and constructivist paradigms (Amaratunga et al., 2002)

Factors / Themes	**Quantitative (positivist)**	**Qualitative (constructivist)**
Belief system	• External world and objective • Independent observer • Science is value free	• A socially constructed world • The observer is part of the observation • Science is driven by human interests
Researchers commitment	• Focus on Facts • Look for causality and fundamental laws	• Focus on meanings • Try to understand what is happening

	• Reduce the phenomena to the simplest elements. • Formulate hypotheses and test them	• Look at the totality of each situation • Develop ideas through induction of data
Strengths	• They can provide coverage of a wide range of situations • They can be fast and economical • Where statistics are aggregated from large samples, they may be of considerable relevance to policy decisions	• Data analysis methods are seen as more natural than artificial
Weaknesses	• Methods used tend to be relatively inflexible and artificial • They are ineffective in understanding processes, or the significance people attach to actions • They are not very helpful in generating theories • Because the focus on what is or what has been recent, they make it hard for policy makers to infer what changes and actions should take place in the future	• Data collection can be tedious and require more resources • Analysis and interpretation of data may be more difficult • Harder to control the pace, progress and endpoints of the research process • Policy makers may give low credibility to results from a qualitative approach

This discussion of various qualitative and quantitative methods highlights their strengths and applications within the field of construction management. However, these approaches individually were deemed inadequate for addressing the intricate and multifaceted nature of the research questions posed in this study. Understanding the "what and the why" of QM and productivity in the construction sector necessitated a more integrated approach.

Contemporary research suggests that combining the strengths of both objective and subjective data enhances the understanding of complex events, underscoring the primary strengths of mixed-methods research (Creswell & Clark, 2017). This methodological choice aligns with the pragmatic paradigm, as articulated by Johnson & Onwuegbuzie (2004) which emphasises the importance of using 'what works' to address research questions and generate practical solutions, thereby bridging the gap between theoretical insights and real-world applications.

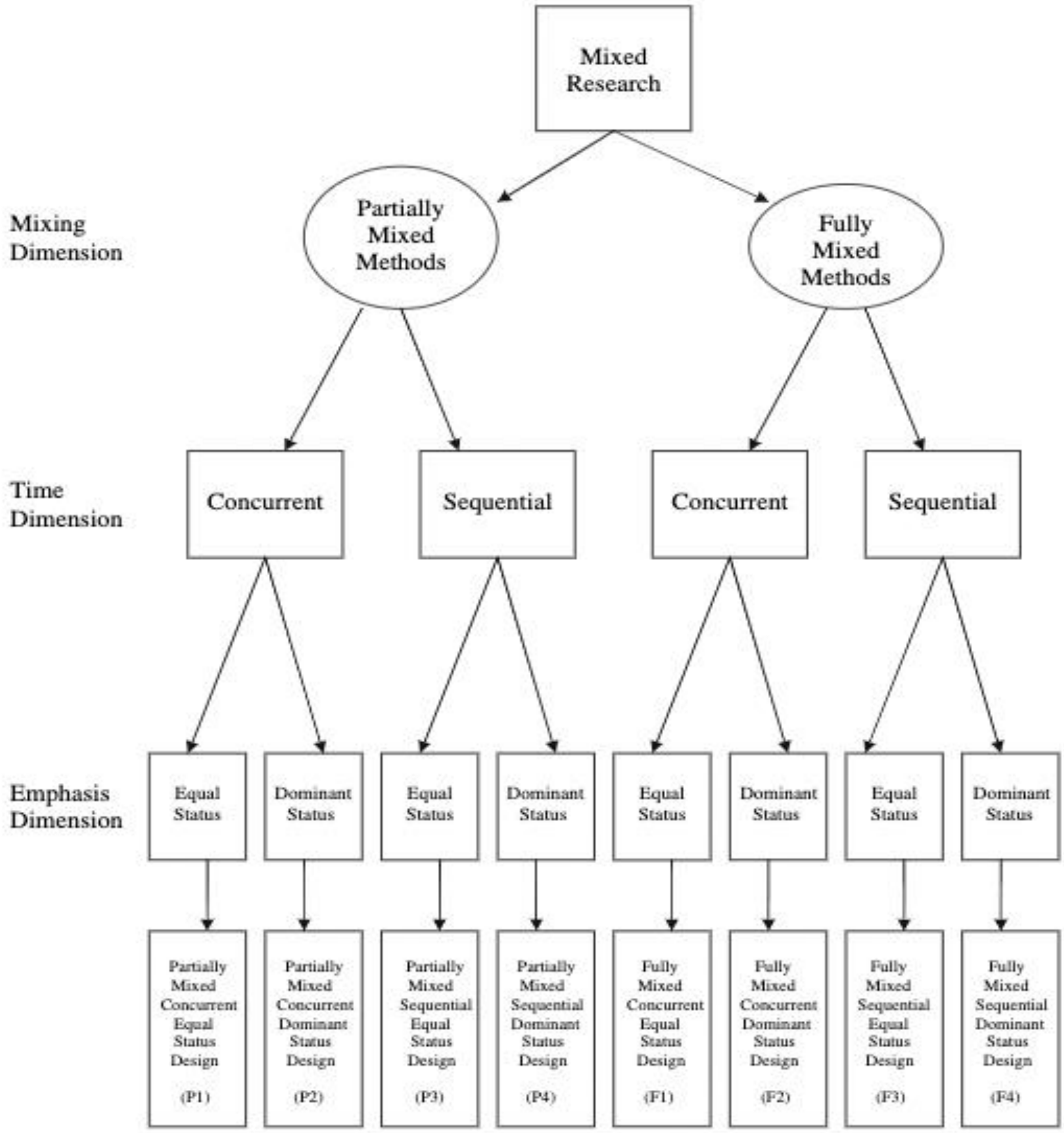
2.11 Mixed methods

Given the diverse strengths and limitations of the popular dichotomous methods, mixed methods research (MMR) offers a pragmatic alternative by integrating both qualitative and quantitative approaches. Indeed, empirical research (Creswell & Clark, 2017) confirms this integration is consistent with the pragmatic paradigm by emphasising effective strategies to tackle intricate research questions, thereby promoting a more comprehensive and nuanced understanding of the phenomenon in question.

The history of mixed-methods dates back to the 1800s (Hesse-Biber, 2010), although it became a prominent research methodology in the late 1990s and is suggested to have been formalised by Caracelli and Greene (1997). It developed from the necessity for greater effectiveness in addressing research issues amid traditional divergent approaches. Leech & Onwuegbuzie (2009) indicate that MMR is used where one method alone lacks sufficiency in answering the research problem. Moreover, Scalcau (2021) warns that triangulation of findings is essential for valid and reliable MMR. In addition, Morse (1991) discusses the importance of using a mixed methods approach that is appropriate for the research question. Arguing that researchers should carefully consider the strengths and weaknesses of different methods before selecting a final approach.

Leech & Onwuegbuzie (2009) confirms MMR allows a researcher to conduct a multi-level analysis that captures data in the study's individual (qualitative) and general (quantitative) context. The authors identify three dimensions necessary in guiding the choice of an MMR typology (Figure 2.4). Leech & Onwuegbuzie (2009) further propose that a researcher must determine if the level of mixing undertaken within the study is either part or thoroughly mixed. Next, they highlight that a researcher reviews the time orientation, which, in context, refers to the order in which research is undertaken, either sequentially or concurrently. In their final dimension, Leech & Onwuegbuzie (2009) acknowledge that a researcher must review the emphasis on the approaches, generally referring to whether there is a dominant or equal status amongst the qualitative and quantitative research components.

Figure 0.4: Various Types of Mixed Methods (Leech & Onwuegbuzie, 2009)



MMR employs quantitative and qualitative research methods, enabling sequential or concurrent studies (Onwuegbuzie & Leech, 2005). When a mixed methods approach is selected, the qualitative method provides detailed and varied observational data (Onwuegbuzie & Leech, 2005). Conversely, quantitative methods provide more generalisable survey data (Onwuegbuzie & Leech, 2005; Sieber, 1973). By investigating multiple perspectives, the mixed-methods approach can provide unique awareness of the research problem, which may lead to original and innovative thinking, engaging a deeper enriched understanding of the research problem (Krivokapic-Skoko & O'Neill, 2011; Morgan, 2007).

Creswell & Clark (2017) highlight two sequential mixed method research designs, the explanatory sequential and the exploratory sequential, both of which allow the researcher to leverage the strengths of quantitative and qualitative data to suit their unique research problem.

2.11.1 The sequential mixed methods design

In recent years, mixed methods research has gained popularity, especially with sequential explanatory and exploratory approach designs. These approaches collect and analyse quantitative and qualitative data in a single study (Ivankova et al., 2006). Creswell & Clark, (2017) discuss two main sequential mixed methods categories: explanatory and exploratory. Sequential mixed methods designs provide robust tools for examining complex phenomena (Fetters et al., 2013) and enable the acquisition of quantitative and qualitative data across research stages (Creswell & Clark, 2017; Valdez et al., 2022).

Conversely, the sequential exploratory design usually starts with gathering and analysing qualitative data, which is then complemented by quantitative research to validate or elaborate on the preliminary results (Christ, 2007; Hadi & Closs, 2015). This method is instrumental in scale or questionnaire development and is beneficial for investigating intricate phenomena (Fetters et al., 2013; Zhu et al., 2023). A key strength of sequential exploratory designs is their ability to comprehensively understand research problems by combining different data types (Fetters et al., 2013; Hadi & Closs, 2015). However, they can be time-consuming due to their multi-phase nature (Hadi & Closs, 2015). Additionally, researchers may face challenges in integrating quantitative and qualitative data effectively, which requires expertise in both methodologies (Fetters et al., 2013; Hadi & Closs, 2015).

Researchers using the sequential exploratory mixed methods design should consider the following;

1. Integration across various levels (Fetters et al., 2013),
2. The study's design, methods, and how results are interpreted and reported (Fetters et al., 2013)
3. The creation of survey instruments grounded in qualitative findings (Bussell et al., 2017)

The sequential exploratory mixed methods approach helps guide instrument development and is effective across multiple fields. Its ability to dive deeply into intricate phenomena suggests its worth as a methodological approach (Fetters et al., 2013). The design's versatility allows researchers to gain early insight into data analysis and adapt to the evolving nature of mixed methods research (Fetters et al., 2013).

Additionally, this research employs an investigative inquiry methodology utilised across different contexts and disciplines. Investigative inquiry methodologies in construction management research, range from traditional surveys, case studies, to other, more innovative techniques (Cheng et al., 2022; Fox & Alldred, 2014). Furthermore, these approaches offer valuable insights into complex phenomena, challenge existing assumptions, and open new research opportunities (Capps et al., 2016; Lehnert et al., 2016). However, they also reveal the need to carefully implement and interpret inquiry-based methods. The construction management field is also open to new philosophical approaches that could reshape how research is conducted and analysed in the construction industry (Cheng et al., 2022; Fox & Alldred, 2014).

The sequential exploratory mixed methods design demonstrates its value across various fields. Its strengths lie in informing instrument development, exploring complex phenomena, and comprehensively understanding research subjects. The design's versatility allows researchers to gain early insight into data analysis and adapt to the evolving nature of mixed methods research (Fetters et al., 2013).

Additionally, this research employs an investigative inquiry methodology utilised across different contexts and disciplines. Investigative inquiry methodologies in construction management research are diverse, ranging from traditional surveys and case studies to other, more innovative techniques (Cheng et al., 2022; Fox & Alldred, 2014). Furthermore, these approaches offer valuable insights into complex phenomena, challenge existing assumptions, and open new research opportunities (Capps et al., 2016; Lehnert et al., 2016). However, they also reveal the need to carefully implement and interpret inquiry-based methods. The construction management field is also open to new philosophical approaches that could reshape how research is conducted and interpreted in the construction industry (Cheng et al., 2022; Fox & Alldred, 2014).

The explanatory sequential design prioritises the quantitative phase before the qualitative component (Fetters et al., 2013). It begins with quantitative data collection and analysis and then uses qualitative methods to elucidate or expand upon the initial findings, hence its "explanatory" label (Ivankova et al., 2006; Toyon, 2021). This methodology enables researchers to gain profound insights into preliminary quantitative results and proves particularly useful when interpreting unforeseen results or exploring the underlying mechanisms behind quantitative relationships (Fetters et al., 2013). Sequential explanatory designs entail various phases of research that must be carefully considered within the realm of a researcher's worldview (Kuhn, 1962). Ivankova et al. (2006), state that researchers must consider several key aspects when using this design:

1. Priority or weight given to quantitative and qualitative data
2. Sequence of data collection and analysis
3. Stages at which quantitative and qualitative data are connected and integrated

Additionally, McCrudden & McTigue, (2018) state that integration in explanatory sequential designs can happen at various levels: 1. Study design level, 2. Methods level (in sampling frame and interview protocol development), and 3. Interpretation and reporting level (for example, through narrative and joint reporting).

While this approach offers powerful tools for investigating complex processes and systems (Fetters et al., 2013), it also presents data processing and presentation (Toyon, 2021) challenges. Hadi & Closs, (2015), confirm researchers need the requisite expertise to perform qualitative and quantitative data collection, analysis, interpretation, and integration, which can pose a considerable challenge. A significant issue is that sequential designs are often time-intensive, requiring multiple data collection and analysis phases (Hadi & Closs, 2015).

Despite their challenges, explanatory mixed methods design boast numerous strengths. They facilitate the triangulation of findings, clarify results from one method through another, and enable the examination of various research questions within a single study (Hadi & Closs, 2015). This approach enhances the validity, completeness, and confirmation of findings while reducing the inherent limitations of mono-method strategies (Dewasiri et al., 2018). By harnessing the complementary strengths of qualitative and quantitative techniques, explanatory mixed methods designs provide deeper insights into complex phenomena than either method could offer individually (Curry et al., 2013).

A key consideration of this research is understanding the complex interplay between QM and construction productivity. Creswell & Clark (2017) suggest that the mixed methods approach offers an unparalleled choice for examining complex, nuanced events. Hence, the sequential explanatory mixed methods approach is best suited for this research. By leveraging the research design and overarching paradigm, this methodological choice enables the creation of actionable insights. The study employs quantitative methods initially to identify trends and patterns, followed by qualitative inquiry that delves into the 'why' behind these findings, linking theoretical understanding with practical application. Consequently, this approach ensured that the research not only addressed the specific research questions but also aided in creating practical solutions for the industry, thereby satisfying the essential principles of pragmatic research (Johnson & Onwuegbuzie, 2004).

2.12 Research phase one

2.12.1 The sampling approach

Research designs are significantly affected by the choice of sampling methods which impact the quality and applicability of research outcomes (Ahmed, 2024; Rahman et al., 2022). Therefore, researchers need to understand the specific differences among various sampling techniques and methods to enable informed choices that allow the selection of the most appropriate option for their investigation.

However, creating a sampling frame for an online community study poses various challenges. In contrast to membership organisations, many online communities such as bulletin boards and chat rooms rarely offer the ability to contact participants. Wright (2005) asserts that using industry body associations to garner participants from association memberships is a practical and effective data collection approach. Aligned with Wright (2005), industry body associations are used to capture research participants' responses in Phase 1 of this study.

2.12.2 Acceptance criteria

The sample participants must possess a minimum of two years of experience in the specified roles within the residential construction sector in New Zealand. The following acceptance criteria are applied to all Phase One research participants:

- The experience must be in the New Zealand residential construction industry;
- A minimum of 2 years' experience in relevant New Zealand residential construction projects;
- Willingness and availability to participate.

Before data cleaning, a sample of (N)121 participants was captured from the sample group. Data cleaning reduced the final sample size to (N)106 participants. Geographically, the sample group extends to all of New Zealand.

2.12.3 The sample group

Probability sampling requires an adequate understanding of the sample population, which is deemed essential for effective implementation (Collins et al., 2007). A stratified probability sampling approach is used to gather participants from various roles within the New Zealand residential construction sector (Collins et al., 2007). Participants for this study are selected from industry associations that routinely collate information, such as membership professions on a "membership scorecard," revealing five typical roles (subsets) within the broader membership: project manager, company/managing director, quantity surveyor, construction manager, and site manager. A selection of industry organisations are chosen according to their membership profiles aligned with the intended study population.

Rowley's (2014) methodology ensures that the sample group's characteristics align with those of the wider industry population, thus guaranteeing a representative sample. Hence, aligned with industry membership profiles and previous research (Rowley, 2014) the professions chosen for this study are roles that closely engage with the research problem. A final sample group comprises residential construction industry professionals from the following five categories: general manager, construction manager, project manager, site manager and subcontractor representation. Stratified sampling is suitable for this study due to the variation within the population (Taherdoost, 2016). This sampling approach suggests that a multidisciplinary sample group may yield more diverse and thorough responses (Collins et al., 2007). Probability sampling is usually favoured due to its ability to represent the population effectively (Tongco, 2007). Table 2.4 confirms the representativeness of this study sample used in the Phase One online survey questionnaire.

Table 0.4: Sample size representativeness (Author's work)

Industry Profession	PM	CM	SM	GM	SUB
N	21	20	22	18	25
Total N	106				

2.12.4 Probability sampling

Of the various methods, probability sampling, including simple random, stratified, and cluster sampling, is highlighted for its ability to ensure generalisability. According to Curtin et al (2005) and Fowler (2014, pp.14-39) probability sampling techniques typically refer to a method where each individual in the population has an identical likelihood of being selected. This approach is generally considered the most effective means of ensuring that all sampling units accurately represent their respective populations (Rahman et al., 2022). Stratified sampling occurs when the information is divided into various strata according to shared attributes such as age, sex, ethnicity, occupation, financial status, educational background, and cultural heritage (Rahman et al., 2022). Random sampling is then conducted within each stratum (Ahmed, 2024). This approach offers the benefit of ensuring all population segments are represented. Stratified random sampling yields improved population coverage as researchers have greater control over the subgroups and can guarantee their inclusion (Rahman et al., 2022). Probability sampling is usually favoured due to its ability to represent the population effectively (Tongco, 2007).

2.12.5 Non-probability sampling

In contrast, non-probability methods such as convenience, purposive, and snowball sampling are helpful in exploratory situations (Ahmed, 2024). Tongco (2007) affirms that purposive sampling techniques are a non-probability sampling typology that is particularly effective when studying specific cultural domains with knowledgeable experts. Interestingly, while probability sampling is generally preferred for its representativeness, the inherent bias of purposive sampling can contribute to its efficiency, ensuring it remains robust even when tested against random probability sampling (Tongco, 2007).

Therefore, choosing an appropriate sampling method requires careful consideration of various factors, including the research objectives, population characteristics, and practical constraints (Rahman et al., 2022; Senila, 2023). Rowley (2014) describes the different sampling methods available to a researcher (Table 2.5).

Table 0.5: Sampling typologies (Rowley, 2014)

Sample Type	Description
Probability sampling	
Random	Cases are selected at random- as in a lottery, or roulette wheel or using a table of random numbers
Stratified	Population is divided into groups by characteristics appropriate for the research questions (e.g. age, occupation, income, profit, location) and then a sample is selected from each group
Cluster	Population is divided into segments (e.g. Geographical, by street) then several segments (e.g. Streets) are chosen at random
Non probability sampling	
Systematic	Cases are selected choosing every nth case- e.g. 5th, 10th, 20th etc. Systematic sampling is often regarded as close to probability sampling, depending on the order of the list
Quota	Cases are selected on the basis of set criteria (e.g. gender , age , income group) to ensure that sample has a spread of cases in different categories, even though some of the categories might be small
Purposive	The sample is 'hand-picked' for the research. Used when the researcher already knows something about the specific cases and deliberately selects specific ones to produce the most valuable data
Convenience	The sample is built from cases which are accessible, such as the organisations in certain regions, or the members of a social networking site
Snowball	A few key individuals are selected, and asked to contact or recommend other relevant individual. Could be viewed as mix between purposive and convenience sampling

Probability sampling is the preferred method for this research due to the necessity of a sample group that is representative of the target population in order to achieve the research objectives

(Tongco, 2007). Hence, researchers must stay informed to select the most suitable sampling technique for their study, ensuring robust and reliable results.

In line with previous research, this study employs a stratified probability sampling approach, considered the most suitable method for this research (Curtin et al., 2005; Fowler, 2014; Rahman et al., 2022). The stratified probability sampling entails selecting a sample group that accurately reflects the broader residential construction industry population. Concentrating on professions closely related to the research problem enables statistical generalisations and is well-suited to the aims of this study (Rowley, 2014). Table 2.4 confirms the representativeness of this study sample used in the Phase One online survey questionnaire.

2.12.6 Sample size

Contemporary research in construction management emphasises the importance of adequate sample sizes (Sapra, 2021) and diverse samples (Dobgegah et al., 2011) for quantitative research. Suggesting sample size considerations should be viewed alongside response rates and reliability of measurement tools to ensure validity and the generalisation of research findings (Dobgegah et al., 2011; Liberatore et al., 2001; Sapra, 2021).

However, Rowley's (2014) work challenges the idea that larger sample sizes are always superior in qualitative research. It emphasises the importance of context, the research approach, and meaningful insights over rigid numerical guidelines. Rowley's (2014) study highlights that determining sample size in research is contextual and varies by scientific paradigm. Positivist studies typically require larger samples to represent a population, while in-depth qualitative research can use smaller samples (Boddy, 2016). Rowley (2014) argues that even single-case samples can be highly informative, especially in management and medical research. The author offers further insight, suggesting that the sample size range can be substantial. Varying anywhere from 100 to 1,000 participants, depending on the questions, the proposed analysis, the research paradigm and the sample population. Boddy (2016), agrees with Mason (2010), that theoretical saturation is a helpful guide and critical when evaluating sample sizes for qualitative research design. Saturation occurs when the collected data provide no further insights or connections to new data or additional theoretical perspectives (Boddy, 2016; Mason, 2010; Rowley, 2014). For example, Boddy (2016), confirms that practical research shows data saturation can occur with samples as small as 12 participants in homogeneous populations. However, Lee & Lings (2008) highlight the inconsistencies in the methods used for selecting sample sizes in previous research. Conversely, Mayr et al. (2007) suggest alternate measures such as the use G*Power software for adequate sample size calculations. Thus, this study uses an a-priori power analysis to ensure sample size adequacy regarding statistical analysis.

2.12.7 Data collection - The questionnaire survey

Strong questions are a key component of effective questionnaire surveys in construction management research, enhancing empirical data gathering. Indeed, several investigations have highlighted the need for reliable and valid tools for data collection, identifying various methods, including well-designed surveys (Li et al., 2014; Zhang et al., 2021).

Research by Stewart, (2007 pp.171-191) and Teerajetgul & Charoenngam, (2006) on "knowledge creation processes" and Md & Mahesh (2020) "Knowledge management and safety culture" underscores the need for questionnaires that can adeptly capture the complexities of the construction sector. Furthermore, contemporary research by Phua (2013), challenges traditional industry perspectives in terms of construction industry questionnaires, highlighting the significance of individual-level constructs when developing questionnaires, suggesting elements like culture, empowerment, and trust are key factors in the discovery of fresh insights into project performance.

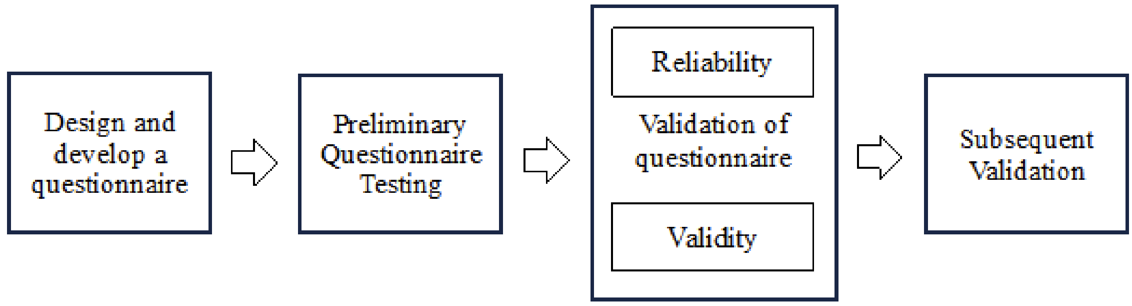
2.12.8 Questionnaire development

Several studies have highlighted the importance of questionnaire development and survey methods in the field of construction management (Simonaitis et al., 2023; Tam, 2024). Confirming that surveys are a significant method for data collection, with data mainly processed through statistical and descriptive analysis (Yuan & Shen, 2010). Furthermore, Faraji et al. (2022) affirm the importance of questionnaire content and warn that superior results come through alignment with industry-specific characteristics.

Research has extensively discussed the various impacts of questionnaire design on web surveys, emphasising its critical role in affecting response rates and data quality. Moreover, Žmuk (2024) warns that longer and more complicated questionnaire designs can risk reduced participation. However, the effect lacks uniformity across all domains. Similarly, long questionnaires can dissuade participant engagement; additionally, those who are engaged generally provide less detailed responses as the survey progresses (Žmuk, 2024). Others suggest variables such as visual presentation, interactivity, and question/response formats are essential factors to consider in questionnaire design (Hubbard et al., 2017; Ramirez Jr & Burgoon, 2004). Furthermore, researchers should balance the technical potential of web surveys with the need to motivate respondents and avoid overwhelming them with complex features. Cheng et al. (2022) affirm that researchers must carefully consider participant selection, device selection, task design, and area of interest determination when developing questionnaires using these techniques (Li et al., 2014; Zhang et al., 2021).

Hence, developing a questionnaire from empirical data in construction management research involves several essential steps. Aithal & Aithal (2020) provide a comprehensive framework (Figure 2.5) for questionnaire development, emphasising the importance of preliminary testing and validation using statistical methods.

Figure 0.5: Questionnaire design and development, reliability testing and validation stages (Aithal & Aithal, 2020)



This approach ensures the questionnaire is psychometrically sound and suitable for social sciences, business management, and health sciences research (Aithal & Aithal, 2020).

Aithal & Aithal (2020) confirm that rigorous survey methods are structured across three essential phases, beginning with the conceptual development. It involves building a preliminary model, identifying the problems constructs and formulating hypothesis for testing. The subsequent data collection and validation phase focusses on the sequential development, rigorous testing, validation (reliability and validity) and distribution of a questionnaire to a determined sample size. Finally the analysis and modelling phase utilises statistical methods to analyse the collected sample and consequently rebuild the preliminary model as the final, validated outcome.

Creswell & Hirose, (2019) identify key variables in survey development, such as the importance of clearly articulated research objectives and specific research questions. Creswell & Hirose (2019) affirms the importance of conducting a thorough literature review and the advantages of developing a conceptual framework. Yusoff et al. (2021) confirm a systematic questionnaire development and validation approach is crucial for producing high-quality survey research. An overview of the empirical perspectives employed in this research, specifically regarding the questionnaire development process, is presented in Table 2.6.

Table 0.6 : Questionnaire development overview (Author's work)

Stage of Development	Action to Consider	Source
1. Define Research Objectives & Questions	• Clearly articulate research objectives and specific research questions • Ensure research questions are: measurable, answerable, relevant	Sekaran & Bougie (2020) Aithal & Aithal, (2020)
2.Literature review & conceptual framework	• Conduct a thorough literature review • Develop a conceptual framework • Identify key variables and constructs	Creswell (2019); Sekaran & Bougie (2020)
3. Data collection & analysis (Empirical phase)	• Collect relevant data: review existing literature, conduct preliminary studies (e.g., focus groups, interviews), analyse existing data • Analyse collected data: Identify key themes, patterns, relationships, critical success factors, challenges, and best practices	Aithal & Aithal (2020)
4. Questionnaire development	• Determine the type of questionnaire • Develop clear and concise questions • Design the questionnaire layout • Refine questions based on empirical data and expert feedback	Aithal & Aithal (2020)
5. Pilot testing & refinement	• Conduct a pilot test with a small sample of the target population • Gather feedback from pilot test participants to identify any ambiguities, inconsistencies, or difficulties in understanding the questions • Revise the questionnaire based on pilot test feedback	Fowler (2014); Aithal & Aithal (2020)
6. Ethical considerations	• Obtain informed consent from all participants • Ensure confidentiality and anonymity of participant responses • Obtain necessary approvals from relevant ethical review boards	American Psychological Association (APA). (2010); Aithal & Aithal (2020)
7. Data collection & analysis	• Administer the questionnaire • Collect and clean the data • Conduct statistical analysis	Hair et al., (2010); Fowler (2014); Aithal & Aithal (2020)
8. Interpretation & reporting	• Interpret the findings in the context of the research objectives and literature review • Draw conclusions and make recommendations • Report the findings in a clear, concise, and well-structured manner	Creswell, J. W. (2019); American Psychological Association (APA). (2010)

Interestingly, while traditional design principles for desktop and laptop-based surveys may not be adequate for smartphone questionnaires, researchers have identified specific design heuristics for creating effective smartphone questionnaires (Antoun et al., 2017). The readability, ease of selection, visibility across the page, simplicity of design elements, and predictability across devices are key determinants of cross-platform questionnaire success (Antoun et al., 2017).

The questionnaire survey for this study was meticulously designed to ensure its relevance and effectiveness in addressing the research questions. The survey instrument was developed through a comprehensive process that included:

- **Narrative literature review:** An extensive review of relevant literature was conducted to identify existing scales and questionnaires used to measure QM practices and productivity in the construction industry.
- **Expert consultation:** Industry experts and academics were consulted to gather feedback on the survey design and ensure its alignment with current practices and challenges in the New Zealand residential construction sector.
- **Pilot testing:** A small group of construction professionals is engaged for preliminary testing of the questionnaire survey, which is used to refine the survey instrument and ensure its clarity and comprehensibility.

The questions were derived from a review of established scales and literature, which tailored items designed to address the research questions. This approach ensured that the survey instrument is both valid and reliable, capturing the relevant information needed to answer the research questions effectively. As well as allowing for further exploration of the trends and patterns identified through descriptive statistics and mean value analysis.

2.12.9 Online questionnaires

Globally, numerous studies in construction management have employed online surveys as the primary research tool, effectively addressing various industry aspects and demonstrating their versatility and efficiency in this field (Bowen et al., 2009; Othman et al., 2020; Potter et al., 2018; Unegbu et al., 2024). The benefits of online survey methods are evident compared to other formats, highlighting respondent convenience as a key determinant, which ensures end-user control in terms of time, method, and location (Hays et al., 2015). Furthermore, with platforms like Qualtrics, respondents can complete the survey over multiple sessions if necessary (Regmi et al., 2017). For the researcher, cost and speed are significant advantages (Couper, 2000; Lavrakas, 2008).

Lee & Lings (2008 p, 273) assert that mail surveys in the UK typically yield response rates of approximately 15-30%. Bryman (2011p. 235) found that follow-up measures increased the response rate to 37% and affirmed that a 20% response rate may be sufficient for social science research. Conversely, Rowley (2014) asserts the popularity and effectiveness of online surveys when conducted effectively and provides suggestions for designing and managing web-based surveys.

The phase one research employs an online questionnaire survey using Qualtrics software. Table 2.7 further expands on the advantages and disadvantages of web-based survey methods.

Table 0.7: The advantages and disadvantages of web-based survey methods (Author's work)

Advantages	Disadvantages	Sources
Cost-effectiveness: significantly reduce costs associated with printing, mailing, and data entry	Sample Bias might exist, hence not representing the target population accurately	(Couper, 2000; Lavrakas, 2008)
Time-efficiency: rapid data collection and analysis, real-time access to data	Web based surveys can have lower response rates compared to other methods	(Dillman, et al., 2014)
Increased reach and geographic flexibility: reach a wider and more geographically diverse population.	Data quality concerns may occur if respondents do not take online surveys seriously, leading to careless or inaccurate responses	(Schonlau et al.,, 2004)
Improved data quality: built-in features to minimize data entry errors	Ethical considerations around ensuring data privacy and confidentiality can be challenging	(Groves et al., 2009) (Groves, 2006)
Enhanced data collection capabilities: incorporate multimedia elements and advanced features	Respondents may encounter technical difficulties.	(Couper, 2008; Dillman, et al.,2014)

In conclusion, developing questionnaires for empirical research in construction management requires careful consideration of design principles (Aithal & Aithal, 2020), validation processes (Creswell & Hirose, 2019; Sekaran & Bougie, 2016) and the intended platform for survey administration (Antoun et al., 2017). Researchers should follow a systematic approach to questionnaire development, ensuring reliability and validity through appropriate statistical methods (Yusoff et al., 2021). This process is critical for gathering accurate data and producing meaningful results in construction management research (Aithal & Aithal, 2020; Creswell & Hirose, 2019; Sekaran & Bougie, 2016).

In accordance with established protocols from the empirical literature review, an online questionnaire was developed and used in this study via Qualtrics software (Aithal & Aithal, 2020; Sekaran & Bougie, 2016). The primary research instrument comprises a nationwide survey of quantitative and qualitative questions. Data are collected through a self-administered online questionnaire. This elicits respondents' perspectives on QM systems, practices, processes, techniques, behaviours and productivity improvement strategies employed in residential construction organisations to address enhanced productivity. The survey incorporates diverse question formats to maximise generalisability. Participants were asked to provide their views on a 5-point Likert scale consisting of fourteen (14) items related to construction productivity and QM. The questionnaire is supplemented by three open-ended questions, one ranked-order question, and demographic information, including age groups, professions, industry experience, and office locations. Open-ended questions enable respondents to provide additional commentary on the rationale behind their choices, thereby simultaneously capturing and connecting data from both qualitative and quantitative methods.

2.12.10 Quantitative - closed questions - Likert scale

The Likert scale, a widely used psychometric tool in social sciences research, has a rich history of debate and development (Joshi et al., 2015; Tanujaya, Charitas, et al., 2022). Originally introduced as a measurement tool for qualitative approaches, it has become one of the most essential rating scales in survey research (Anjaria, 2022). Despite its widespread use, the Likert scale has been subject to numerous controversies. These include data quality, latent variable assessment, the accuracy of collected data. Furthermore, the ranking order and distance between scale options, and the possibility of performing mathematical operations on the data (Anjaria, 2022; Joshi et al., 2015). When considered strictly as an ordinal scale, the scale's treatment as an interval scale has also been a strong point of contention (Wu & Leung, 2017). Thus, ascertaining data normality or the assumption of normal distribution for Likert scale data is essential, as it significantly influences the selection of appropriate statistical tests (Kwak & Park, 2019). A shared finding across studies is that the group of items must initially pass internal consistency tests (Allen & Seaman, 2007; Garland, 1991; Krosnick, 1999; Likert, 1932; Wu & Leung, 2017).

The significance of Likert scales is evident in their widespread popularity in questionnaire research, highlighting their continued importance. Despite its widespread use, the Likert scale has been subject to numerous controversies and debates. These include data quality, latent variable assessment, the accuracy of collected data, the ranking order and distance between scale options, and the possibility of performing mathematical operations on the data (Anjaria, 2022; Joshi et al., 2015). Research suggests that the concept of "scale length" is a contentious topic among empirical researchers, highlighting a lack of consensus on the optimal number of points, which can range from 4 to 11 points. Dawes (2008) and Hodge & Gillespie (2007) advocates for using an 11-point scale (0-10) due to its superior sensitivity, alignment with normal distribution, and clarity for respondents, which can potentially capture the finer distinctions in respondent opinions. Research indicates that treating data as an interval scale can enhance the power and interpretability of analyses; however, this method may lead to misleading or misrepresented findings (Allen & Seaman, 2007; Leung, 2011; Wu & Leung, 2017). This type of scale could benefit the analysis of complex, nuanced attitudes where subtle distinctions matter.

In contrast, Xu and Leung (2018) indicated that cost could be a factor to consider on longer scales and contend that respondents may find it challenging to consistently differentiate between adjacent points on extended scales. However, Moors et al. (2014) argued that end-point labelling of categories at the extremes may introduce response bias. In contrast, Likert (1932) advocates for labelling every selectable option. Krosnick (1991) posits that longer scales may increase cognitive load, potentially leading to fatigue, satisficing, and dropout and further suggests that the 5-point scale may be more manageable for respondents to navigate.

Researchers (Unegbu et al., 2020; Wu & Leung, 2017) confirm that 5-point Likert scales are commonly used in construction management to assess project performance and management practices, providing several benefits. The scale offers a standardised method for measuring attitudes and opinions, allowing for time-efficient data collection and analysis. Its simplicity makes it accessible to most respondents, potentially increasing response rates. Additionally, the 5-point scale strikes a balance, providing enough options for nuanced responses while avoiding overwhelming respondents with the paradox of choice.

Garland (1991) argues that odd-numbered scales with a neutral midpoint can provide an option for respondents who are uncertain or ambivalent. While this allows for the expression of neutrality, it may also result in central tendency bias, where respondents tend to cluster around the midpoint, potentially obscuring genuine differences in opinions. Garland (1991) argues that including midpoints reduces social desirability bias, while others see it as a "forced choice" when removed (Allen & Seaman, 2007; Leung, 2011). Using even-numbered scales may mitigate this bias, although the author warns that this approach may be counterproductive for respondents (Garland, 1991).

Research demonstrates that shorter and longer scales can achieve acceptable reliability and validity regardless of scale size (Chang, 1994). Some authors (Leung, 2011; Wu & Leung, 2017) simplify this notion and infer that the key is to ensure that the scale is appropriately constructed with unambiguous wording of the items and response options. The choice of scale length should be justified based on the research objectives and the nature of the measured construct.

Following empirical research (Chang, 1994; Krosnick, 1991; Unegbu et al., 2020; Wu & Leung, 2017) this study uses two five-point Likert scales to measure participant opinions, attitudes, and behaviours regarding QM practices and productivity improvement strategies in the New Zealand residential construction sector. The five points range from strongly disagree, neither agree nor disagree, and strongly agree (Likert, 1932). The researcher developed the questionnaire by combining existing empirical knowledge with established theory, using a deductive method for the formulation process.

The choice of a 5-point Likert scale for this research was chosen for its balance between providing sufficient response options and minimising participant burden and aligns with the pragmatic principle of selecting the most effective and efficient tools for answering the research questions. was guided by its balance between providing sufficient response options and minimising participant burden, aligning with the pragmatic principle of selecting effective and efficient tools. As recommended by Dawes (2008), a 5-point Likert scale offers a reasonable level of discrimination without overwhelming respondents, making it suitable for capturing nuanced responses to the research questions (RQ1-5) while maintaining a pragmatic focus on data collection that is feasible and manageable within the study's constraints.

2.12.11 Qualitative - open-ended questions

Aligned with empirical studies by Braun & Clarke (2006), open-ended questions complement the closed-ended Likert scale questions in this research. Thus, providing participants with the opportunity to express their perspectives and views naturally, thereby capturing valuable, rich, and diverse insights into their subjective realities. This approach aligns with the mixed-methods nature of this research, which integrates quantitative and qualitative data to engage a deeper understanding of the research problem (Creswell & Clark, 2017). The incorporation of open-ended inquiries serve as a vital bridge between the quantitative data and research objectives, facilitating a more comprehensive exploration of the research problem. For instance, where statistical analysis shows a high adoption of certain factors and strategies, the open-ended questions can uncover the reasons for this adoption, perceived benefits or drawbacks, providing invaluable depth. Thus, aiming to discover the reasoning behind the observed phenomena, analysing quantitative and qualitative data, particularly the "why" behind the "what" directly contributes to RO2 and seeks to gain a more profound insight into the productivity factors and their effect on QM and construction productivity in the local residential context. Secondly, open-ended questions facilitate the collection of a wide range of perspectives and experiences that might not be fully captured through closed-ended questions (Baburajan et al., 2020; Hansen & Świderska, 2023). This contributes to RO3 by offering insights into how effective developed QM strategies are in the residential context, particularly crucial in understanding the viewpoints of multiple industry stakeholders.

The open-ended format can uncover unforeseen insights and themes that the researcher may not have anticipated, paving the way for new research directions and a more profound understanding of the research issue (Alshaikh et al., 2024). This can inform RO5 by proposing potential QM strategies for enhancing productivity.

Thematic analysis is employed to examine the answers to open-ended questions, which are used to help validate prior research findings informing RO4. Following Braun & Clarke (2006) six-step framework, which involves a systematic approach that starts with data familiarisation and code generation, followed by searching for and reviewing themes, and defining and naming them. A final report ensures that the qualitative data is rigorously analysed, and the findings are presented clearly and meaningfully.

This study seeks to deepen the understanding of the intricacies associated with QM and productivity by incorporating open-ended questions into the survey and employing thematic analysis of captured data, thus facilitating the creation of practical and effective solutions.

2.12.12 Ranked order questions

In addition to the Likert scale and open-ended questions, this research employed ranked-order questions within the questionnaire to gain further insights into participant perspectives on productivity improvement factors. Ranked-order or ranking questions require respondents to prioritise items based on their perceived importance, preference, or relevance (Brace, 2018, p.77). This method allows for a nuanced understanding of participant viewpoints by capturing their relative importance to different factors or options. As Ismanto et al. (2018) argued ranked-order questions provide valuable data for understanding how individuals prioritise various aspects of a phenomenon, offering insights that may not be captured through other question formats.

This research's use of ranked-order questions aligns with the pragmatic paradigm, emphasising the importance of generating academically rigorous and practically relevant knowledge. By asking participants to rank common empirical factors that may positively influence productivity, this research aims to identify the most critical areas for improvement. Thereby contributing to the development of targeted and effective interventions and generating actionable insights that can be used to address real-world problems and enhance practice.

The ranked-order questions in this study were specifically designed to address RO2, which explores the common factors that positively affect construction productivity in the New Zealand residential sector. Furthermore, the data on the ranked-order questions can contribute to RO5 by providing insights into the relative importance of different QM strategies, aiding in formulating recommendations for improving productivity.

The data obtained from the ranked-order questions is analysed using appropriate statistical techniques, such as the Garrett Ranking Technique, to determine the relative importance of different factors and inform the development of targeted interventions. This approach aligns with the pragmatic worldview, emphasising appropriate methods to address research questions and generate practical solutions.

2.12.13 Demographic questions

In addition to gathering data on QM practices and productivity, this research also collected demographic information from participants through the questionnaire survey. Demographic data, which includes characteristics such as age, gender, education level, and industry experience, provides valuable context for interpreting the research findings and understanding potential variations in perspectives across different groups (Davis et al., 2023) As Babbie (2010) argues, demographic data allows researchers to "paint a picture" of the research population, providing insights into the characteristics of the individuals who participated in the study. The inclusion of demographic questions in this research aligns with the pragmatic paradigm, which emphasises the importance of generating academically rigorous and practically relevant knowledge.

By collecting demographic data, this research aims to identify potential patterns and variations in perspectives across different groups, contributing to a more nuanced understanding of the research problem (Gupta et al., 2019; Knight et al., 2009). This approach reflects a pragmatic focus on generating insights that can inform the development of targeted interventions and strategies for improvement.

The demographic questions in this study were designed to capture information on industry experience, age groups, geographic location, and education levels. This data is relevant to all the research questions as it allows for exploring potential relationships between demographic characteristics and perspectives on QM and productivity. For instance, the research can investigate whether there are differences in the perceived effectiveness of QM systems across different age groups, experience levels and professions. This analysis can provide invaluable insights into the factors influencing the adoption and implementation of QM practices in the New Zealand residential construction sector.

The demographic data will be analysed using descriptive statistics and potentially more advanced statistical techniques, such as correlation analysis and the Kruskal-Wallis test, to explore potential relationships between demographic characteristics and the variables of interest (Ali & Bhaskar, 2016; Gupta et al., 2019). This analysis will contribute to a more comprehensive understanding of the research problem and inform the development of targeted recommendations for improving QM and productivity in the construction industry.

2.12.14 Pilot study

Pilot studies offer advantages and constraints in construction management research surveys, serving as 'trial runs' that enable the identification of problems, allowing for the refinement of survey presentation, questions, and format before a full-scale study (Abbott, 2014; Leon et al., 2010; Teijlingen & Hundley, 2005). Indeed, empirical research suggests pilot studies are crucial for enhancing the reliability and validity of research findings (Leon et al., 2010).

For instance, Sha'Ar et al. (2016) used a pilot study and literature review to gather information on design-construction interface problems. Similarly, (Benjeddou, et al., 2023) used a pilot study with exploratory factor analysis to identify critical BIM barriers in Malaysian small construction projects. They suggested pilot studies refine hypotheses before the primary survey, enhancing research quality. However, Leon et al. (2010) present a contrasting view, confirming that pilot studies help validate and improve survey instruments.

Research on sample sizes of pilot projects in construction management suggests that selecting an appropriate sample size is crucial for reliable and practical primary research. However, there is a lack of clear consensus on the exact number of participants needed for a pilot study in this field (Johanson & Brooks, 2009; Westlund, 2017). Pilot studies are fundamental for evaluating the feasibility of methods and procedures used in more extensive studies (Teresi et al., 2021). These investigations help estimate recruitment and retention rates, assess intervention fidelity, and evaluate acceptability, adherence, and engagement (Teresi et al., 2021). In construction management research surveys, these aspects are essential before the main study, as they help identify potential problems that guide the refinement of the questionnaire.

Boddy (2016) asserts that limitations exist in pilot studies, notably smaller sample sizes, which may restrict the generalisability of findings and require additional time and resources. Conversely, Rowley (2014) affirms that the significant benefits potentially outweigh limitations, suggesting that methodological refinement and improved data quality enable a more rigorous research approach.

In construction management research surveys, aiding in identifying potential issues, refining survey instruments, and enhancing research quality. Insights from pilot studies can significantly improve the validity and reliability of research findings in construction management (Sha'Ar et al., 2016; Alaloul, et al., 2023). While pilot studies are often used to estimate effect sizes for sample size calculations in primary studies, this practice has been criticised (Bell et al., 2018; Teresi et al., 2021) due to limited sample sizes and substantial confidence intervals (Teresi et al., 2021). Instead, pilot studies should evaluate feasibility aspects like recruitment, retention, intervention fidelity, acceptability, adherence, and engagement (Teresi et al., 2021).

While there is no definitive answer for the ideal sample size in pilot studies for construction management research surveys, some general guidelines can be followed. The probability sampling approach is used in this study's pretesting phase (pilot study), engaging similar industry professionals to those proposed in the main study. The questionnaire pilot study survey targets participants from the following residential construction industry subgroups: general management, project management, site management, construction management and subcontractor representatives. By adhering to empirical guidelines (Roopa & Rani, 2012; Rowley, 2014) this pilot study achieved a random sample of approximately 5-10% (n = 7) of the final sample size (n = 106). Aligned with the empirical literature (Leon et al., 2010; Rowley, 2014), the small-scale study aimed to identify and address potential issues with the questionnaire, specifically regarding question wording and understanding. While also further assessing the validity and reliability of the research instrument. Feedback from respondents on the questionnaire's wording and usability prompted slight modifications to the main questionnaire's phrasing. Pilot study participants were mobilised through a survey link distributed through the membership portals of five professional associations (Nayak & Narayan, 2019; Nowell et al., 2017).

2.12.15 Phase 1 quantitative data analysis techniques

Table 2.8 outlines the quantitative methods employed in this research, along with the rationale behind their selection, which is closely tied to the relevant research objectives. These methods were chosen based on their alignment with the pragmatic worldview and suitability for addressing the research questions and objectives. A further discussion of each quantitative method used in this research is provided beyond Table 2.8.

Table 0.8: Quantitative methods chosen for this study (Author's work)

Method	Reasoning	Research question addressed
A-priori power analysis	To determine the appropriate sample size, ensuring sufficient statistical power to detect meaningful effects	RO2 - RO4, how effective is the developed strategy for QM in the NZ residential sector?
Cronbach's alpha	To assess the internal consistency and reliability of the Likert scale questions, validating the survey instrument	RO2 - RO4: all research questions rely on the validity of the survey instrument
Descriptive statistics	To analyse the demographic data, providing a comprehensive overview of the participant characteristics	Understanding participant characteristics is relevant to research questions RO2 - RO4
Likert Scale analysis-questionnaire survey	To measure participants' attitudes and perceptions regarding QM and productivity improvement strategies	Research questions RO2 - RO4 involve assessing attitudes and perceptions
Mean value analysis	To evaluate the central tendency of responses to Likert scale questions, helping to identify key trends and patterns	Identifying trends and patterns is relevant to research questions. RO3 - RO4
Kruskal-Wallis test	To examine the differences in perspectives among various groups of research participants	RO2 - RO4. this test can help identify if certain factors affecting productivity are perceived differently by different groups.
Spearman's Rho test	To infer bivariate relationships between ordinal variables	RO2 - RO4: this test can help identify relationships between QM strategies and productivity (RO3 and RO4) relationships between different factors affecting productivity (RO2)
Garrett ranking technique	To analyse and prioritize the factors that can improve construction productivity in the NZ residential construction sector	This technique directly addresses the prioritization of factors affecting productivity (RO2) and informs the suggestion of improvement strategies (RO4)
Kolmogorov-Smirnov test	To test for normality of the data set	This test is relevant to research questions RO3 - RO4 as it informs the choice of appropriate statistical tests for further analysis

2.12.16 A-priori power analysis

G*Power is a statistical power analysis program designed specifically for behavioural research, offering precise analyses for standard statistical tests (Erdfelder et al., 1996; Mayr et al., 2007). It can perform post hoc, a-priori, and compromise power analyses, allowing researchers to calculate power values, sample sizes, and α and β values (Erdfelder et al., 1996). The advantage of using G*Power in mixed-methods research is its ability to help researchers determine appropriate sample sizes for the quantitative components of their studies. However, it's crucial to recognise that mixed-methods research often requires a balance between qualitative and quantitative elements, and sample size considerations may differ between these approaches (Heyvaert et al., 2011; Love & Corr, 2021). Thus, this study employs an a-priori power analysis to ensure that it has sufficient statistical power to detect meaningful effects. The a-priori power analysis, particularly relevant to RO2-RO5, explores the effectiveness of developed QM strategies and productivity improvement factors. Determining the sample size of this study through an a-priori analysis ensures more valid and reliable findings, aligning with the pragmatic emphasis on potentially generating robust and practical solutions for industry. Additionally, aligned with empirical research, which affirms the importance of power analysis in avoiding Type II errors in quantitative research, it ensures that the study can accurately detect the effects of interventions or relationships between variables (Cohen, 2013).

Thus, this study employs an a-priori power analysis to ensure sample size adequacy and sufficient statistical power. Using G*Power 3.1.9.7, a sample size of 305 participants was determined to be optimal for achieving sufficient statistical power. Of the 305 questionnaires issued, 121 responses were received, of which 15 were deemed invalid, rendering a sample group of 106 valid responses. The sample size is calculated on a 95% confidence level and a 5% margin of error.

This study's 34% response rate aligns with empirical research that asserts a 25% sample response rate is sufficient for robust data analysis (Hedlin, 2020; Rowley, 2014). Furthermore, The Statistical Packages for the Social Sciences (SPSS) V25 is used to assess data normality, while the Kolmogorov-Smirnov test revealed a non-parametric distribution.

2.12.17 Cronbach's alpha

The internal consistency and reliability of the Likert scale items in this study are assessed using Cronbach's alpha. This measure ensures that the survey instrument consistently captures the intended constructs related to QM and productivity. Empirical research suggests (Tavakol & Dennick, 2011). Cronbach's alpha was employed to assess the internal consistency and reliability of the Likert scale items used in the questionnaire. This measure ensures that the survey instrument consistently captures the intended constructs related to QM and productivity. As Tavakol and Dennick (2011) recommended, a Cronbach’s alpha value of 0.7 or higher is generally acceptable, indicating good internal consistency. In this study, Cronbach’s alpha is calculated for each multi-item scale to ensure the reliability of the data used for subsequent analyses. This step is essential for validating the survey instrument and ensuring the findings are based on reliable data, aligning with the pragmatic emphasis on robust and trustworthy results. This method is used for all research questions in this study.

Before proceeding with further statistical analysis, the normality of the data distribution is assessed, ensuring the appropriateness of subsequent statistical tests.

2.12.18 The Kolmogorov-Smirnov test

The Kolmogorov-Smirnov test is a pivotal step in selecting the appropriate statistical tests in this study. Razali & Wah (2011) recommended the Kolmogorov-Smirnov test as a reliable method used to test the normality of the data set. It provides a comparison of the cumulative distribution function of the sample data with a theoretical normal distribution, providing a measure of goodness-of-fit, ensuring the assumptions of parametric tests are met (Razali & Wah, 2011). Thereby, informing the choices of further statistical analysis addressing all research questions.

2.12.19 Descriptive statistics

Various descriptive statistical methods including measures of central tendency and dispersion are used to describe and summarise the demographic characteristics of the sample group and the distribution of survey item responses (Field, 2022). The statistical analysis provides a comprehensive overview of the sample data, enabling the researcher to understand the context of the study and identify any potential biases or outliers. Empirical literature identifies that descriptive statistics are fundamental for providing a clear and concise data summaries which is essential for interpreting the results of more advanced statistical analyses (Field, 2022; H. Wu & Leung, 2017). This step is crucial for contextualising the findings and ensuring that the research questions (RO1-RO5) are addressed meaningfully (Jebb et al., 2021).

The groundwork for quantitative analysis has been laid through power analysis, reliability assessment, data normality tests, and descriptive statistics. The upcoming sections will explore the specific methods used to analyse the data and address the research questions.

2.12.20 Likert scale analysis - questionnaire survey

From a pragmatic perspective, Likert scale items are valuable for measuring attitudes and perceptions with observable consequences. Thus, the use of Likert scales is widely accepted as a reliable and valid approach for data collection in construction management research (Bryman, 2016; Jebb et al., 2021). Empirical research (Bryman, 2016) suggests that Likert scales offer a structured and standardised approach for quantifying subjective opinions and experiences provided. Thereby, suggesting their suitability for capturing the nuances of participants' perspectives (Wu & Leung, 2017).

This study uses Likert scale questions to measure participants' perceptions of QM systems and productivity improvement strategies in enhancing productivity. A questionnaire survey is administered to a representative sample of construction professionals to gather data on their experiences and opinions. This data is pivotal in addressing RO3 by offering insights into the perceived effectiveness of the developed QM strategy. The survey data will also inform RO4 by identifying areas where QM practices can be improved to enhance productivity.

A narrative literature review informs the design of this study's survey, adapting empirical knowledge to the specific context of the local residential construction industry (Hettithanthri & Hansen, 2021). The formulation of questions enables direct addressing of the research questions, ensuring that the collected data is relevant and meaningful (Juntunen & Lehenkari, 2019).

The application of Likert scales and their further analysis advances the descriptive overview by delving into the intricate responses gathered from the survey questionnaires, thereby yielding enhanced insights into the participants' attitudes, opinions and perspectives.

2.12.21 Mean value analysis

Mean Value Analysis is used to evaluate the central tendency of responses to Likert scale questions. This method will help identify key trends and patterns in participants' attitudes and perceptions, providing insights into the overall effectiveness of QM practices (Ali & Bhaskar, 2016). The overall sentiment towards different QM strategies is calculated by the mean scores for each Likert scale item, allowing the researcher to determine levels of agreement and disagreement among participants.

As Guzik & Więckowska (2023) recommended, mean value analysis is a fundamental technique for summarising and interpreting Likert scale data, providing a clear and concise overview of the participants' responses by identifying trends and patterns and is relevant to all research questions**.** This data is used to answer RO1 by identifying the most common QM systems used by residential construction organisations. Additionally, RO2-RO5 are informed by identifying the factors perceived to have the most significant impact on New Zealand residential construction productivity.

Further analysis uses the Kruskal-Wallis test to investigate potential differences in perspectives among various participant groups. This test allows for the comparison of responses across different demographics and professional roles (Ali & Bhaskar, 2016; Siegel, 1957).

2.12.22 The Kruskal-Wallis Test

The Kruskal-Wallis test, a non-parametric equivalent to the parametric ANOVA test. It is used in this study to examine the perspectives and differences in various roles or experience levels among the diverse professional groups of research participants. Empirical research (Pham et al., 2021; Siegel, 1957) suggests the Kruskal-Wallis test is particularly suitable for analysing ordinal data from Likert scales, asserting it is a robust method for comparing the medians of multiple groups. It ensures its suitability for identifying statistically significant differences in attitudes and perceptions among different sample segments within this study.

Comparing medians between different groups helps determine stakeholder perceptions regarding how variables for improving productivity are identified, which is crucial for answering RO2, as it seeks to understand the common factors that enhance productivity in New Zealand residential construction.

Further analysis will be used to examine the relationships between different variables and explore potential associations, providing insights into the relationship between QM practices and productivity levels.

2.12.23 Spearman's Rho Test

As suggested by Schober et al. (2018), Spearman's Rho test is a suitable non-parametric test for measuring the strength and direction of monotonic relationships between ordinal variables. It provides researchers with in-depth insights into the associations between various factors that influence productivity. Spearman’s Rho test, a non-parametric correlation coefficient, is employed in this study to infer bivariate relationships between ordinal variables, such as the relationship between the adoption of specific QM practices and perceived productivity levels. This analysis identifies potential relationships between QM strategies and productivity and also informs the development of targeted interventions addressing RO2 and RO5.

Further analysis will be employed through the Garrett ranking technique to prioritise the factors influencing construction productivity, enabling a structured understanding of participants' perceptions.

2.12.24 Garrett Ranking Technique

As demonstrated by several studies in construction management (Chan & Kumaraswamy, 1997; Ismanto et al., 2018), the Garrett ranking technique is a valuable tool for prioritising factors and identifying key areas for improvement. This study utilises the method to determine the most critical factors influencing productivity, addressing RO2 and RO5.

In this study, participants rank the importance of various factors, thereby providing a clear understanding of their relative significance in terms of productivity enhancement. These factors subsequently inform the development of targeted strategies to enhance performance.

In conclusion, the pragmatic worldview of using "what works" to address research questions and generate practical solutions informs this study's selection of suitable quantitative methods. The chosen methods offer a diverse toolkit for analysing and exploring data, reflecting the philosophical foundation principles that guide this research.

Emphasising the importance of achieving statistical power through an A-priori power analysis, validating the survey instrument with Cronbach's alpha, and utilising descriptive statistics to provide context for research findings aligns with the pragmatic objective of producing results that are both robust and credible.

Furthermore, the use of Likert Scale Analysis, Mean Value Analysis, the Kruskal-Wallis test, Spearman's Rho test, the Garrett ranking technique, and the Kolmogorov-Smirnov test reflects a pragmatic approach to selecting methods based on their suitability.

This research employs a flexible and problem-focused approach that aims to contribute insights into improving productivity in the New Zealand residential construction sector. Thereby enhancing the body of knowledge in construction productivity and offering practical recommendations for enhancing QM practices in the New Zealand residential sector.

2.13 Reliability and validity

Social science research methodologies are key components of construction management research that regularly encompass human behaviours. Hence, conducting effective research in this discipline demands meticulous attention to the validity and reliability of the design and implementation of measurement instruments (Abowitz & Toole, 2009)

Unsurprisingly, research validity and reliability are crucial concepts in construction management research, encompassing various aspects of study design, measurement, and interpretation of findings (Unegbu et al., 2020a). Content, construct, and criterion validity are the three main types of validity (Heale & Twycross, 2015). However, (Collins et al., 2007) suggest that validity can be assessed through criterion, content, face, and construct validity.

2.13.1 Validity

Heale & Twycross (2015) assert that the extent in which a concept is accurately measured in a study refers to its validity while reliability concerns the consistency and accuracy of the measurement instrument. Taherdoost (2018) confirms that ensuring that research instruments measure their intended purpose is crucial for validity and guaranteeing high-quality research.

In construction management research, a mixed-methods approach combining quantitative and qualitative data collection can enhance validity and reliability, although this approach is more resource-intensive (Abowitz & Toole, 2009). Validity in research is a complex concept that includes measurement, statistical conclusion, and internal and external validity (Cor, 2016). Internal validity examines whether the study design, conduct, and analysis answer the research questions without bias, while external validity assesses the generalisability of findings to other contexts (Andrade, 2018). In construction management research, ecological validity, a subtype of external validity, is fundamental as it examines whether study findings can be generalised to real-life settings (Andrade, 2018). Furthermore, research suggests (Collins et al., 2007) that validity can be assessed through criterion, content, face, and construct validity. Empirical research indicates that ensuring research instruments effectively measure their intended constructs is vital for maintaining validity and ensuring the overall quality of research (Taherdoost, 2018).

2.13.2 Face and content validity

Lim 2024 posits that face validity is a subjective criterion employed to evaluate the extent to which an assessment or test appears to measure the variable or construct it is designed to assess. Face validity is evaluated based on its ability to ostensibly accomplish its declared purpose (Abowitz & Toole, 2009; Lim, 2024). Numerous studies within the field of construction management research have examined both face and content validity (Abowitz & Toole, 2009) For example, a project risk management maturity (PRMM) model was developed and subject to empirical testing, thereby demonstrating face validity, content validity, and additional variants of validity (Hartono et al., 2014). This study highlights the importance of empirical validation in the development of construction management models (Abowitz & Toole, 2009). Content validity constitutes a fundamental aspect of research methodology within the construction management domain (Abowitz & Toole, 2009). The evaluation determines the degree to which an instrument, such as a test or survey, comprehensively covers the relevant aspects of the construct it aims to measure (Hartono et al., 2014). This ensures that a wide range of topics and dimensions pertinent to the concept under investigation are sufficiently represented (Hartono et al., 2014).

2.13.3 Reliability

Reliability, conversely, is concerned with whether something performs as it should and is a prerequisite for validity (Storey et al., 2024). Reliability can be assessed through stability, internal consistency, and equivalence (Souza et al., 2017). Researchers should provide detailed reports on the quality assessment of validity and reliability for their measurement tools to ensure the trustworthiness and comparability of their findings (Jahangiri & Vakili, 2018). In quantitative research, reliability is often associated with the consistency and reproducibility of measurements. However, in qualitative research, which is also valuable in construction management for exploring psycho-social aspects, the concepts of reliability and validity must be redefined to reflect the multiple ways of establishing truth in naturalistic approaches (Golafshani, 2015; Leung, 2015).

Empirical research confirms the effectiveness of employing various strategies to enhance the credibility of research findings in construction management (Unegbu et al., 2020a; Vaske et al., 2017). Incorporating mixed methods approaches (Abowitz & Toole, 2009; Zohrabi, 2013) and carefully considering methodological aspects of research design can significantly enhance the validity, reliability and causality inferences of studies in this field, ultimately strengthening the overall quality of research outcomes.

Triangulation extends beyond adding depth to data collection; it is integral to establishing and maximising validity and credibility, especially in qualitative research (Golafshani, 2015). Some consider the importance of consistency and reliability in research instruments (Unegbu et al., 2020a; Vaske et al., 2017). Noting that it is essential to ensure they accurately measure their intended objectives, which is vital for maintaining validity and ensuring high-quality research (Collins et al., 2007). Taherdoost (2018) and Zohrabi (2013) suggest that researchers should also consider the reliability and validity of their research instruments, such as questionnaires, interviews, and observations. In construction management research, the robustness and practical relevance of research findings can be enhanced by focusing on the validity and reliability of research methodologies.

2.13.4 Cronbach's alpha

Research in construction management has highlighted the advantages and disadvantages of using Cronbach's alpha to measure internal consistency reliability. Research indicates that Cronbach's alpha has been widely employed in construction management research to evaluate the reliability of measurement instruments. For example, a study on ISO 9000-certified quality systems in Hong Kong construction organisations used Cronbach's alpha to evaluate the internal consistency of their survey instrument (Dissanayaka et al., 2001). Similarly, research on e-learning adoption among university lecturers employed Cronbach's alpha to confirm the reliability of the measurement before conducting further analysis (Hsbollah & Kamil, 2009). A Malaysian construction sector study employed Cronbach's alpha coefficient to test the reliability of their questionnaire, examining the factors affecting the implementation of Total QM (TQM) in construction companies (Othman et al., 2019).

Interestingly, regardless of its popularity, ongoing debates exist about its appropriateness and limitations. For instance, some researchers argue that Cronbach's alpha may not always be the best technique to assess reliability, especially when dealing with multidimensional scales (Barbaranelli et al., 2014; Cho & Kim, 2014). McNeish (2018) warns that methodological studies have revealed limitations of Cronbach's alpha based on unrealistic assumptions that, when violated, can lead to underestimating reliability.

Additionally, the pilot study serves as a significant instrument for the initial assessment of the validity and reliability of measurement tools. Numerous studies affirm the utility of pilot studies in evaluating preliminary validity and reliability during the development of questionnaires (Cramer et al., 2002; Kristjanson, 1993; Pettersen, 2004; Rosenblum, 2008). This methodology enables researchers to devise more robust and reliable instruments tailored to their specific research objectives (Rosenblum, 2008).

Thus, this research employs Cronbach's alpha in line with empirical studies (Dissanayaka et al., 2001; Hsbollah & Kamil, 2009; Othman et al., 2019). The assessment of 14 Likert scale items yielded a coefficient of 0.720, indicating suitable internal consistency (Vaske et al., 2017). In addition to Cronbach's alpha, a pilot study involving seven construction professionals from similar fields within the New Zealand residential sector assessed the research instrument's validity and reliability (Collins et al., 2007; Roopa & Rani, 2012). This research used face and content validity in developing and pre-testing questionnaires. These methods involve regular evaluation of questionnaire items' presentation and relevance through expert assessment (Collins et al., 2007; Taber, 2018; Taherdoost, 2016b).

2.13.5 Data entry and coding - SPSS software

Statistical Package for the Social Sciences (SPSS) is a widely used software for statistical analysis, data management, and documentation (Čaplová & Švábová, 2020). It offers a range of capabilities for descriptive and inferential analysis, including tools for means, percentages, correlational analysis, t-tests, and analysis of variance (ANOVA) (Roever & Phakiti, 2017).

SPSS is particularly popular in social sciences research and is often used to analyse quantitative data in psychology, sociology, and education (Brown et al., 1996). SPSS is a versatile software package for statistical analysis that can be applied to various types of quantitative data, including survey data. Its wide range of analytical capabilities makes it suitable for analysing data from multiple sources, including online survey platforms like Qualtrics (Čaplová &

Švábová, 2020). Interestingly, while SPSS is a powerful tool, it does have some limitations and risks associated with coding survey data. Research suggests that the programming language can overcome some of the dialogue limitations of SPSS, mainly when dealing with ordinal, Likert-type data, commonly found in survey research (Basto & Pereira, (2012). Concerns include increasingly deterministic and rigid processes, privileging of coding and retrieval methods, rectification of data, and pressure on researchers to focus on volume and breadth rather than depth and meaning (John & Johnson, 2000).

Additionally, the time and energy required to learn software applications and increasing commercial interests may interfere with fundamental analysis tasks (John & Johnson, 2000). Absent data in surveys can significantly impact analysis outcomes, making the selection of data-handling methods vital (Cheema, 2014). Although coding survey data for analysis provides notable benefits in efficiency and rigour, researchers should recognise possible limitations.

Numerous studies explore how to code data from Likert scales in SPSS for quantitative analysis, highlighting SPSS's strengths and versatility for analysing data gathered from Likert scale questionnaires (Chan & Idris, 2017; Khan et al., 2023; Pallant, 2013; Roever & Phakiti, 2017). Researchers coding Likert scale data in SPSS, typically assign numerical values to each response option, facilitating statistical analysis (Li, 2012; Tanujaya et al., 2022). The process requires inputting the data into SPSS, defining the variables, and assigning suitable measurement levels (nominal, ordinal, or scale) (Pallant, 2013; Roever & Phakiti, 2017). Depending on the research approach and analysis methods, ordinal or scale levels are commonly used for Likert scales (Tanujaya et al., 2022; Wu, 2007). Interestingly, there is ongoing debate about the appropriate statistical analysis methods for Likert scale data (Tanujaya et al., 2022; Wu, 2007). Tanujaya et al. (2022) suggest that some researchers claim that Likert scales yield interval data appropriate for parametric tests. In contrast, others assert that data are ordinal and necessitate non-parametric approaches (Tanujaya et al., 2022; Wu, 2007).

Researchers emphasise several key factors when deciding between parametric and non-parametric statistical methods for analysing Likert scale data (Jakobsson, 2004; Jamieson, 2004; Knapp, 1990; Kuzon et al., 1996; Martilla & Carvey, 1975; Vigderhous, 1977). However, Likert data can be treated as interval data under certain conditions, allowing for parametric methods (Bishop & Herron, 2015). The advantages of parametric tests are generally more pronounced with larger sample sizes (Bishop & Herron, 2015). Conversely, non-parametric tests may be more suitable for smaller samples (Sullivan & Artino, 2013).

Parametric methods often assume a normal distribution of data. However, non-parametric tests are generally used when data lacks a normal distribution (Tanujaya et al., 2022). Choosing between non-parametric and parametric methods should depend on specific research goals and questions being addressed (Hair Jr et al., 2019). The data may be more appropriate for parametric analysis if composite scores are derived from multiple Likert scale items measuring the same element (Clason & Dormody, 1994). The quantity of points in a scale affects the analysis selection. Scales with a minimum of 5 points are more likely to resemble interval-level measurement, which justifies the use of parametric methods (Tanujaya et al., 2022). Some researchers propose that parametric tests are sufficiently robust for analysing Likert data, even when assumptions are not entirely met (Knapp, 1990). Therefore, it is crucial to recognise the ongoing debate within the research community regarding methods. The differing opinions among researchers suggest that any decision should stem from a thoughtful analysis of the aspects mentioned above, the unique attributes of captured data, and the established conventions in a field study.

This study is aligned with empirical research particularly Li, (2012). and Tanujaya et al., (2022) relevant to coding data and Čaplová & Švábová, (2020), who confirm the use of SPSS for survey data coding and analysis. Tanujaya et al., (2022) and Wu, (2007) also imply that empirical research highlights smaller sample sizes and data lacking a normal distribution should be considered ordinal data. This research follows established research conventions by using existing protocols to determine statistical methods (Pallant, 2013; Roever & Phakiti, 2017). Hence, this study uses non-parametric methods for inferential statistics that align with the specific research goals of this study (Sullivan & Artino, 2013; Tanujaya et al., 2022).

Non-parametric methods align with the pragmatic paradigms' emphasis on "what works" ,ensuring robust data analysis that directly addresses RO1-5 through the use of appropriate statistical techniques for ordinal data, thereby generating valid and practically applicable research findings.

2.14 Research phase two

2.14.1 Data collection - The semi-structured expert interviews

The several types of interviews available to the researcher can be classified as structured, unstructured, and semi-structured (Yin, 2009). This study identifies the semi-structured interview method as the most effective, as it gathers more detailed and focused responses to the research questions (Yin, 2009) and allows the researcher to engage with the subtleties of participant responses, clarifying ambiguities where needed (Irvine et al., 2012). This study employs semi-structured questions at the validation stage to validate previous research findings in phase one, pursuing a more nuanced and comprehensive understanding of the factors and strategies influencing QM and productivity in the New Zealand residential construction sector. This research incorporates 15 expert interviews as a key qualitative data collection method. Expert interviews are a well-established approach in qualitative research, recognised for their ability to elicit in-depth information and insights from individuals with specialised knowledge and experience in a particular field (Bogner et al., 2009). Several researchers (Ashal & Morshed, 2024; Giacomini et al., 2000) argue, expert interviews provide access to "information-rich cases" that offer new perspectives, contributing to a deeper understanding of complex phenomena.

Expert interviews provide crucial insights from industry leaders and experienced practitioners on challenges and opportunities in New Zealand's residential construction sector. Expert interviews play a pivotal role by providing rich insights and practical implications that extend beyond the reach of quantitative methods (Im et al., 2023) aligning with the principles of the pragmatic approach.

Pragmatism emphasises the importance of engaging with stakeholders and valuing their knowledge in the research process. The study aims to merge scholarly inquiry with real-world application by integrating insights from industry professionals, producing findings that are both academically sound and practically applicable, effectively narrowing the divide between theoretical research and industry implementation.

This research conducts semi-structured expert interviews with experienced professionals in the New Zealand residential construction sector, including industry leaders such as general managers, project managers, construction managers, site managers, and subcontractors.

Two specific purposes are derived through expert interviews.

- Initially, through semi-structured interviews, quantitative findings are integrated to provide a more robust approach. This is key in developing a more in-depth understanding and validation of quantitative results that ensure their practical resonance with the construction sector.
- Secondly, a deeper exploration of complex issues related to QM and construction productivity goes beyond quantitative research. It enables valuable insights into industry challenges and perceptions, providing opportunities to develop specifically targeted interventions for industry improvement.

The expert interviews allow for a combination of predetermined questions and emergent probes, driven by an interview guide developed based on the quantitative findings, ensuring that the data collected is relevant and focused. The Microsoft Teams platform used in this research enables the recording of interviews and the transcription of these recordings verbatim. Thematic analysis (Braun & Clarke, 2006) facilitates the examination of data from expert interviews. By integrating expert interviews in this study's quantitative findings, more profound insights are captured relevant to the intricacies of QM and productivity in the local context.

Semi-structured interviews foster a collaborative environment where participants feel at ease (Byrne et al., 2015). They offer flexibility to explore diverse topics while capturing unanticipated lines of inquiry that may arise during discussions encompassing rich and nuanced data around the nature of human experiences (Ozcan et al., 2021). This aligns with the pragmatic value of engaging with stakeholders and valuing their knowledge in the research process. By combining thematic analysis and semi-structured interviews within a pragmatic framework, this research aims to generate academically rigorous findings that are also practically relevant to the construction industry.

The insights gained from the qualitative data provide targeted interventions that can improve QM practices and enhance productivity in the New Zealand residential construction sector. Quantitative methods deliver essential numerical data and statistical insights. In contrast, qualitative approaches delve into the subtleties, intricacies and personal experiences related to QM and productivity in the New Zealand residential construction sector. This research employs semi-structured interviews, offering a flexible and interactive approach as the primary qualitative data collection method to gather rich, in-depth information from industry professionals (Conrad & Tucker, 2018; Lun et al., 2024).

Bryman, (2016) asserts that they allow for a combination of pre-determined questions and emergent probes to explore participants' nuanced realities with new perspectives, offering key advantages for investigating QM practices and their impact on productivity in the New Zealand residential industry.

Semi-structured interviews offer several advantages in construction management research, particularly in terms of flexibility and their dynamic nature. A powerful research tool that provides numerous benefits for in-depth exploration of complex topics, allowing researchers to gain additional levels of insight that were previously considered unobtainable (Eppich et al., 2019).

The dynamic nature of semi-structured interviews offers greater flexibility in capturing and exploring emergent themes (Eppich et al., 2019). The structure allows a researcher to maintain focus on predetermined topics while exploring the unexpected data that can yield rich, detailed insights into the participants' subjective realities. The interactive approach to semi-structured interviews, combined with the flexible format, helps build rapport between the researcher and participants, promoting openness and honest dialogue (Adeoye-Olatunde & Olenik, 2021).

This research conducts semi-structured interviews with a diverse group of construction professionals, including project managers, site supervisors, general managers, construction managers and subcontractors. The interview, which serves as the second phase of data collection, aims to validate the findings of phase 1 questionnaire survey research, ensuring that the data collected is relevant and focused. Specifically, the interviews will explore the following research objectives.

- **RO1:** To define the characteristics of QM systems used in residential construction organisations through a critical literature review.
- **RO2:** To establish the common factors that positively affect construction productivity in the New Zealand residential sub-sector.
- **RO3:** To evaluate the effectiveness of a developed strategy for QM in residential construction.
- **RO4:** To validate the effectiveness of a developed strategy for QM in residential construction.
- **RO5:** To suggest ways to improve construction productivity through QM.

Through semi-structured interviews, this research aims to deepen the understanding of the complexities surrounding QM and productivity in the New Zealand residential construction sector, contributing to the development of practical and effective solutions.

2.14.2. The semi-structured expert interview questions

A key stage of this sequential explanatory mixed methods study is the design of the semi-structured interview questions. Empirical data assert that the qualitative phase in sequential explanatory design is intrinsically linked to the preceding quantitative phase (Teddlie & Tashakkori, 2012). This integration of objective and subjective data aims to deepen understanding and provide more nuanced insights into observed patterns in the quantitative data phase (Teddlie & Tashakkori, 2012).

In this research, the development of the interview questions was directly informed by the findings from the Phase 1 Quantitative survey data and thematic analysis of open-ended questions, ensuring the qualitative inquiry delved into the most salient themes and patterns identified from the quantitative survey. Furthermore, it allows for the exploration and validation of research findings.

A systematic and iterative approach is used to develop the interview questions.

First, the key themes and patterns identified through the open-ended survey responses were reviewed and categorised thematically. Next, initial interview questions were developed to gather comprehensive insights into the participants' perspectives.

Additionally, academic experts reviewed the interview questions to enhance clarity and relevance, ensuring their alignment with the research objectives. This rigorous process of developing the interview questions ensured that the qualitative data collection was focused and purposeful, directly addressing the research objectives RO1-5 that guided this study.

Specifically, the objectives explore the types of QM systems used by residential construction organisations (RO1), the factors affecting construction productivity (RO2), the effectiveness of the developed QM strategy (RO3), and potential strategies for improving productivity (RO5).

This methodological decision reflects the core tenet of the pragmatic paradigm, which is to select research strategies based on their effectiveness in addressing the research questions and providing actionable outcomes (Morgan, 2014).

The study's design integrates interview questions derived from quantitative findings. The design ensures that the qualitative exploration remains aligned with the research objectives and contributes to the development of practical and actionable insights for the construction industry. The research design's flexibility and adaptability enable the iterative development of the interview questions, which enables the discovery of new insights and the exploration of unexpected research directions (Morgan, 2014).

2.14.3 Interview protocol - semi-structured expert interviews

Empirical research suggests that the quality and trustworthiness of qualitative data are directly linked to a balanced and defined interview protocol (Plummer, 2017). Research suggests that interview protocols provide structured guidance that ensures interviews are conducted effectively and ethically (Jacob & Furgerson, 2015).

This comprehensive framework helps in upholding consistency and rigour throughout the expert interviews (Ahmed & Ishtiaq, 2021). Aligned with empirical literature (Ahmed & Ishtiaq, 2021; Jacob & Furgerson, 2015), this protocol outlined the procedures and guidelines for conducting the interviews, ensuring the data collected was reliable, valid, and ethically sound. A detailed interview protocol was developed and adhered to throughout the expert interview process to ensure consistency and rigour in the qualitative data collection. Thus, interview protocols are more than just a "list of questions" (Jacob & Furgerson, 2015).

The interview protocol encompassed the following key elements:

- **Participant recruitment and selection:** An explicit criterion for selecting expert participants includes their years of industry experience, industry expertise, and a profession closely associated with the research topic. Drawing on Patton et al's. (2015) research, a detailed overview of participant requirements is provided, involving contacting potential participants, explaining the research objectives, and obtaining informed consent, aligning with recommendations for purposive sampling in qualitative research.
- **Interview setting and logistics:** A comfortable and conducive environment for participants to share their insights. Thus, this research utilises the preferred online interview setting due to its convenience and cost-effectiveness. Considering research by Kvale, (2007) that affirms the principles of creating a safe and respectful space for participants, logistics such as the scheduling of interviews, including arranging suitable times and locations, are also addressed.
- **Interview guide:** The preparation and approach for conducting interviews are detailed using the interview guide. It outlines key topics and questions relevant to the research, focusing on maintaining alignment with the research objectives while allowing for flexibility to explore emergent themes and unexpected avenues of inquiry, reflecting the principles of semi-structured interviewing described by Bryman (2016).
- **Ethical considerations:** The protocol emphasised the importance of ethical considerations, including informed consent, confidentiality, and anonymity and risk (Irvine et al., 2012). Participants were informed of their rights to withdraw from the study at any time and to remove their data from the analysis, adhering to the ethical guidelines outlined by the Auckland University of Technology Ethics Committee (AUTEC approval 24/83) guidelines and procedures (*AUTEC Guidelines and Procedures - AUT*, 2025).
- **Data recording and transcription:** The protocol specified the procedures for recording and transcribing the interviews. Further, ensuring the data was accurately captured and preserved. The audio recording was captured through the Microsoft Teams Platform for online meetings, and verbatim transcription was emphasised to maintain the integrity of the qualitative data. This research aligns with empirical literature (King, 2004) suggesting the use of follow-up emails to clarify instances of poor sound recording.

- **Data saturation criteria:** The protocol explicitly incorporated a defined criterion for thematic data saturation (Fusch & Ness, 2015; Guest et al., 2006). Saturation served as the formal stop-point for expert interviewing, ensuring the sample size was sufficient to adequately capture the full range of perspectives and experiences relative relevant to the research questions. Thematic saturation is achieved when no new information or themes emerge from successive interviews, indicates that the data set is theoretically rich enough for robust analysis and answering the research objectives (Fusch & Ness, 2015; Guest et al., 2006).

  Conceptual saturation was sought requiring that all constraints and variables formally identified within the theory of constraints diagnosis (derived from the phase one quantitative data findings), were thoroughly explored and validated by the diverse expert panel (Creswell & Clark, 2017; Vasudevan, 2021). Saturation was thus confirmed when no novel constraints were introduced by successive interviewees demonstrating the stability and consistency of the final conceptual model (Fusch & Ness, 2015).

Developed following established empirical research principles, ethical standards and best practices in qualitative inquiry. The strict adherence to this protocol aimed to provide high-quality qualitative data that would both complement and corroborate the quantitative findings. Ultimately, the protocol ensured high-quality qualitative data that provided a more in-depth understanding of the intricacies associated with the research problem.

2.15 Phase 2 qualitative data analysis methods

Although quantitative methods provide valuable numerical data and statistical insights, they lack the finer nuances of qualitative approaches that offer a deeper understanding of the intricacies, complexities, and subjective experiences surrounding QM and productivity in the New Zealand residential construction sector (Proudfoot, 2023; Rowley, 2014). This second phase of the research design employs a qualitative method, to gain a more comprehensive understanding of the research problem.

The qualitative component of this research involves a two-step process:

1. **Analysis of open-ended questions:** Thematic analysis is employed to analyse the open-ended survey questions included in the quantitative survey. This enables identifying key themes, patterns, and unexpected insights from the participants' responses. These themes are used to inform the development of the semi-structured interview questions (Fuchs, 2023).

2. **Semi-structured interviews:** The findings from the thematic analysis of the open-ended questions, combined with the quantitative analysis from Phase 1, are used to develop a set of semi-structured interview questions that delve deeper into the identified themes, allowing for further exploration and expert validation of the initial statistical findings (Rowley, 2014).

Empirical research suggests that experts offer a crucial benefit to the research process (Shepherd et al., 2021). Their extensive experience and knowledge in construction-related fields play a vital role in validating research findings (Shepherd et al., 2021). For instance, Baiche et al. (2006) mention interviews with building control inspectors from local authorities and approved inspectors, suggesting that these professionals are considered experts in their field. Similarly, Shepherd et al. (2021) includes participants from various occupational groups, such as workers, site supervisors, safety trainers, and safety practitioners as experts. Education research has identified traits common among experts across six domains that may apply to other industries. These generalised expert characteristics include thorough reflection on practice, a commitment to continuous learning, robust pedagogical content knowledge, adaptability, and strong interpersonal relationships (Anderson & Taner, 2023) thought relevant to the construction sector.

Moreover, experts play a crucial role in validating systems, ensuring the quality and dependability of the decision-making process. Validation methods involve separately analysing the knowledge base and inference engine, while also evaluating the entire system (Jiang et al., 2017; O'Keefe & O'Leary, 1993; O'Leary, 1988; Younas et al., 2023). This approach emphasises the importance of experts in both component-level and system-level validation. The above indicates that expertise can be found at different levels within the construction industry (Shepherd et al., 2021).

Construction management research often relies on expert opinions for validation due to the challenges of conducting field studies. Methods such as the Delphi technique, nominal group technique, interviews, and focus groups offer distinct advantages over other validation strategies (Bhandari & Hallowell, 2021). A significant benefit is their ability to bypass resource limitations, restricted site access, and ethical concerns that might impede field studies in construction engineering and management (CEM) research (Bhandari & Hallowell, 2021). Experts provide a unique alternative to observational or experimental techniques and have become a significant method for confirming research outcomes in construction management studies.

For example, experts provide a nuanced understanding of complex construction management issues, enabling researchers to explore unexpected findings and expand on existing theories (Modell, 2005). Therefore, combining expert interviews with quantitative findings improves data interpretation (Drury et al., 2011), further enhancing the validity and reliability of research results (Ellen et al., 2013). Highlighting that expert interviews can help overcome the challenges and limitations of purist quantitative methods (Drury et al., 2011).

While questionnaire-based surveys may yield generalisable results, augmenting them with qualitative expert interviews can substantially enhance the precision of data interpretation and analysis (Drury et al., 2011). Semi-structured interviews often enhance credibility and guide improved research outcomes, providing a more balanced perspective in comparison to structured and open-ended questions (Drury et al., 2011).

However, it's important to note that expert-based validation methods are not without limitations. Cognitive and social biases can threaten the validity and reliability of results obtained through expert opinions (Bhandari & Hallowell, 2021).

Thus, mitigation of these potential risks requires researchers to employ controls such as anonymity, multiple rounds, and controlled feedback during data collection and analysis (Bhandari & Hallowell, 2021).

Regardless, while expert-based validation offers practical advantages in construction management research, careful consideration of the research design is key to balancing research constraints with study objectives.

2.15.1 Thematic analysis and semi-structured interviews

Phase 2 of this sequential explanatory study design employs thematic analysis is an appropriate qualitative data analysis approach (Othman et al., 2020). The following section will detail how it effectively addresses this study's research questions. Pragmatism emphasises the use of the most suitable methodological approach in addressing research questions that can yield practical solutions (Kelly & Cordeiro, 2020). The choice of thematic analysis and semi-structured interviews aligns with the pragmatic worldview that underpins this research (Wright et al., 2016). Thematic analysis provides a flexible and versatile tool for analysing qualitative data. It allows for identifying emergent themes and patterns from the participants' experiences and perspectives, aligning with the pragmatic emphasis on understanding the complexities of real-world situations and generating actionable insights (Braun & Clarke, 2006).

2.15.2 Thematic analysis

This study's primary qualitative data analysis method is thematic analysis, which is applied to the responses from open-ended survey questions and from semi-structured expert interviews. This approach is well-suited to address RO2-RO5 due to its inductive, exploratory nature, which enables the researcher to identify patterns and themes that may not have been anticipated (Ando et al., 2014). This is crucial for establishing common factors positively affecting construction productivity in the NZ residential sub-sector (RO2). The flexibility and adaptability of thematic analysis make it an ideal method for this mixed methods study, as it can complement the quantitative data and provide deeper insights into the research (Ando et al., 2014). The thematic analysis revealed a rich tapestry of perspectives on QM systems and their impact on the NZ residential sector, ensuring a systematic and rigorous approach to qualitative data analysis (Braun & Clarke, 2006). Themes are categorised by the research objectives they address and provide valuable insights into the industry's current state, highlighting opportunities for improvement (Ando et al., 2014).

This methodical process helps validate (RO3) the effectiveness of developed QM strategies for improving residential construction. The method's ability to reveal actionable and nuanced perspectives is achieved through the identification and analysis of both semantic and latent themes, thereby enhancing the depth of the overall study. Thematic analysis provides a more in-depth understanding of the underlying factors that affect productivity. The practical insights generated through thematic analysis are particularly valuable for (RO4), which seeks to suggest QM strategies capable of enhancing productivity.

This qualitative approach provides the necessary depth and context to develop comprehensive recommendations for enhancing productivity in the New Zealand residential construction sector, directly addressing RO4. While the thematic analysis contributes to but doesn't directly address RO1 (defining characteristics of QM systems), it does provide valuable industry perspectives that can complement and contextualise the findings from the narrative literature review.

Employing thematic analysis enabled the study to capture nuanced perspectives from industry professionals, identify common themes and develop practical recommendations (Hao & Demir, 2024) for improving productivity through QM in the New Zealand residential construction sector.

2.15.3 Thematic analysis - process

This research employs thematic analysis as the primary method for analysing qualitative data gathered through semi-structured interviews and open-ended survey questions. Thematic analysis enables the development and examination of themes using an inductive, deductive, or combined approach (Robinson, 2022). Thematic analysis enables the identification of themes and patterns within a data set and is a flexible and widely applicable qualitative approach (Braun and Clarke, 2006).

Thus, aligned with empirical research, this study employs an inductive approach to thematically analyse data sets, where themes emerge naturally from the data rather than being shaped by pre-established theoretical constructs (Cascio et al., 2019). The inductive approach ensures that the analysis remains grounded in participants' lived experiences, contributing to a rich and nuanced understanding of the research problem (Jackson et al., 2018).

This process involves data familiarisation, code initiation, and theme derivation, as well as a report presenting the themes and their significance to the research questions (McTavish et al., 2022; Umar et al., 2020). Hence, this research aims to generate academically rigorous and practically meaningful findings for the construction industry by grounding the analysis in the data and maintaining a focus on practical relevance.

While this study does not strictly adhere to a single qualitative methodology, such as ethnography or phenomenology, it draws on the principles of these approaches to provide a deeper understanding of the participants' subjective experiences.

From an ethnological standpoint, the study incorporates elements such as a focus on industry-specific aspects, various stakeholders' viewpoints, and an examination of the industry culture. Phenomenological aspects encompass the lived experiences of participants, the use of open-ended questions, and the application of thematic analysis. It is essential to note, however, that although these elements are presented in this study, they are not fully adopted as the primary methodology.

The approach aligns more with mixed methods, utilising thematic analysis of qualitative data to complement the findings of quantitative analysis.

Thematic analysis, following an inductive approach, is guided by Braun and Clarke's (2006) six-step framework (Table 2.9).

Table 0.9: A 6-step approach to thematic analysis (Braun & Clarke, 2006)

Step number	Process	Actions
1	Familiarising yourself with the data	This involves actively reading and re-reading the transcripts, notes, and any other qualitative data collected
2	Generating initial codes	Identifying and labelling interesting features of the data, which are then collated into potential themes
3	Searching for themes	Examining the codes and collated data to identify overarching themes that capture the essence of the data
4	Reviewing themes	Checking if the identified themes accurately reflect the data and refining them as needed
5	Defining and naming themes	Clearly define and name the themes, ensuring they are distinct and capture the essence of the data
6	Producing the report	Writing a clear and concise report that presents the themes and their significance in relation to the research questions

This systematic approach to thematic analysis ensures that the open-ended survey responses and the semi-structured interview transcripts are rigorously analysed and the findings are presented clearly and meaningfully. By combining thematic analysis with semi-structured interviews in this iterative manner, this research aims to gain a deeper understanding of participants' nuanced experiences surrounding the complexities of QM and productivity in the New Zealand residential construction sector, thereby contributing to practical and effective solutions.

2.15.4 Triangulation

Triangulation is used to ensure the validity of research findings, which involves using multiple data sources or methods to investigate a phenomenon. In mixed methods research, triangulation combines quantitative and qualitative data to further understand the phenomenon under study (Morse, 1991). Denzin & Lincoln (2005) agree and state that triangulation is a tool for critical reflexivity. Researchers can use it to assess their biases and assumptions, identify blind spots, and advance a deeper understanding of the research process. The authors add that triangulation is a multifaceted concept that is more than simply combining methods because we can. Thus, it is better defined as a complex process involving critical thinking and reflexivity. Bryman (2006) highlights that triangulation is not simply a mechanical process of combining data. It requires careful consideration of the research question, selecting appropriate methods, and integrating findings.

Bryman (2006) and Denzin and Lincoln (2005) agree with Morse (1991) and offer insightful summaries of the significance of triangulation in mixed-methods research. The researchers contend that triangulation enhances the validity and reliability of research results and identify four types of triangulation:

Data triangulation involves collecting data from multiple sources, including interviews, surveys, and observations.

Method triangulation involves using multiple methods to collect data, including surveys, interviews, and focus groups.

Researcher triangulation involves using multiple researchers to collect and analyse data.

Theoretical triangulation involves the use of multiple theories to interpret a phenomenon.

Morse (1991) argues that triangulation is an essential part of mixed methods research, ensuring the findings are valid and reliable, additionally, helping to identify data inconsistencies and develop an in-depth understanding of the research phenomenon (Modell, 2015).

Interestingly, the development of triangulation in qualitative research and the impact of social representations theory have led to a shift in perspectives in social science research (Vivek et al., 2023). Caillaud et al. (2019) affirm that highlighted differences in data gathered through multiple methods are no longer seen as a threat to scientific validity; instead, they are viewed as opportunities to deepen our understanding of the phenomenon being studied. Therefore, analysing discrepancies is a key component of triangulation in mixed methods research, especially when integrating objective and subjective data sources.

In these instances, discrepancy analysis may serve as a systematic approach to explore and comprehend the differences between quantitative and qualitative findings (Caillaud et al., 2019; Tariq & Woodman, 2013).

Bryman (2006) asserts that the advantages of using multiple data sources and methods include enhanced validity and reliability, which increase the credibility and trustworthiness of research findings. Denzin and Lincoln (2005) concur and affirm that triangulation can also exude a more comprehensive and nuanced understanding of the research problem, reduce researcher bias by using multiple methods and perspectives, and increase rigour by providing numerous lines of evidence to support research findings.

Regardless, triangulation has its limitations. For instance, Denzin and Lincoln (2005) assert that using multiple methods or researchers may not always be feasible. Bryman (2006) warns of the added complexity of research design and data analysis, noting that the process may be resource-intensive. A consensus among researchers is that using mixed methods does not guarantee valid and reliable findings (Bryman, 2006; Denzin & Lincoln, 2005; Morse, 1991; Tashakkori & Teddlie, 2003).

A strength of this research is its robust triangulation strategy (Table 2.10), which provides a comprehensive approach. Integrating specific QM theories (Lean Construction, ISO 9000, TQM, PDCA, Six Sigma) and productivity theories (Theory of Constraints) provides a robust framework for understanding and analysing the research problem.

Thus, the research aims to provide a more refined and contextually relevant understanding of the research phenomenon by analysing the impact of QM systems on enhancing productivity. The design uses multiple layers of triangulation, including data triangulation, by utilising both survey and interview data and method triangulation by employing both qualitative and quantitative approaches. Theoretical triangulation is achieved in this study through the study's use of multiple QM and productivity theories as well as its grounding in the Theory of Constraints. The study encompasses New Zealand's political, social, and industry dynamics within the global sector, providing crucial context for understanding and interpreting the findings. The explicit plan to compare and contrast participant and expert rankings, and to use empirical data and national and industry culture to explain discrepancies, demonstrates a more rigorous approach to analysing and interpreting data.

Aligned with empirical research, this plan provides a broad framework shaped by the research process, integrating insights gathered during data collection and analysis. Table 2.10 provides a simplified overview to guide the execution of the triangulation plan, which necessitates a more interactive and adaptable approach to data collection, analysis, and interpretation.

Table 0.10: Triangulation plan for this study (Author's work)

Type of triangulation	Source	Description	Specific strategies
Data triangulation	(Bryman 2006)	Utilising multiple sources of data (survey questionnaire, and semi structured interviews)	Comparing participant rankings (Garret Ranking Technique) with expert opinions and empirical research
			Analysing survey data using descriptive and inferential statistics (mean value analysis spearman rho, Kruskal Wallis and Thematic analysis are used)
			Using interview data to explain and elaborate on survey findings
Method triangulation	(Denzin and Lincoln, 2000; Morse, 1991; Bekhet & Zauszniewski, 2012)	Combining quantitative and qualitative methods	Employing surveys to gather quantitative on participant perceptions
			Conducting in depth interviews to gather qualitative data on expert perspectives
			Integrating quantitative and qualitative findings to provide a more comprehensive understanding.
Theoretical triangulation	(Morse, 1991; Bekhet & Zauszniewski, 2012)	Utilising multiple theories	Analysing data through the lens of Lean Construction, ISO 9000, TQM, PDCA, Six Sigma, and the Theory of Constraints
			Examining how the findings relate to the principles and concepts of these theories

			Assessing the extent to which the identified factors align with the key principles of these QM approaches.
Contextual triangulation		Considering the specific context of the research	Analysing data within the context of NZ's socio-cultural, political and industry landscape
			Examining the influence of national culture (e.g.: collectivism /individualism) on QM practices and productivity outcomes
			Comparing findings with existing research on QM and productivity in other countries
Discrepancy analysis	(Caillaud et al., 2019; Tariq & Woodman, 2013b)	Investigating and explaining discrepancies between data sources	Analysing discrepancies between participants and expert rankings
			Exploring potential reasons for discrepancies (i.e., industry experience, role within the construction sector, national culture, empirical literature and industry nuances)
			Utilising empirical data on QM and productivity for other countries to explain discrepancies

The triangulation approach used in this second research phase further strengthens the research outputs, adding another valuable layer of data analysis. The study explores practical applications and potential solutions by concentrating on enhancement strategies related to QM and productivity. By identifying two primary themes (QMS concerns and construction productivity & QMS) based on survey data, it establishes a structured method for analysing improvement strategies.

Descriptive statistics and mean value analysis effectively summarise participants' perceptions of various improvement strategies. Utilising percentages to analyse data helps visualise participant opinions and facilitates straightforward comparisons between different methods.

Initial survey results are strengthened through expert interviews, which help validate and refine questions based on the initial survey results, providing a more robust research process and enhancing the credibility of empirical outcomes. The triangulation strategy employed in this research provides a comprehensive method that incorporates multiple layers of triangulation, including data, method, theoretical, and contextual aspects. Moreover, the research is data-driven and theory-informed, effectively integrating data-driven analysis (surveys, interviews) with theoretical frameworks (QM, productivity, Theory of Constraints, and cultural dimensions) to generate a deep and nuanced understanding of the enduring socio-economic concern.

The in-depth explorations throughout this research design provide a clearer understanding of the symbiotic relationship between QM and productivity in the NZ residential sector, adding unique value to the construction management domain. Additionally, the potential impact of cultural dimensions on construction performance across various stakeholder professions offers valuable insight.

2.15.5 Chapter Conclusion

As this chapter draws to a close, the methodological and philosophical frameworks underpinning the research have been thoroughly articulated. Anchored by the pragmatic paradigm, the study justifies the use of the sequential explanatory mixed methods design as the most suitable approach to empirically diagnose the complex relationship between QM and NZ residential construction productivity (Cherryholmes, 1992; Johnson & Onwuegbuzie, 2004). The strategic framework defined by methodological triangulation (survey questionnaire validated by semi-structured expert interviews) and the systemic application of the Theory of Constraints (TOC) ensure the findings will yield high-utility knowledge capable of informing sector-wide reform and resolving the conceptual divergence identified in the literature.

This thoughtfully crafted methodology is structured to address the research objectives and fulfil the primary objective of evaluating, what affect QM has in boosting productivity within the NZ residential construction sector.

Chapter 3 will now address the first research object (RO1) through a comprehensive narrative literature review. It explores the existing body of knowledge surrounding the characteristics of QM systems and establishes the preliminary list of productivity factors suitable for empirical investigation in the local context. Additionally the review explores their interrelationships within both the global and New Zealand context. Chapter 3 therefore provides the essential theoretical foundation and construct definitions for the subsequent quantitative research phase.

Chapter 3

An investigation into quality management systems and factors affecting construction productivity: The New Zealand residential construction industry

Overview

This study addresses the persistent challenges faced by the New Zealand residential construction sector, particularly inadequate construction productivity, a systemic issue with significant socio-economic implications. While quality management is recognised as a contributor to productivity improvement, its potential as a comprehensive strategic management approach remains underexplored in this context.

A narrative literature review was conducted to bridge this gap, employing a rigorous selection process that yielded 38 papers from reputable Q1 and Q2 journals. This review, spanning four decades of research focusing on historical and recent publications, aims to define the characteristics of QM systems and their impact on productivity. The findings reveal a positive association between QM systems and productivity, identifying specific systems, such as Total QM and ISO 9000, as potentially beneficial for the New Zealand residential sector.

This research distinguishes itself by considering QM as an integrated strategic approach to enhance New Zealand residential construction productivity, rather than merely as a contributory factor.

It provides a new line of thought on fresh perspectives, synthesising existing knowledge and lays the foundation for further empirical investigations aimed at quantifying the effectiveness of QM systems in improving residential construction productivity in this context. Ultimately, the study provides actionable insights for the New Zealand residential construction industry. This research offers valuable insights that advance the existing productivity literature, informing industry practices and policy decisions to promote sustainable growth and efficiency.

This chapter is based on the following published conference paper[1].

Kirby, M., Rotimi, F., & Naismith, N. (2022). An investigation into QM systems and factors affecting construction productivity: The New Zealand residential construction industry. in P Izadpanahi and F. Perugia (eds), Architectural Science and User Experience: How can Design Enhance the quality of Life, 55th International Conference of the Architectural Science Association 2022, pp135-143., 1-2 December 2022, Curtin University, Perth, Australia.

Abstract

Poor construction productivity is described as a systemic issue globally. In New Zealand (NZ), it is known as a substantial and enduring socio-economic problem. Among the numerous factors, quality is often correlated as a contributory factor to improving construction productivity. However, it is yet to be explicitly explored in the NZ residential construction sector as a more comprehensive strategic management approach. Thus, this study aims to provide new insights into strategies for improving construction productivity from a QM perspective in the NZ residential construction subsector. This preliminary literature review uses a mixture of Q1 and Q2 journals and selects 38 papers using the keywords "construction productivity, improvement, factors, residential construction, and QM". A range of papers was chosen to span 40 years in research from the mid-1980s to 2021, with the largest representation of papers within the last 10 years, as the topic became more prolific globally. The preliminary literature review findings highlight that QM systems are positively linked to improved productivity and further define the characteristics of QM systems that may benefit the NZ residential construction sector. Theoretically, it is hoped that this research makes a valuable contribution to the existing productivity literature[1].

3.1 Introduction

It is known that construction sectors globally play a notable role and are a central driver of a nation's continued and sustained economic growth (Hasan *et al.,* 2018; OECD, 2021). Moreover, as in most countries, the New Zealand construction sector contributes to Gross Domestic Product (GDP), providing around 7% (Ministry of Business, Innovation & Employment, 2020; Productivity Commision, 2021). Of interest, the NZ construction sector is one of the larger sectors by total employment, contributing around 10% (MBIE, 2021). In addition, the NZ residential subsector now comprises approximately 40% of all consented works (Stats NZ, 2021). Further confirmed is the importance of construction productivity at the NZ industry level, where a one per cent annualised increase in construction productivity returns to a rise in GDP of around $139m (Pricewaterhousecoopers, 2016; Tran and Tookey, 2011). Moreover, is considered a direct link toward improved societal living standards (Small et al., 2021). Paradoxically, the NZ construction industry currently shows signs of rapid growth, although often criticised for its poor productivity (Hasan et al., 2018; OECD, 2021; Productivity Commision, 2021). Subsequently, it is reasoned that New Zealanders are working (10%) more (Nolan et al., 2018; Commission, 2020; Productivity Commision, 2021) and producing less (20%), highlighting the substantial and enduring socio-economic problem (Tran and Tookey, 2011; Nolan et al., 2019).

A significant link between quality and productivity exists today as before (Lam et al., 2008; Small et al., 2021). Further, some note QM as a contributory factor in enhancing construction productivity (Ghodrati et al., 2018; Hwang et al., 2020; Seadon and Tookey, 2019; Small et al., 2021). According to Deming (1982), the benefits of enhanced quality through integrated processes are seen through sustained quality improvements, greater productivity, and improved organisational profits (Iyer et al. 2013). Based on the ideas of Latham (1994), Crosby (1989), Arditi and Mochtar (1996) and Small et al. (2021), it can be argued that QM is considered effective in improving construction productivity. A factor considered equally important today (Ghodrati et al., 2018; Hasan et al., 2018). Additionally, productivity is critical to the survival of organisations.

In terms of organisational improvement, quality has been linked to construction productivity since the mid-1990s (Arditi and Mochtar, 1996). A study from Small et al. (2021), quantified the positive link between QM systems and construction productivity. Regardless, it is purported that construction companies experience similar limiting factors at the organisational level in NZ. Factors like poor productivity, persistent lack of standards, high industry fragmentation and low-quality control all contribute to the prolonged negative industry performance (Bloom et al., 2016; Nasir et al., 2016). Conversely, the benefits of enhanced productivity organizationally are shown through corporate competitiveness, reduced costs, and increased profits, all of which directly affect end-user costs (Arditi and Mochtar, 1996; Hasan et al., 2018). However, irrespective of the importance of existing literature, continued research efforts, technological advancements, governmental strategies, and educational opportunities focused on productivity gains, over time, productivity growth levels in the NZ construction industry have generally remained stagnant (Tran and Tookey, 2011; Nolan et al., 2018).

3.2 Research methodology

This paper forms part of a PhD Thesis. A preliminary literature review and analysis of the existing literature is undertaken relative to QM systems and common factors linked to improved construction productivity at the project, industry, and organisational levels. This paper aims to identify characteristics of various QM systems that may benefit the NZ residential construction sector. In line with research from Tranfield et al. (2003), Emerald Insight, ASCE, ScienceDirect and Google Scholar were the chosen search engines for the desktop review. The "title/abstract/keyword" fields are the search parameters used. Of those search engines, this study used a mixture of Q1 and Q2 journals and selected 38 papers using the keywords; "Construction productivity, improvement, factors, residential construction, and QM." A range of papers was chosen from the early 1980s to 2021, with the largest representation of papers within the last 10 years, as the topic has become more globally prolific. The search boundaries extended to QM systems and factors affecting construction productivity and used the following journals due to their relevance to the research objectives: *Journal of Management in Engineering, International Journal of Production Economics, International Journal of Lean Six Sigma, Administrative Science Quarterly, Construction management and economics, Production and Operations Management and Engineering Construction and Architectural Management.*

The preliminary literature review highlights the importance of QM systems and their positive relationship to construction productivity (Small et al., 2021). Further, defined the characteristics of Lean Six Sigma (LSS) and Total Quality Management (TQM) and the ISO 9000 standards. Additionally, TQM or ISO 9001 as quality management systems may benefit the NZ residential sector. To this author's best knowledge, quality has only been recognised as a contributory factor in isolation and is yet to be explored in the NZ residential construction sector as a broader strategic management approach towards improving construction productivity. Additionally, Hwang et al. (2020) identify that few have quantified how quality affects productivity at the organisational level. Continued research is needed to understand the effect that QM as a management strategy at the organisational level has on construction productivity in the NZ residential construction sector.

3.3 Research objectives

The following two research objectives will be pursued further through the preliminary literature review and will help define this proposed research:

- Define the common factors that positively affect construction productivity.
- Determine the characteristics of QM systems suitable for NZ residential construction organisations.

3.4 Literature review

3.4.1 Factors affecting construction productivity

Due to its significance, identifying factors that affect construction productivity has been researched extensively, albeit with mixed results (Hasan et al., 2018; Seadon and Tookey, 2019). That it is researched extensively implies its global importance. It follows that a commonality exists over time in agreed factors in enhancing productivity. Some authors (Nasir et al*.,* 2016; Hasan et al*.,* 2018) highlight the non-availability of materials, inadequate supervision, change orders and weather as factors that limit productivity. Additionally, others (Hasan et al*.,* 2018; Hwang et al*.,* 2020) take a human resourcing perspective and highlight factors around the workforce. Likewise, Hasan et al*.* (2018) agree with Nasir et al*.* (2016) and (Dixit et al*.*, 2019) and note poor communication and a lack of tools and equipment as limiting factors. However, a reasonable agreeance globally recurring factors affecting construction productivity (Table 3.1) does exist, although not universal (Hasan et al*.* 2018). Thus a sound basis for the agreement is because of the research over an extended time frame, global reach, the inclusion of countries regardless of socioeconomic development, and varied project environments (Ghodrati et al., 2018). Conversely, although comprehensive, the research is somewhat limited by scope, sector and origin, which may explain the variability in factors noted within the study. In addition, other factors such as management strategies, project culture, sustainability initiatives, government influences, legislation, site amenities, emerging technologies and workers' welfare initiatives are also noted as possible contributors but beyond the scope of the study (Hasan et al., 2018).

Table 2.1: Recurring Global Productivity Factors (Author's work)

Recurring global productivity factors	Source
Non-availability of materials	Hasan et al. (2018), Nasir et al. (2016),
inadequate supervision,	Hasan et al. (2018), Nasir et al. (2016),
skill shortage, training, unskilled workers	Hasan et al. (2018), Hwang et al (2020). Ofori et al (2020),
lack of proper tools and equipment,	Hasan et al. (2018), Nasir et al. (2016), Gurmu et al (2016)
incomplete drawings and specifications, poor	Hasan et al. (2018), Nasir et al. (2016)
communication,	Hasan et al. (2018), Nasir et al. (2016), Gurmu et al (2016)
rework, poor site layout,	Hanna Heale (1994), Hasan et al. (2018), Nasir et al. (2016),
Weather conditions and change orders,	Hasan et al. (2018), Nasir et al. (2016)
motivation, legal constraints, weather, quality, Site-management	Hanna Heale (1994), Hasan et al. (2018), Nasir et al. (2016) Adrian (1995) Gurmu (2016), Lam (2008) Small et al. (2020)

3.5 Quality management systems and construction productivity

3.5.1 Total Quality Management (TQM)

Indeed, quality as a management function has been linked to improved construction productivity since the mid-1990s (Arditi and Mochtar, 1996), and various quality management systems (QMS) exist that can be used organizationally within the construction industry (Hwang et al., 2020). In terms of a QMS, in the mid-1980s, Total QM (TQM) was proposed as a solution to organisational improvement worldwide. TQM was seen as an integrated management strategy for organisations globally, viewed favourably as a future advantage for organisational competitiveness (Deming, 1986; Crosby, 1989; Small et al., 2021). Chini and Valdez (2003) define TQM as a management philosophy intertwined with four principles; people, quality, organisations, and the role of senior management that help guide its normative outcomes (Hackman and Wageman, 1995). Fundamentally TQM is founded on the belief that the costs of poor quality (COQ) are more than the perceived costs associated with developing processes to produce higher-quality goods and services.

The benefits of TQM are purported through lower costs in production and improved customer-centricity organizationally (Baron and Kreps, 1999) as well as the ease of integration strategically with planning and design coordination. Barriers to uptake globally are thought to be; a lack of human resource development, lack of planning for quality, lack of leadership for quality, lack of customer focus and lack of resources needed for TQM implementation, considered similarly in the local NZ residential sector. Organizationally, TQM provides a competitive edge and is linked to improved productivity and performance among manufacturing companies (Maani et al., 1994). By way of example, Small et al. (2021) quantified the positive effects of QM in improving construction productivity in the Middle East/North African (MENA) region. Although limited to Mechanical, Engineering, and Plumbing (MEP) trades in the commercial construction sector, it concluded that Mechanical works were seen to improve productivity outputs by around 40% (Small et al. 2021). The study by Small et al. (2021) is restricted by sector and trade. However, it quantifies using QM as a holistic, integrated management strategy to improve construction productivity, thought beneficial locally, although needing further research.

3.5.2 Lean Six Sigma (LSS)

A recent adaptation to Six Sigma is Lean Six Sigma (LSS), which combines lean principles and techniques with Six Sigma (Singh and Rathi, 2018). LSS is a business strategy explicitly aiming to increase quality and enhance organisational productivity, highlighting the strategic significance between quality and productivity (Lam et al., 2008; Small et al., 2021). Like Six Sigma, LSS is process-driven and is considered a lean construction methodology that eliminates defects and reduces variation within a process (Chakravorty, 2009; Sreedharan and Raju, 2016). A data-driven methodological approach that quantitatively assesses a processes performance through statistical representation, aiming to define, analyse, improve, measure and control organisational processes (DMAIC) to eliminate defective works

(Singh and Rathi, 2018). Often considered effective in managing operations and achieving improved quality (Sreedharan and Raju, 2016). Barriers to uptake are a need for an industry road map, operational expertise in practice, certification, a lack of data for analysis and time and cost implications (Chakravorty, 2009; Singh and Rathi, 2018). LSS is suited to larger organisations because they can resource effectively and provide adequate funding and time (Singh & Rathi, 2018). By comparison, it can be reasoned that the NZ construction sector profile, being mainly consistent with micro-companies, may lack the human capital, financial resources, and specific expertise relevant to successfully implementing LSS as a QM strategy and is therefore considered less adaptive to the NZ construction sector than TQM.

3.5.3 Industry standards - ISO 9000

QM has been recognised as an international standard (ISO 9000) since 1987 and is a well-regarded global QMS (Dissanayaka et al., 2001; Chini and Valdez, 2003; ISO - About us, nd). The integral point of difference with ISO 9000 is in the form of a set of standards as opposed to other QM systems, TQM, and LSS, which are reasoned as management philosophies (Chini and Valdez, 2003). Furthermore, the ISO 9000 family is based on 8 principles of QM: customer focus, leadership, people involvement, process approach, systematic approach to management, continual improvement, factual approach to decision-making, and mutually beneficial supplier relations. This QMS requires training, certification, and audit organizationally, ensuring a robust, effective, and adaptable solution to organisational and industry-wide QM. It is an international standards system that provides versatility and integration at the organisational and industry sector levels (Dissanayaka et al., 2001; Ofori et al., 2020). The generic nature of the ISO 9000 standards allows for adaptability in meeting organisational needs and providing a level of freedom organisationally to integrate other related but less structured internal policies, processes, and procedures (Chini & Valdez, 2003) and resulting in a less prescriptive approach to organisational QM (Dissanayaka et al., 2001). It could benefit the NZ construction sector regardless of organisational size and may be used as a government strategy at the industry level to lead a more holistic integrated strategy towards improved productivity and quality enhancements throughout the industry.

Conversely, some debate exists about whether QM as a strategy significantly increases performance (Lee et al., 2011). For example, Haupt and Whiteman (2004) identified excessive paperwork as a negative factor. Georgiou (2010) agrees with Keenan & Rostami (2019) that the industry acceptance of defects as standard practice is a barrier to QMS implementation. A human resource approach highlights the transient workforce and a lack of subcontractor involvement (Ofori et al., 2020; Keenan & Rostami, 2019) as limitations. Other factors like measuring results, staff unwillingness, cost and time implications also rate highly in the research (Keenan and Rostami, 2019) as problems that may affect the implementation of QMS organizationally. Needing further review in the local context. Although empirical data identifies the importance of QM systems and their positive relationship to construction productivity (Small et al., 2021), few have quantified how QM systems at the organisational level affect construction productivity (Hwang et al., 2020). This highlights the need for further research.

3.6 Quality management as a management strategy

Hackman and Wageman (1995) agree with Deming (1986) and Ishikawa (1985), reasoning that the ultimate purpose of an organisation is to remain profitable and provide sustainable growth for both its people and society through the generation of services and products. Indeed, since the 1980s, governments have used quality management (Australia, Hong Kong, Singapore) to help guide their industry quality objectives (Adrian, 1987; Ofori et al., 2020). However, it is reasoned that consistently providing justifiable levels of quality over time has proven more difficult across the wider industry. It is known that QM systems are critical to project performance and are linked as direct drivers for enhancing productivity (Crosby, 1989; Deming, 1986; Seadon and Tookey, 2019). They are observed as far back as the late 20th century when improved productivity was identified as reflecting positively on quality and safety and innumerable other factors (Adrian, 1987). Moreover, where previously viewed through a lens of reactivity as a site-based tool, construction Quality Management (QM) today has adapted and evolved as an essential strategic business function. An integral point of difference for today's construction companies.

Of equal importance organisationally, QM should also be viewed as a strategic system that may enhance construction productivity by increasing overall outputs and consistency in product delivery (Nasir et al., 2016; Hwang et al., 2020). Through the use and adherence to industry standards, product specifications and integrated management processes, organisational QM performance evolved more holistically than separately when viewed from the global industry perspective. QM, as a management strategy, creates corporate competitiveness. Adding further context, Love and Smith (2003) consider that through incorporating lean principles, a comparison of rival organisations can be benchmarked, adding value, adaptability, and versatility at the organisational and industry level. Hence, an integrated management strategy focused on QM simultaneously identifies an opportunity to use QM as a management strategy to improve construction productivity in the NZ residential sector. Compared to the economic wastage (approx. 12%) realised from poor project performance on construction projects globally, a QMS may be a sustainable and cost-effective solution to improved organisational and industry performance (PMI, 2016) and provides a competitive edge among organisations as projected many years prior (Deming, 1986; Crosby, 1989). Moreover, a QMS benefits organisations through improved customer satisfaction, increased profit, and fewer reworks (Small et al., 2021).

An element of quality exists within most construction project deliverables, regardless of the industry sector. Therefore, when viewed globally, quality can be seen broadly as a universal factor that is significant, unique, and high in propinquity among contractors, clients, and other stakeholder groups. Moreover, it is a measurable and controllable factor that produces tangible results. A QMS can be integrated at the project and organisational levels and may also provide benefits at the government and industry levels. However, despite the innumerable factors presented in the various literature over time (Nasir et al., 2016; Hasan et al., 2018; Hwang et al., 2020), quality has only been recognised as a contributory factor in isolation and is yet explored more broadly in the NZ residential construction sector as a strategic management approach towards productivity improvement. Highlighting the need for further research. It is considered that through construction organisations addressing QM strategically, improvements to productivity will be a by-product of effective management practices, highlighting a significant strategic shift in thinking around improving productivity in the residential construction sector.

3.7 Potential benefits of the research

The current study contributes to the extant knowledge in productivity literature by highlighting common factors affecting construction productivity and defining QM systems suitable for use in NZ residential construction organisations. This proposed research may benefit residential construction organisations and the wider NZ construction industry. Enhanced productivity is reasoned when construction organisations strategically address QM as an integrated strategy. Moreover, it may contribute to other areas of future research, including industry longitudinal studies in construction productivity and adaptation to other subsectors within this and other industries. Limitations to the proposed research exist throughout the residential subsector due to the uniqueness of construction projects and the variability within the current sector, through NZ market conditions.

3.8 Conclusions and further research

Improving construction productivity is a global problem. This preliminary literature review highlights common factors affecting construction productivity over 40 years. Although a commonality of various factors correlated to enhancing construction productivity from many global perspectives exists, construction productivity in NZ remains an enduring socio-economic problem. This research highlights the characteristics of Lean Six Sigma (LSS), Total Quality Management (TQM), and the ISO 9000 QM standards. This paper analysed the benefits of each QMS relevant to the local NZ residential construction sector. Additionally, identifying TQM or ISO 9000 as QM systems potentially benefits the NZ residential sector. Furthermore, the factors noted as effectively increasing construction productivity are mainly considered in isolation rather than against the broader productivity problem.

Additionally, as before, a significant link between quality and productivity exists. Indeed, as far back as the mid-1990s, integrated management functions have been linked to improved construction productivity. Consequently, QM systems are critical to project performance and are linked as direct drivers for enhancing productivity. Hence, an integrated management strategy focused on QM simultaneously identifies an opportunity to use QM to improve construction productivity in the NZ residential sector. After this research, it is hoped that QM at the organisational level will be effective as a management strategy in improving construction productivity in the NZ residential construction sector. Pursuing the need to be more productive is essential to organisational survival and improving societal living standards, benefiting all of NZ.

3.9 Chapter conclusion

The comprehensive analysis of existing research highlights the synergistic relationship between QM and construction productivity, particularly Lean Six Sigma, Total Quality Management and ISO 9000 standards. Nevertheless, a knowledge gap persists regarding the quantifiable effects of QM systems in improving productivity at the organisational level in New Zealand’s residential construction industry.

Key findings:

Quality's impact on construction productivity has been primarily studied in isolation, and a comprehensive, holistic management perspective is lacking within the New Zealand residential context. The organisational-level effects of QM systems on construction productivity in New Zealand remain unquantified. Despite global research on productivity factors, New Zealand's construction productivity growth has stagnated.

This research proposes a holistic approach to QM as a potential productivity enhancer in New Zealand's residential construction, subject to empirical validation.

The following research phase employs surveys and interviews to gather empirical data from industry practitioners and experts. The study will aim to quantify the relationship between QM systems and construction productivity in New Zealand. This will provide local insights and contribute to a broader understanding of QM's productivity impact in construction sectors.

3.9.1 Original contribution and realisation of aims, questions and objectives

This study overarching aim uniquely investigates the effectiveness of integrated QM systems as an organisational approach to enhance construction productivity in the New Zealand residential sector, departing from prior research that primarily examined quality as an isolated factor. The study emphasises the essential role of QM systems in enhancing sector performance, providing practical guidance on strategies to improve New Zealand's residential construction sector through their incorporation.

Moreover, (Table 3.2) the outcomes from this initial narrative review answer RO1 and contribute to answering RO2 by highlighting globally recognised common factors.

Table 2.2: Research outputs achieved (Author's work)

Research aim	To determine what effect QM as a strategy has on improving New Zealand residential construction productivity	
Manuscript title	An investigation into QM systems and factors affecting construction productivity: The New Zealand residential construction industry (Published Conference paper ASA 2022.).	
Research objective	**Research questions**	**Outputs achieved**
RO1. To determine the characteristics of QM systems that may be suitable for use in the New Zealand residential construction sector	RQ1.What QM systems do residential construction organisations use to improve construction productivity?	The review identified Lean Six Sigma, Total QM, and ISO 9000 as potentially beneficial QM systems for the NZ residential construction sector
RO2. To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector	RQ2. What are the common factors that positively affect construction productivity in the New Zealand residential construction sector	The review identified common factors positively affecting construction productivity, synthesised from 40 years of literature

3.9.2 Final considerations

While this study proposes an integrated QM strategy to enhance productivity and offers several potential solutions, such as ISO 9000, Total Quality Management and Lean Six Sigma in New Zealand's residential construction, empirical validation is necessary. The study also determines factors that can enhance productivity through global empirical research.

The forthcoming phase will empirically scrutinise the relationship between QM systems and construction productivity in New Zealand's residential construction sector through targeted data collection and analysis. This extensive investigation, incorporating surveys and interviews with industry practitioners, is poised to yield critical insights into both productivity-enhancing factors and the effectiveness of various QM strategies, a comparatively under-researched domain within the New Zealand context. Consequently, it holds significant implications for residential construction companies and the wider industry, by showcasing avenues for productivity gains and operational enhancements. The study also identifies crucial research gaps, such as the need to quantify the organisational-level impact of QM systems on construction productivity, thereby setting the stage for future empirical inquiries.

Ultimately, this research seeks to establish a foundational understanding of how QM improves New Zealand’s residential construction productivity. The following chapter will identify the common factors influencing construction productivity in New Zealand's residential sector.

Chapter 4
Factors for improving productivity in the New Zealand residential construction sector
Overview
Mirroring a global trend, the New Zealand residential construction industry faces persistent productivity challenges, despite its considerable economic and employment contributions. The study provides a unique, impactful analysis of productivity drivers by applying statistical methods, including the Garret ranking technique. Rigorously identifying and ranking key factors to enhance New Zealand's residential construction.

This focused examination within the New Zealand setting generates novel insights that address existing empirical investigation deficiencies. The findings provide actionable recommendations for industry stakeholders and policymakers, facilitating the implementation of targeted interventions to enhance the residential sector's performance.

Adopting a comprehensive methodological approach, this evidence-based research transcends incremental analyses to reveal critical productivity determinants, thereby creating strategic opportunities for sector-wide advancements and significantly contributing to the overarching aim of improving residential construction in New Zealand and beyond.

4.01 Technical Note on Garret Ranking Weighting
Note to reader: As this is a previously published manuscript, the following section provides essential supplementary methodological detail. Requested by the examiner to clarify the statistical weighting applied in the quantitative analysis.

Garrett ranking technique or Garrett scoring method is a nonparametric approach used to convert the ordinal rank order assigned by survey respondents into a quantifiable interval data. This process is crucial because it achieves a more statistically defensible prioritisation that using simple arithmetic means. The weighting relies on a 2-step transformation.

1. **Percentage position calculation:** The rank assigned to a factor by respondent is converted by a percentage into a Garret percentage position using the formula.

   $$P_{ij} = \frac{100\,(R_{ij} - 0.5)}{N_j}$$

2. **Score conversion:** This percentage position is then converted into a Garrett score or weight by referring to a standardised table of values derived from a normal probability distribution. This conversion assigns scores that reflect the factors position on a continuous scale, ensuring that the differences in perceived significance between ranks

(e.g., the perceived importance gap between rank1 and rank 2) are weighted according to statistical probability, not just numerical order.

The final ranking of factors in this study is determined by the mean Garrett score for each factor, with the highest mean score indicating the greatest perceived significance for improving NZ residential construction productivity.

This chapter is based on the following published Journal article [2]:

Kirby, M., Rotimi, F. E., & Naismith, N. (2024). Factors for improving productivity in the New Zealand residential construction sector. *Journal of Engineering, Design and Technology*. https://doi.org/10.1108/JEDT-03-2024-0192.

Abstract

Purpose - The New Zealand (NZ) construction industry significantly impacts the country's economy and is one of the largest sectors in total employment. However, a persistent and pressing need for improvement exists. Meeting the ongoing demand for housing and urban development requires enhancing residential construction productivity. The purpose of this paper is to determine what factors improve construction productivity in the NZ residential construction sector.

Design/methodology/approach - Data were obtained from construction industry bodies using a semi-structured online questionnaire survey. From 305 online questionnaires administered, 106 samples were completed by residential industry construction professionals across NZ. The data were analysed using descriptive and inferential statistics to establish the importance of empirical factors for improving construction productivity in the NZ residential construction sector.

Findings - The Garrett ranking technique revealed the top 5 factors for enhancing construction productivity in this study: adequate design, communication, QM, supervision, and organisational training. Other factors, such as unskilled workers, skilled workers, reworks and employee motivation, ranked less critical.

Originality/value - This research offers a unique perspective on residential construction productivity in NZ by identifying and analysing specific factors that can enhance efficiency across the sector. It provides novel findings and valuable insight into possible organisational improvement strategies yet considered in the NZ residential sector[2].

4.1 Introduction

Poor construction productivity is an enduring socio-economic concern permeating societies globally (Nasir et al., 2016; Hasan et al., 2018; Seadon and Tookey, 2019). In 2017, the McKinsey Global Institute (MGI) found that the construction industry has an intractable (McKinsey Global Institute, 2017) productivity problem.

Several reasons account for this problem, chief among which is the nature of the industry itself. Yet, the benefits of enhanced construction productivity are not lost on the industry, such as corporate competitiveness, reduced costs, and increased profits, all of which directly affect end-user costs and consumer choices (Arditi and Mochtar, 1996; Hasan et al., 2018). Researchers in New Zealand confirm the significance of improving productivity, considering the economic contributions of the construction sector (Davis, 2007; Tran and Tookey, 2011; Rotimi, et al., 2015; Chowdhury et al., 2019; Seadon and Tookey, 2019). A 1% annualised increase in construction productivity returns to a rise in gross domestic product (GDP) of around $139m, which means a direct link to improved societal living standards (Pricewaterhousecoopers, 2016; Tran and Tookey, 2011). Therefore, the poor performance of the NZ construction industry continues to receive attention (Barbosa et al., 2017; Seadon and Tookey, 2019). Barbosa et al. (2017) called for industry reform and improved quality within the sector. Seadon and Tookey (2019) offered a conceptual model highlighting processes, quality, affordability, and sustainability as drivers of improved performance.

Nevertheless, factors like poor productivity, persistent lack of standards, high industry fragmentation and low-quality control perpetuate the prolonged negative industry performance (Nasir et al., 2016; Hasan et al., 2018; Bloom et al., 2016). At the macro level, New Zealand is only one of a few comparable countries in the Organisation for Economic Cooperation and Development (OECD), exhibiting low productivity and low productivity growth (OECD, 2021). However, when measured against similar OECD countries, New Zealand remains significantly lower than the average OECD productivity benchmark (New Zealand Productivity Commision, 2021; OECD, 2021). Since the mid-1990s, it has lacked improvement compared to the top half of OECD countries. Indeed, the 34% gap since 1996 has widened considerably (Nolan et al., 2019; OECD, 2021), highlighting the persistent socio-economic concern. In addition, the country's capacity to transform longer hours into higher output per hour remains a problematic mystery (New Zealand Productivity Commission, 2023). In fact, the once-productive New Zealand economy is now one of the least productive across the OECD (New Zealand Productivity Commission, 2023). A New Zealand Productivity Commission

(2023) report underscores the severity of the problem, highlighting that for over 50 years, New Zealanders have worked longer hours and produced less per hour than other OECD economies, bringing to attention that productivity growth has slowed since the 1970s. Thus, improving productivity enhances the nation's well-being and highlights this study's importance (New Zealand Productivity Commission, 2023). Although several researchers have tried to model, forecast and predict construction productivity, they have yet to agree universally on factors to enhance productivity, particularly within residential construction (Hasan et al., 2018; Nasir et al., 2016; Thomas et al., 1990). Empirical data suggests that improving construction productivity locally requires understanding the factors affecting it (Green, 2016; Hasan et al., 2018).

Hence, this study aims to determine what factors improve construction productivity in the New Zealand residential construction sector.

4.2 Literature review

4.2.1 Analysis of factors affecting construction productivity

The construction industry in New Zealand plays a significant and critical role in driving the country's sustained economic growth (Hasan et al., 2018; Metri, 2005; OECD, 2021) and material standard of living (Barbosa et al., 2017). Hence, improvements to construction productivity can positively affect a nation’s economic growth. Moreover, the construction sector enhances the performance of other sectors, such as manufacturing and transportation (de Valence, 2018; Ofori et al*.,* 2020). The industry comprises around 80,000 businesses or service-related entities (Stats NZ, 2024a). Thus, the New Zealand construction sector ranks among the largest sectors by total employment, providing employment for approximately 10% of the total workforce (New Zealand Productivity Commission, 2023) and is primarily composed of micro-companies, accounting for 91% of all companies in the sector (Seadon & Tookey, 2019).

Due to its poor performance over many years, New Zealand construction productivity has received considerable negative attention, confirming the need for sustainable improvement (Barbosa et al., 2017). However, despite numerous industry reports, governmental strategies, research efforts, and sector initiatives over the years (Davis, 2007; Kane, 2012; McKinsey Global Institute, 2017; OECD, 2021; New Zealand Productivity Commission, 2023) aimed at enhancing productivity within the New Zealand construction industry, growth rates have remained mainly unchanged (Tran and Tookey, 2011; Carson and Abbott, 2012; Nolan et al., 2018; New Zealand Productivity Commission, 2023). The lack of progress highlights the ongoing challenge and emphasises the critical nature of the issue. A common theme in past research is the incremental approach to identifying strategies and factors for enhancing productivity, leading to systematic failures (Seadon and Tookey, 2019). Thus, there is a pressing necessity for innovative research to define improvement factors to enhance New Zealand residential construction productivity.

Globally, poor construction productivity is described as a systemic issue. Geographically, many industry-level productivity studies originate from Australia, the USA, and Singapore due to the focused research opportunities and governmental productivity initiatives and policies (Karimi, et al., 2017; Dixit et al., 2019). Productivity factors exist at both the macro and micro levels. Government laws, legislation, regulations, and standards take precedence at the macro level (Böhme et al., 2018). Significant improvements at the macro level may counteract inflationary effects and improve living standards (Shoar & Banaitis, 2019). This is opposed to the micro level, which deals with operational and management factors at the project level (Nasir et al., 2016). Improvements to productivity at the micro level may reduce organisational costs, improve profits, enhance project performance and directly affect macro-level outputs (Pricewaterhousecoopers, 2016; Tran & Tookey, 2011).

Hence, the global societal importance of measuring construction productivity has been highlighted since the 1990s (Latham, 1994). However, as far back as the mid-80s, macro-level studies (Allen, 1985) discuss productivity measurement, the various ways construction productivity is measured, and the relative benefits, strengths, and weaknesses. Similarly, research from Carson and Abbott (2012) reviewed productivity measurement in the New Zealand residential construction industry. The consensus is that not all productivity is the same, and productivity measurement should reflect what is being measured (Allen, 1985; Carson and Abbott, 2012; Nasir et al., 2016).

A construction industry study from the United Kingdom (UK) finds a need for supply chain integration, investment in training and education, and research and development as factors that transcend the wider industry. Some note these factors as points of difference that must change if the industry is to become more productive (Latham, 1994; Wolstenholme et al., 2019). Numerous studies have emphasised the favourable consequences of organisational training on enhancing construction productivity (Latham, 1994; Ofori et al., 2020; Manoharan et al., 2024). In their Sri Lankan construction industry study, Manoharan et al. (2024) support the findings of others (Gurmu et al., 2016; Nasir et al., 2016; Hwang et al., 2020) and provide insights into the importance of structured organisational training in improving performance across various construction projects in Sri Lanka. Results show training strategies enhanced quality and productivity and potentially improved the socioeconomic standings of unskilled workers.

Likewise, a systematic literature review centred around human capital that established the link between employee competency, performance and productivity.

Another UK study by Naoum (2016) looked at the project level and identified 46 factors under five headings: managerial, motivational, leadership issues, pre-construction, construction, and organisational factors. They noted incomplete drawings, poor communication, work overload, lack of material, tools and equipment breakdown, absenteeism, poor site conditions and improved quality as factors positively and negatively affecting construction productivity. In the United States (US), a study in the mid-1990s by Adrian, (1995) defined worker motivation, technology adoption and training as factors for improving productivity which are still relevant today. Further afield, the Indonesian construction sector identified factors, such as technology, scheduling/planning, quality control, worker training, adequate design practices, material availability, improved communication, and equipment maintainability, as highly relevant to improving construction productivity (Arditi & Mochtar, 1996; Nasir et al., 2016). The Malaysian sector offers a psychosocial approach to improving productivity. According to a study conducted, Islam and Zaki, (2008) high wages, good working conditions, promotions, job security, and recognition for work done are significant motivational factors that enhance employee performance.

Dixit et al.'s (2019) systematic literature review highlights seven general areas of classifications within the productivity literature from 101 papers over ten years (2006-2017). They determined factors at the industry level that affect or improve productivity, such as CP measurement techniques, models and simulations, equipment and technology, issues and problems associated with CP, and techniques for enhancing CP and frameworks. Other common factors noted at the industry level are construction reworks, adequate supervision, shortages of quality materials, shortages of skilled labour, lack of detailed design, and communication and management issues (Kazaz & Ulubeyli, 2007; Nasir et al., 2016). Whereas Dai et al. (2009), Naoum, (2016) and Dixit et al. (2019) indicates that productivity factors exist at the project level, possibly due to the ease of application and adaptation of factors.

Dai et al. (2009) researched the American (US) construction industry and aimed to gain craft workers' viewpoints on construction productivity through an industry survey. Findings indicate the relative impact of 83 factors positively and negatively affecting construction productivity. Additionally, results found that craft workers thoroughly understand the factors affecting their productivity. Interestingly, factors noted such as safety, adequate supervision, lack of leadership, improved communication, and lack of materials and equipment are predominantly site factors easily addressable by site management teams. A different path by Nasir et al. (2016)

presents an integrated perspective from the US construction industry and differs from others (Dai et al., 2009; Dixit et al., 2019) in several ways. Nasir et al. (2016) identified that the quality of infrastructure is linked to the living standards of communities. Additionally, they set out to implement a "best practice productivity implementation index" (BPPII). The BPPII comprises the best management practices to enhance construction productivity across the US infrastructure sector. It is also a form of benchmarking that can be used as a checklist for improving construction productivity on infrastructure projects.

An Iranian study on the construction sector, conducted by Ghoddousi and Hosseini, (2012) pinpointed 31 factors across seven categories that can lead to increased subcontractor productivity. These factors include adequate tools, supervision, planning, construction methods, technology, weather, site conditions play a vital role in enhancing subcontractor productivity. Equally, Loosemore, (2014) Australian construction industry paper also references the subcontractor perspective and addresses the lack of diversity in perspectives. Their findings include early contractor involvement (ECI), better document control, improved project management skills, scheduling, quality information, and risk management as areas of improvement for subcontractor productivity. Findings show similarities but differ between countries, indicating that factors are not universal and may be subject to a country's socioeconomic development. Another study by Hasan et al. (2018) concentrated on a systematic review (SLR) of mainstream studies. Findings here indicate a reasonable agreement of global factors among researchers for improving productivity, although not universally. The agreement is well-founded due to the extensive research conducted over an extended period and its global coverage, including countries of different socio-economic statuses and diverse project environments.

In their Singaporean study, Pheng et al. (2016), argue that organisational learning (OL) can enhance construction productivity in labour improvement initiatives. The study found using Building Information Modelling (BIM), Buildable Design Appraisal System (BDAS), and Constructability Appraisal System (CAS) can enhance productivity improvement. Another Singaporean viewpoint from Ofori et al. (2020) offers a modern perspective that highlights construction productivity should be a corporate strategic management policy to improve it. From the organisational perspective, many (Ghodrati et al., 2018; Gurmu et al., 2016; Hasan et al., 2018) agree that management strategies could improve construction productivity. For example, New Zealand research from the organisational level (Ghodrati et al., 2018) used management strategies centred around incentive programs, organisational training, communication, adequate supervision, planning, resource scheduling and labour management to enhance construction productivity in general construction projects. Findings indicate a strong positive relationship between management strategies such as communication and incentivisation programs and improving labour productivity. They also found higher productivity in construction projects with higher management practices.

According to Chowdhury et al. (2019), adopting technology in the New Zealand residential construction industry presents numerous benefits. The authors suggest that incorporating technological advancements can improve construction processes, ultimately leading to increased performance. Although advantageous, technology implementation is limited due to the necessity of a highly skilled workforce and the prevalence of micro companies in the New Zealand sector (Bloom et al., 2016; Nasir et al., 2016). Studies by Small et al. (2021) and Adrian (1995) support the notion that a long-standing connection between quality and improved productivity still exists. New Zealand studies align with other global studies and noted quality as a secondary factor among other factors in improving construction productivity, demonstrating its importance locally (Naoum, 2016; Ghodrati et al., 2018; Dixit et al., 2019; Keenan and Rostami, 2019; Seadon and Tookey, 2019; Hwang et al., 2020). One commonality among the research is that quality is often determined as a secondary factor to improve productivity and is rarely explored as a strategic primary approach toward productivity enhancement. However, the multiplicity and variance of globally recurring factors (Hasan et al., 2018) are linked to the various project environments and a country's developmental status, as highlighted in Table 4.1. Whereas Table 4.1 shows the factors affecting productivity, conversely, it suggests the focal areas where productivity could be improved within local industries. It is prudent to consider other factors requiring improvement, such as culture, sustainability, regulations, site facilities, new technologies, and employee well-being. Thus, research identifying the prevalent factors in local frameworks is significant (Dai et al., 2009; Dixit et al., 2019; Hasan et al., 2018; Nasir et al., 2016). The current study finds its relevance by determining the key factors that could enhance productivity within the New Zealand residential construction subsector. There is a dearth of literature within this critical subsector, hence this study’s focus.

4.3 Methodology

This study aims to determine the factors that can enhance construction productivity in the New Zealand residential construction sector. A review of existing literature looks at factors impacting construction productivity regardless of a country's socio-economic development. Selected factors were chosen from the universal literature based on their recurrence over an extended timeframe and their relevance to the New Zealand residential construction sector. Guided by the pragmatic paradigm, (Cherryholmes, 1992) this study employs a mixed-methods (MM) approach to bridge the knowledge gap between the factors that negatively affect New Zealand residential construction productivity and those that can improve it. Primary data for the study was collected through a semi-structured online questionnaire. An online questionnaire method (Qualtrics) was selected because it minimizes the time and human resources required for collecting and managing data. It is also more effective due to fewer errors in data transfer (Regmi et al., 2016). Survey participants were construction practitioners recruited through five industry body associations via a link to the research on the respective association websites. The five associations enabled representative sampling by a stratified probability sampling approach to select industry professionals that resemble the broader industry population (Rowley, 2014). An a-priori power analysis was conducted using G*Power software package 3.1.9.7. to determine the appropriate sample size. The sample size determined was 305 across the five associations (Faul et al., 2007). Of the 305 targeted over five weeks, 121 responses were received, 15 of which were deemed unusable due to missing data. Therefore, the total response rate was 34% of the total 305 anticipated. This is consistent with empirical research conducted by Rowley (2014), which found that a response rate of 25% within a sample size of 400 individuals is deemed adequate. The participants comprise general managers, construction managers, project managers, site managers, and subcontractors from the New Zealand residential construction industry. The questionnaire consisted of sections on background information and semi-structured questions relating to factors that could improve productivity.

Kolmogorov-Smirnov test was used to test for normality. Statistical Package for the Social Sciences (SPSS) is used to test the normality of the dataset. The test results indicate that the collected data had a non-parametric distribution. Garrett's ranking technique is used to measure the responses to the ranked-order question, where participants were asked to rank 10 factors from empirical data (1 to 10) in terms of their significance in improving New Zealand residential construction productivity, with 1 representing the most significant factor choice and 10 representing the least significant factor choice. Participants were asked to suggest additional factors beyond those presented to enhance New Zealand residential construction productivity. Thus, two factors of leadership and lack of tools and equipment are reflected in Table 4.1.

Regarding validity and reliability, the seminal work published in 2017 by Vaske et al. emphasised that the consistency of instrument measurements is assessed through reliability.

Cronbach's alpha determines reliability through internal consistency. In this study, 305 participants were sent a four-part questionnaire centred around construction productivity. The survey consisted of 14 items, and Cronbach's Alpha value was deemed acceptable $\alpha = .720$.

While validity can be assessed using criteria, content, face, and construct validity (Taherdoost, 2016). Face and content validity are essential during questionnaire development and pretesting, which involve evaluating the presentation and relevance of questionnaire items, often with expert judgment (Straub et al., 2004).

This study utilised a pilot study (n=7) involving construction professionals from comparable professions within the NZ residential sector to assess the validity and reliability of the research instrument. Following Roopa and Ranis', (2012) recommendations, a random sample of around 5 to 10% of the final sample (n-106) size was administered to identify and resolve potential issues.

Table 3.1: Empirical factors for improving NZ residential construction productivity (Author’s work)

		Developing Countries					Developed Countries				
Factors	Egypt	India	Iran	Indonesia/ Thailand	New Zealand	United Kingdom	United Arab Emirates	Singapore	United States	Australia	References
Employee Motivation			✓	✓	✓	✓	✓		✓	✓	Adrian, (1995): Islam and Zaki (2008); Hwang, (2020): Ghodrati et al., (2019); Cox and Deck, (2005): Rivas eta l., 92011) Holmes, (2011): Naoum (2016)
Adequate Supervision	✓	✓	✓	✓					✓	✓	Hasan *et al*., (2018); Dixit *et al*., (2019) Ghoddousi and Hosseini (2012); Dai *et al*., (2009); El-Gohary and Aziz (2014); Makulsawatudom *et al*., (2004); Naoum (2016)
Lack of leadership	✓			✓		✓		✓	✓	✓	Dai *et al*., (2009); Lessing *et al*., (2017); Jarkas and Bitar (2012); Ofori *et al*., (2020); El- Gohary and Aziz (2014)
Workers skill levels	✓							✓	✓	✓	Manoharan et al. (2024) Bloom et al. (2016); Nasir *et al*., (2016); Hasan *et al*., (2018); Ofori *et al*., (2020); Hwang *et al*., (2020) Gurmu et al., (2016)
Lack of Training and Education	✓				✓		✓	✓		✓	Hasan *et al*., (2018); Ofori *et al*., (2020); Hwang *et al*., (2020); Ghodrati *et al*., (2018); Sing (2010); Latham (1994)
Communication		✓			✓				✓	✓	Hasan *et al*., (2018); Nasir *et al*., (2016); Gurmu *et al*., (2016); Dixit *et al*., (2019); Dai *et al*., (2009); Latham (1994)
Lack of proper tools and equipment	✓		✓			✓		✓	✓	✓	Zakeri *et al*., (1996); El- Gohary and Aziz (2014); Nasir *et al*., (2016); Hasan *et al*., (2018); Gurmu *et al*., (2016); Horner *et al*., (1989); Hwang *et al*., (2020)
Design and specifications	✓			✓			✓		✓	✓	Hasan *et al*., (2018); Gurmu *et al*., (2016); Jarkas (2015); El- Gohary and Aziz (2014; Makulsawatudom *et al*., (2004)
Communication	✓	✓		✓	✓	✓			✓	✓	Dixit *et al*., (2019); Nasir *et al*., (2016); Hasan *et al*., (2018); Lessing *et al*., (2017); Dai *et al*., (2009); Naoum (2016); Makulsawatudom *et al*., (2004)
Rework		✓	✓	✓					✓	✓	Nasir *et al*., (2016); Hasan *et al*., (2018); Ghoddousi and Hosseini (2012); Jarkas *et al*., (2012): Makulsawatudom *et al*., (2004): Dixit *et al*., (2019)
Quality		✓		✓		✓			✓	✓	Naoum (2016); Ardit and Mochtar (1996): Dixit *et al*., (2019); Nasir *et al*., (2016); Loosemore (2014)
Variations		✓		✓		✓			✓	✓	Lindhard, (2014) Makulsawatudom *et al*., (2004); Dixit *et al*., (2019); Naoum (2016); Nasir *et al*., (2016); Hasan *et al*., (2018)

The respondents provided feedback on the wording and usability of the questionnaire, leading to minor adjustments in the main questionnaire's wording.

The Henry Garret Ranking Technique analysed the qualitative ranked order data using Microsoft Excel v16.85 (Asadi et al., 2021). This technique assigns a score to each rank position (where rank 1 = most significant, rank 10 = least significant). Firstly, the per cent position is estimated using Garrett's table and then converted into scores using the given Garret Ranking formula. The scores of each factor were then added, and the total and mean values of the scores were calculated. The factor with the highest mean value was considered the most crucial in positively influencing New Zealand residential construction productivity. The Garrett ranking method was employed to prioritise the factors. After calculating the per cent position of the ranks of the existing factors, the order of merit was transmuted following the Garrett method (Asadi et al., 2021). The final ranking of the factors was determined based on their mean score to establish their relative priority. Compared to a simple frequency distribution, the primary benefit of this approach is that the improvement factors are organised according to their importance, as perceived by the respondents. This approach allows improvement factors to be ranked by order of importance, contributing to new knowledge by providing an ordered list of factors by importance that can improve New Zealand residential construction productivity.

4.4 Results

4.4.1 Demographic survey results

The questionnaire survey was offered nationwide in New Zealand and is limited to the New Zealand residential construction sector. A sample group of (n) 106 details the contributors’ age, profession, NZ residential construction experience, and highest levels of education. Survey results show that approximately 70% of participants were in the middle age range of 30-60 years, and more than 49% were 30 or older. In addition, the survey indicates that 71.7% of the participants had over five years of experience in the New Zealand residential construction industry, and around 61.3% held a diploma-level qualification or higher. These findings indicate that participants' attributes demonstrate their competence to add significant value, quality feedback, and reliability to the study. Consequently, factors suggest that the opinions gathered in the survey are reliable and can be used to draw valid conclusions about the New Zealand residential construction industry.

Table 3.2: Cronbach's alpha analysis (Author's work)

Reliability statistics		
Cronbach's alpha[a]	**Cronbach's alpha based on standardised items**	**N of items**
.720	.765	14

a. Listwise deletion based on all variables in the procedure

4.4.2 The Henry Garret ranking technique

Garret's ranking technique was adopted to evaluate the weight participants assigned to 10 factors that can improve New Zealand residential construction productivity. Sample respondents were asked to rank ten factors on a scale of 1-10, where one is the most significant factor, and 10 is the least important factor relative to how much they considered a factor could improve New Zealand residential construction productivity. The factor choices provided by respondents are converted into scores using the Garret formula (Equation 1) to determine percentage positions for each factor. The order of participant sample responses is converted into percent positions to calculate the rankings for each factor. More detailed information about the factors can be found in Table 4.3.

Equation 1: The Garret Ranking formula

$$\text{Percent Position} = \frac{100\,(Rij - 0.5)}{Nj}$$

Where:

- ***Rij*** is the rank given for the ***i***th factor by the ***j***th respondent
- ***N$_j$*** is the number of factors ranked by the ***j***th respondents.

Table 4.3 discusses the ranked order results from the empirical factors presented in this study that may positively affect residential construction productivity. The Garrett Ranking Conversion Tables derive each factor's corresponding Garrett value from its per cent position (Table 4.3).

Respondent rankings are summated. Each rank (1-10) is multiplied by its corresponding Garret value (Table 4.3) to produce a total value (Table 4.4). The rank totals for each factor are then multiplied by the corresponding Garrett Ranking Values. The average score is obtained by individually summating ranked values across the ten factors (Table 4.4). Factor totals are then divided by (n) (Table 4.5) to produce a score leading to a final rank. This paper aims to identify the factors that can improve construction productivity in the New Zealand residential construction industry. The findings of this study indicate that 29.2% of the participants selected complete design and specifications and communication as the top two factors that could enhance productivity in the New Zealand residential construction sector (Table 4.6). Moreover, 41.5% of respondents (Table 4.6) identified QM as the third most important factor for improving productivity.

Table 3.3: Garret ranking value percent positions of improvement factors (Author's work)

S.No	Factors	Formula	Per cent Position	Garret Value
F1	Design and Specification	100(1-0.5)/10	5	82
F2	Communication	100(10-0.5)/10	95	18
F3	Quality management	100(3-0.5)/10	25	63
F4	Adequate supervision	100(4-0.5)/10	35	58
F5	Organisational training	100(9-0.5)/10	85	29
F6	Employee motivation	100(7-0.5)/10	65	42
F7	Lack of skilled workers	100(5-0.5)/10	45	52
F8	Unskilled Workers	100(6-0.5)/10	55	48
F9	Client variations	100(8-0.5)/10	75	36
F10	Construction reworks	100(2-0.5)/10	15	70

Adequate supervision (25.5%) and organisational training (18.9%) were identified in Table 4.6 as the fourth and fifth most critical factors for enhancing construction productivity in the New Zealand residential construction sector. In addition, 17.9% (Table 4.6) of participants identified employee motivation as the sixth most important factor for improving productivity.

Table 3.4: Garret Ranking sample group score estimations of improvement factors in this study (Author's work)

S. NO.	Factors	Respondent ranking										N
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
1	Factor 1	2542	1260	1449	870	416	384	42	0	58	0	***106***
2	Factor 2	246	280	252	174	104	48	378	324	377	1044	***106***
3	Factor 3	738	3080	1638	928	468	0	84	0	0	0	***106***
4	Factor 4	1312	1120	1071	1566	572	384	294	72	58	0	***106***
5	Factor 5	164	0	126	116	624	1104	966	864	435	54	***106***
6	Factor 6	0	0	252	348	416	720	1092	900	406	144	***106***
7	Factor 7	328	210	189	638	780	768	336	684	493	180	***106***
8	Factor 8	0	0	0	0	364	336	882	324	1160	396	***106***
9	Factor 9	820	420	504	464	936	960	504	540	87	108	***106***
10	Factor 10	2542	1050	1134	1044	832	336	0	36	0	0	***106***

Table 3.5: Final factor rankings for improving productivity in the NZ residential sector (Author's work)

S. NO.	Factor	Formula	Per cent Position	Garret Value	Score	Final Rank
F1	Design and Specification	100(1-0.5)/10	5	82	66.23	**1**
F2	Communication	100(10-0.5)/10	95	18	65.79	**2**
F3	Quality management	100(3-0.5)/10	25	63	65.43	**3**
F4	Adequate supervision	100(4-0.5)/10	35	58	60.83	**4**
F5	Organisational training	100(9-0.5)/10	85	29	50.40	**5**
F6	Employee motivation	100(7-0.5)/10	65	42	43.45	**6**
F7	Lack of skilled workers	100(5-0.5)/10	45	52	42.00	**7**
F8	Unskilled Workers	100(6-0.5)/10	55	48	40.35	**8**
F9	Client variations	100(8-0.5)/10	75	36	32.66	**9**
F10	Construction reworks	100(2-0.5)/10	15	70	30.44	**10**

Based on this study, the least important factors for improving construction productivity in the

New Zealand residential construction sector are a lack of skilled workers (7), unskilled workers with client variations as the eighth and ninth-ranked factors and construction reworks as the least important factor (10). These results offer valuable insights into the factors that can positively impact construction productivity in the New Zealand residential construction sector. Table 4.5 shows the final ranking positions of the factors that improve construction productivity in the New Zealand residential construction sector.

4.5 Discussion and recommendations

In addressing the research aim, this study used the Henry Garrett ranking technique to qualitatively analyse 10 factors (from 1 to 10) in improving New Zealand residential construction productivity and rank them by importance (Table 4.5). The ten factors presented in this research for improving productivity can be viewed from both organisational and project levels. For instance, from the organisational level, factors like complete design and specifications, skilled workers and organisational training show mixed rankings where 2 of the 3 factors, complete design and specifications and organisational training, are within the top 5 improvement factors chosen by respondents. When viewed from the project level, factors like adequate supervision, communication and QM also rank highly, whilst employee motivation, unskilled workers, construction reworks, and client variations are viewed as of less importance among participants in this study. The distribution within the top 5 factors implies that 60% of factors can be addressed at the project level for rapid and tangible improvement.

Effective communication emerged as the second most critical factor at the project level in this study, consistent with research worldwide that emphasises its significance in enhancing construction productivity (Seadon and Tookey, 2019; Latham, 1994; Dai et al., 2009; Naoum, 2016; Dixit et al., 2019). Research from NZ underscores the importance of communication as a management strategy in general construction projects, with findings revealing a robust positive correlation between effective communication and productivity (Ghodrati et al., 2018).

Table 3.6: The Mode showing the frequency of choice of improvement factors (Author's work)

Factor	Mode	(N)	% of Population	(N) Valid
Communication	1	31	29.2%	106
Adequate design and specifications	1	31	29.2%	106
Quality management	2	44	41.5%	106
Adequate supervision	4	27	25.5%	106
Organisational training	6	20	18.9%	106
Unskilled workers	7	26	24.5%	106
Lack of skilled workers/	8	19	17.9%	106
Employee motivation	8	19	17.9%	106
Client variations	9	22	37.75	106
Construction reworks	10	58	54.7%	106

Furthermore, the study confirms that management strategies centred on training and supervision also positively impact productivity in general construction projects. Adequate supervision and organisational training were ranked 4 and 5 in this study as key factors for improving New Zealand residential construction productivity. This aligns with previous New Zealand construction sector research, highlighting the role of design changes and complexity as external drivers of construction productivity (Ghodrati, et al., 2018; Page, 2010; Seadon & Tookey, 2019). Similarly, global research emphasises the importance of adequate design in enhancing construction productivity across various socioeconomic backgrounds (Dixit et al., 2019; Naoum, 2016; Nasir, 2013; Zakeri et al., 1997).

This study suggests that QM is the third most important factor for enhancing productivity in the New Zealand residential construction sector. Although it has been recognised as a beneficial aspect of construction productivity for over four decades (Adrian, 1987; Arditi & Mochtar, 1996; Crosby, 1989; Nasir et al., 2016), it is often perceived as a secondary factor. Nevertheless, QM is the only factor from this study that can be applied holistically across all levels of a project, including the organisational and legislative levels. In fact, Small et al, (2021) demonstrated that adopting a holistic approach to QM can improve project-level productivity in general construction projects in the United Arab Emirates. Neyestani (2016), argues that implementing QM can benefit organisations by enhancing customer satisfaction, improving time efficiency, and reducing costs. Chan and Chan, (1999) emphasise the importance of QM as a tool for governance in tendering public projects in Hong Kong, highlighting its effectiveness as a holistic approach to QM and industry-wide performance, leading to improved productivity. A New Zealand study by Seadon and Tookey (2019) offers quality as a factor in a proposed productivity improvement model for the construction sector, highlighting its potential across the local industry. Thus, viewed through this lens, QM can be considered a universal factor for improving construction productivity. However, there is debate about the extent to which QM significantly improves organisational performance (Haupt and Whiteman, 2004), possibly due to the industry culture of normalising defects in the building process. This may imply that QM is viewed more as a reactive task leading to poor productivity than a proactive and strategic approach to improving it.

The above discussion highlights the key factors for improving New Zealand residential productivity, particularly the important role that QM plays in future improvements. Factors noted can be used individually or in unison to create effective organisational responses to productivity improvement in the New Zealand residential sector.

4.6 Implication to theory and practice

Research studies indicate that several construction productivity factors have remained unchanged for over three decades (Arditi and Mochtar, 1996; Hasan et al*.,* 2018). The implications of this study are significant for the residential sector in New Zealand. By identifying key factors that can improve productivity in the industry, such as complete design and specifications, effective communication, QM, adequate supervision, training, skilled labour, and employee motivation, this study provides valuable insights for industry practitioners and policymakers. It expands the existing productivity literature around factors for improving New Zealand residential construction productivity. One important implication of this study is the link between QM and improved productivity, highlighting the significance of strategic organisational investments in QM and the added opportunity presented to policymakers concerning industry-wide improvements. Moreover, the findings suggest that investing in worker training is essential. Ensuring workers possess the necessary skills and knowledge to perform their tasks efficiently can enhance productivity and project outcomes. In conclusion, this study's findings emphasise the factors that can improve construction productivity in residential projects in New Zealand, ultimately leading to improved outcomes for all stakeholders.

4.7 Conclusion

The results of this study offer significant insights into the perceptions of the New Zealand residential construction industry concerning factors that could enhance productivity in the sector. By addressing a complex problem, this research adds to the existing body of knowledge and underscores the depth of our investigation. The primary objective of this paper is to determine factors that improve construction productivity in the New Zealand residential construction sector. Several key factors emerged from the sample group of New Zealand's residential construction professionals, including complete design and specifications, communication, QM, adequate supervision, training, skilled labour, and employee motivation. These factors are critical in improving residential construction productivity in New Zealand. Conversely, unskilled workers, client variations, and construction reworks were found to be less influential in enhancing construction productivity.

This research proposes a novel approach to enhancing modern New Zealand residential construction productivity. It examines and ranks the factors that can improve productivity and provides 7 improvement factors that can be combined or used individually to achieve a more strategic approach to productivity improvement in residential construction projects in New Zealand. The 7 factors identified in this study can be grouped in any order or adapted individually to achieve a more holistic approach to productivity improvement in residential construction projects in New Zealand. For instance, effective communication strategies can improve quality, supervision, and training when structured according to organisational and project requirements. On the other hand, a strategy focused on quality, such as implementing the ISO 9000 standard for QM, can ensure a quality culture, quality communication, quality design and specification, quality training, and quality supervision, which may have far-reaching effects on organisational performance.

The findings of this study offer valuable recommendations for improving New Zealand residential construction productivity through the improvement factors that can be used in the future development of improvement strategies at the organisational, industry, and policy levels.

4.8 Limitations

While providing a valuable exploration of factors that can positively impact residential construction productivity in New Zealand, the present study contains certain limitations. The study's focus on a specific geographic location and a small sample size (n106) may restrict the generalizability of its findings to other regions or countries. Furthermore, the reliance on self-reported data from industry professionals introduces the possibility of bias or inaccuracies in the results. Additionally, the study did not investigate the potential influence of external factors, such as economic conditions or regulatory changes, on residential construction productivity.

Despite these limitations, the study presents a foundation for future research on this topic. Future research could address these limitations by conducting multi-country studies and utilizing objective productivity measures to provide a broader context. Additionally, open-ended questions could be used to collect more detailed qualitative data, enhancing the study's dependability. This methodological constraint could have omitted important experiential nuances, which could be explored in future research to provide more comprehensive and rigorous findings.

4.9 Chapter conclusion

Within this chapter, the empirical findings on productivity factors suitable in the New Zealand residential construction sector are carefully presented, outlining the identification and prioritisation of key drivers facilitated by a semi-structured online questionnaire and the Garrett ranking technique. This investigation revealed five primary productivity contributors in New Zealand's residential construction domain: adequate design, communication, QM, supervision, and organisational training, thereby furnishing direct and actionable insights for both policymakers and industry stakeholders.

Although this study offers foundational conclusions, subsequent research would benefit from examining the relationships between these productivity factors and participant demographics (professional roles, age, industry experience and educational backgrounds) to foster a more granular comprehension of stakeholder viewpoints. This foundational work enables the continuous refinement and expansion of knowledge, ultimately supporting improved efficiency within New Zealand’s residential construction sector.

4.9.1 Original contribution and realisation of aims, questions and objectives

This chapter directly addresses the research aim by empirically validating QM as a key productivity enhancer in New Zealand's residential construction sector.

The study uniquely identifies key factors influencing productivity in New Zealand's residential sector, fulfilling RO2. The emphasis on QM as one of the top five productivity improvement factors reinforces RO3, confirming its role in enhancing productivity as a strategy.

The originality of this study lies in its targeted focus on the New Zealand residential construction sector and its application of the Garrett ranking technique to prioritise productivity factors using local industry professionals. This approach provides a nuanced understanding of the specific challenges and opportunities within this context, offering a departure from broader studies that may not capture the intricacies of the New Zealand market.

Furthermore, Table 4.7 illustrates the success of this chapter in addressing RO2 and answering RQ2 and its contribution towards RO3.

Table 3.7: Research outputs achieved (Author's work)

Research aim	To determine what effect QM has as a strategy for improving New Zealand residential construction productivity	
Manuscript title	An investigation into QM systems and factors affecting construction productivity: The New Zealand residential construction industry (Published Journal Paper JEDT 2024)	
Research objective	**Research questions**	**Outputs achieved**
RO2. To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector	RQ2. What are the common factors that positively affect construction productivity in the New Zealand residential construction sector	The top five productivity factors in the NZ residential sector, ranked by Garrett technique, are: design, communication, QM, supervision, and training
RO3.To validate the effectiveness of a developed strategy for QM in residential construction	RQ3. How effective is the developed strategy for QM in the residential construction sector	This study empirically supports QM as a strategic productivity enhancer in the NZ residential sector

4.9.2 Final considerations

The research reveals that New Zealand's residential construction sector prioritises design, communication and QM as its foremost productivity drivers, insights corroborated by industry professionals. Collectively the findings suggest the necessity for comprehensive improvement strategies to enhance productivity in the local sector. Systematically addressing these pivotal factors holds substantial potential for elevating industry sector productivity and surmounting the current productivity obstacles.

This research offers significant benefits for various stakeholders, providing policymakers with critical insights for shaping supportive regulatory frameworks and enabling the industry to develop best practice guidelines. Concurrently, the research provides organisations with actionable insights for implementing targeted interventions to optimise their operational performance. These improvements contribute to a more efficient and resilient residential construction sector in New Zealand.

Future research should explore the complex relationships among these factors and other influential variables. The next chapter explores the associations between demographic characteristics (age, experience, profession) and their impact on QM and residential construction productivity. This analysis supports the development of targeted strategies that consider the diverse demographic landscape of New Zealand's residential construction industry. Ultimately, these strategies lead to more effective and sustainable improvements within the industry.

Chapter 5

Exploring the interrelations between demographic factors and key variables influencing productivity in New Zealand

Overview

Despite its economic significance, New Zealand's residential construction sector faces persistent productivity challenges, impacting housing affordability and living standards. This study explores the effect of demographic characteristics on QM and productivity in New Zealand's residential construction industry. It provides novel and actionable insights to inform targeted strategies for performance improvement.

Leveraging Spearman's Rho correlation analysis, the study reveals how age, experience, and occupation shape perceptions and adoption of productivity-enhancing strategies.

A multidimensional approach that includes targeted training, experienced personnel, strong leadership, and a balanced focus on quality, time, and cost is essential for improving sector performance.

This research highlights the strategic importance of addressing generational and occupational differences to enhance the sector's productivity, resilience, and equity. It provides empirical evidence for customised initiatives leveraging demographic factors, laying the groundwork for a more productive, resilient, and equitable built environment.

This chapter is based on the following approved conference paper.

Exploring the Interrelations Between Demographic Factors and Key Variables Influencing Productivity in New Zealand

Kirby, M., Rotimi, F., & Naismith, N. (n.d). Exploring the Interrelations Between Demographic Factors and Key Variables Influencing Productivity in New Zealand

In. (eds), 8th New Zealand Built Environment Research Symposium. *Holistic Living, Affordable, and Resilient Built Environment for All.* pp…. February 12-13 2025, Massey University, New *Zealand*

Abstract

Purpose: New Zealand's (NZ) construction sector, a major employer and supporter of transport and manufacturing, is crucial to its economy. However, enhancing productivity in this sector remains challenging despite efforts from government officials, industry experts, and researchers to ensure sustainable economic growth and quality of life.

This paper presents new insights and expands existing research to explore the relationships between demographic characteristics and key variables that may improve the efficiency of NZ's residential construction sector.

Structure: The paper includes an introduction, literature review, methodology, findings, discussion, and conclusions, comprehensively analysing productivity improvement factors in New Zealand's residential construction sector.

Methodology: Data were collected from 106 residential construction professionals across New Zealand through an online questionnaire distributed via five industry associations. The study employed Spearman's Rho correlation analysis to examine relationships between factors considered to enhance productivity.

Results: The analysis revealed several significant correlations: 1. There is a positive association between age and the industry's tendency to prioritise time and cost over quality. 2. There is a moderate positive relationship between industry experience and using the ISO9000 QM System. 3. A small, negative correlation between occupational groups, QM practices, and productivity as a strategic policy.

Conclusions: The findings suggest that improving New Zealand's residential construction productivity requires a multifaceted approach, including targeted training, leveraging experienced personnel, fostering a positive organisational culture, and balancing quality, time and cost. The study highlights the strategic value of QM in enhancing sector performance.

5.1 Introduction

Accounting for over 10% of global gross domestic product (GDP), the construction industry operates across diverse geographic, cultural, and economic settings (McKinsey Global Institute, 2020). It is widely considered a project-based sector, complex and often characterised by low margins, high fragmentation, substantial risk, poor quality, and low productivity (McKinsey Global Institute, 2017). Consequently, poor construction productivity is a significant socioeconomic concern affecting societies globally. The pervasive nature of this issue indicates that productivity enhancements are probably located within local industries instead of being universal across countries or sectors (Green, 2016).

In New Zealand, the construction industry accounts for more than 6.3% of GDP and bolsters sectors such as manufacturing and transportation (Ministry of Business, Innovation & Employment, 2024). As a major employer, it plays a critical role in the economy by supporting housing, education, healthcare, and infrastructure, emphasising its societal significance (New Zealand Productivity Commission, 2023). Moreover, the nation relies heavily on this sector for economic success. Although there was growth from 2019 to 2022 (Ministry of Business, Innovation and Employment, 2024), the industry continues to face ongoing productivity challenges and subpar quality (BRANZ, 2021). A 2017 McKinsey Global Institute report emphasises longstanding productivity concerns, advocating for reform. The NZ Productivity Commission (2023) recently observed that since the 1970s, productivity growth has decelerated, revealing a sustained negative correlation between hours worked and output per hour relative to comparable OECD nations. This indicates that productivity challenges in New Zealand's construction sector are ongoing, primarily driven by the intrinsic characteristics of the industry (Ministry of Business, Innovation and Employment, 2024). Therefore, improving NZ's construction productivity is essential for the country's well-being, highlighting the importance of this research (New Zealand Productivity Commission, 2023).

Recent data shows residential consents make up about 40% of approved developments, highlighting strong demand for housing and urban development (Stats NZ, 2024a). Improving productivity in NZ residential construction could significantly enhance the sector's performance and the economy. A 5% increase in productivity could yield annual savings of NZD1.5 billion, benefiting housing affordability and living standards (Ministry of Business, Innovation and Employment, 2024). Nevertheless, despite continued research on construction productivity, consensus on improvement factors in the NZ residential sector remains elusive (Dixit et al., 2019; Hasan et al., 2018; Nasir et al., 2016). Evidence shows local productivity improvements depend on understanding local factors. However, research on how these factors influence productivity in the NZ residential context is limited. This paper offers novel insights and explores the relationships among demographic factors and key variables to enhance NZ residential construction sector productivity.

5.2 Literature review

5.2.1 Analysis of factors affecting construction productivity

The NZ construction sector includes around 80,000 businesses, with over 90% as micro-companies. As the fifth largest employment sector, it supports manufacturing, drives sustainable economic growth, and enhances quality of life. Therefore, improving construction productivity can positively impact NZ's economic development. However, the residential construction industry has faced criticism for ongoing productivity issues. Productivity, defined as the efficiency of converting inputs into goods and services, is influenced by macro factors like fiscal policies and micro factors such as skills and management practices. Enhancing micro-level productivity can reduce costs, increase profits, and improve project performance, enabling improved macro-level outputs. Understanding the interplay between these factors is crucial for developing strategies to boost overall productivity. At the macro level, researchers widely acknowledge detailed methods for measuring industry productivity as necessary. As far back as 1985, Allen examined various methodologies and their pros and cons. Latham (1994) connected construction productivity measurement to improved living standards, while Carson and Abbott (2012) explored these techniques within NZ’s construction sector. A consensus exists that measuring productivity is complex and context-specific. (Allen, 1985; Carson & Abbott, 2012; Dixit et al., 2019; Latham, 1994).

Dixit et al. (2019) confirmed through a Systematic Literature Review (SLR) that productivity factors could exist at industry, project, and activity levels, identifying key industry-level factors such as measurement techniques, models, and frameworks. Hasan et al. (2018) noted extensive research at the project and activity levels due to ease of implementation. Nasir et al. (2016) and Kazaz & Ulubeyli (2007) identified common factors including rework, supervision, material and labour issues, poor design, management problems, and technology. Enshassi et al. (2007) identified 45 factors affecting residential construction productivity and grouped them into common categories: material deficiencies, labour skills, poor supervision, lack of coordination, and frequent scope changes. Gurmu et al. (2016) found that effective project planning boosts productivity in Australia's construction sector, highlighting strategies such as project initiation planning, traffic management, equipment placement, and flexible site arrangements. Hwang et al. (2020) and Manoharan et al. (2020) discussed how training could improve quality and productivity while enhancing the status of low-skilled labourers. Naoum identified 46 variables affecting productivity in the UK, which are grouped into pre-construction tasks, construction-phase activities, management and leadership concerns, motivational factors, and other aspects. Key factors include the expertise of site and project managers, design errors, practicality of construction methods, project planning, communication effectiveness, management approach, and procurement methods. Enshassi et al. (2007) and Naoum (2016) agree that job satisfaction and motivation significantly enhance productivity. Dai et al. (2009) identified 83 factors influencing U.S. construction craft workers, including equipment, materials, and drawing management, highlighting the site management role. Loosemore (2014) emphasised the importance of subcontractor-main contractor collaboration, early contractor involvement (ECI), transparent bidding, document control, project oversight, planning, scheduling, coordination, risk management, and labour relations. Love (2002) noted that the discontinuity of design staff leads to poor documentation, rework, and reduced productivity and, Pheng et al. (2016), emphasised the benefits of organisational learning for productivity enhancement.

In their 2018 review, Hasan et al. analysed over three decades of research. They pinpointed several global productivity challenges, including unavailability of materials, insufficient oversight, a shortage of skilled labour, inadequate tools and equipment, and subpar drawings and specifications. Notably, about 60% of these issues were similarly highlighted by Nasir et al. (2016) across various sectors.

Ofori et al. (2020) argue that adopting productivity as a strategic management policy can enhance productivity in Singapore's construction sector. Other studies (Ghodrati et al., 2018; Gurmu et al., 2016; Hasan et al., 2018) concur that a management approach is essential for improving construction productivity. Choudhry (2015) supports joint management systems (JMS) for productivity and safety enhancement, noting that communication strategies mitigate safety issues while effective labour management, supervision, leadership, and planning boost performance. Ghodrati et al. (2018) found a strong positive correlation between management strategies, such as communication and incentive programs, and employee productivity in NZ general construction projects. Seadon and Tookey (2019) employed a soft systems dynamics approach (SSD) to model Process, Quality, Affordability, and Sustainability in reducing productivity losses. Chowdhury et al. (2019) claim that technology incorporation significantly improves methods and efficiency in the New Zealand construction sector. However, the McKinsey Global Institute (2017) argues that technology alone cannot resolve productivity issues without accompanying cultural changes and adequate systems, staff, and training. Ruales Guzmán et al. (2019) found that QM significantly impacts productivity and is crucial for economic development, with key components including human resource management, leadership, and process oversight. Although not specific to residential construction, Small et al. (2021) in the UAE supports these findings. A commonality exists in existing studies that often treat quality as secondary in productivity enhancement (Dixit et al., 2019; Keenan & Rostami, 2019; Naoum, 2016; Seadon & Tookey, 2019). However, several NZ studies emphasise QM's essential role in improving project outcomes and efficiency (BRANZ, 2021; Davis, 2007; Ghodrati et al., 2018; Kane, 2012; Rotimi et al., 2015; Seadon & Tookey, 2019). Despite over a decade of initiatives and research (McKinsey Global Institute, 2017; Davis, 2007; Kane, 2012; New Zealand Productivity Commission, 2023; OECD, 2024), productivity growth in NZ's construction sector remains aspirational at best (New Zealand Productivity Commission, 2023). The McKinsey Global Institute (2017) emphasises the necessity for innovative approaches and regulatory frameworks to address these persistent issues. Consequently, further research is essential to identify factors that enhance productivity in NZ's residential construction sector. Building upon previous research (Kirby et al., 2022, 2024), this study's theoretical foundation is grounded in the Theory of Constraints as a managerial approach that prioritises and improves the system's least efficient components to boost overall efficiency. When applied to the construction industry, this methodology can be implemented to tackle productivity challenges by focusing on the most critical constraints (Durdyev & Ismail, 2019; Şimşit et al., 2014). Through this theoretical lens, this study examines the interrelations among demographic factors and key variables believed to enhance productivity in New Zealand's residential construction sector, aiming to deepen industry and academia's understanding of future performance improvement efforts. Table 5.1 discusses the empirical factors employed in this study that can enhance New Zealand's residential construction productivity. The factors are defined to clarify their contextual meanings.

Table 4.1: Empirical productivity factors used in this study (Author's work)

Productivity factors and contextual definitions	Source
Employee Motivation - refers to workers' enthusiasm, commitment, and drive to achieve job tasks and organisational goals.	Adrian, (1995): Islam and Zaki (2008); Hwang, (2020): Ghodrati et al., (2019)
Workers Age – is the chronological age, which can influence their physical capabilities, experience, and adaptability.	Maqsoom et al., (2021); Khahro et al., (2023); Islam and Zaki (2008
Training/ Education - is the formal or informal learning process equipping workers with the skills and knowledge for their trades or professions, in the context of organisational or industry training in this research.	Hasan *et al*., (2018); Ofori *et al*., (2020); Hwang *et al*., (2020)
Design and specifications - refer to the clarity, completeness, and quality of project plans and the associated project requirements through specifications.	Gurmu *et al*., (2016); Jarkas (2015); El-Gohary and Aziz (2014);
Quality management- is the implemented systems and practices that ensure consistent quality in work outputs.	Naoum (2016): Dixit *et al*., (2019); Small et al, (2021)
ISO9000 QMS - refers to a set of globally recognised quality standards organisations can implement to improve efficiency and customer satisfaction	Shaikh and Sohu (2020); Kakouris and Sfakianaki, (2018); Prada, (2018)
Worker Experience - is the knowledge and skills that employees accumulate through their practical work overtime.	Van Tran et al., (2021); (Rostamnezhad et al., 2020); Rahman et al., (2019)
Communication - is the effectiveness of information exchange between various stakeholders in the work environment.	Dixit *et al*., (2019); Hasan *et al*., (2018); Nasir (2016).
Occupation - refers to a worker's specific job role or profession within an organisation or project.	Manoharan et al., (2022); Mustapha et al., (2024)
Management strategies - are techniques organisational leadership uses to plan, organise and direct work activities and resources.	Ghodrati et al., (2018; Hwang et al., (2020); Robbertse & Amoah, (2022).

5.3 Research methodology

This research examines the New Zealand residential construction industry. A literature review identifies global factors that enhance construction productivity, applicable across various socio-economic contexts. Factors relevant to the NZ context were selected (Table 5.1). Data were collected through an online survey to identify common productivity-enhancing factors. The survey method was chosen for its accessibility, reach, efficiency, and cost-effectiveness (Nayak & Narayan, 2019). A semi-structured questionnaire on Qualtrics employed two Likert scales for construction productivity and QM, with nine of 14 Likert statements analysed in this study. The Likert scale measured agreement levels from (1) strongly disagree to (5) strongly agree. Expert judgment ensures face and content validity (Straub et al., 2004). A pilot study involving seven participants confirmed the questionnaire's reliability (Roopa & Rani, 2012), with a Cronbach's alpha of 0.720 indicating acceptable internal consistency. The Kolmogorov-Smirnov test in SPSS showed non-parametric data distribution, leading to using Spearman-Rho correlation to examine bivariate relationships between ordinal variables and assess interrelationships among study factors. G*Power software determined a required sample size of 305 participants (Faul et al., 2007). A survey link was distributed via five industry association websites (Nayak & Narayan, 2019), yielding 121 responses over five weeks; 15 were excluded due to incomplete data, resulting in a final sample size of N=106. Typical membership occupations included project manager, general manager, construction manager, site manager, and subcontractor representation, selected for their relevance to the research problem. Online approaches effectively engage industry professionals (Bakar et al., 2016). Researchers benefit from using industry associations' networks and digital platforms for survey dissemination, combining targeted recruitment with web-based efficiency (Ali & Abdirahman, 2024; Bakar et al., 2016). The study's 34% response rate aligns with Rowley (2014), indicating that a 25% response rate in a population of 400 is adequate for empirical research. The sample, representative of industry demographics, was obtained using stratified probability sampling (Rowley, 2014). The sample comprises general managers, construction managers, project managers, site managers, and subcontractors from the NZ residential construction sector, ensuring diverse responses (Collins et al., 2007). An ethics (Autec 24/77) application has been approved.

5.4. Findings

5.4.1 Demographic survey results

The nationwide questionnaire targeted the NZ residential construction sector. Table 5.2 highlights the demographic data of 106 participants, capturing participants’ age groups, professions, industry experience, and education levels. The characteristics of the sample group suggest that feedback is reliable for drawing valid conclusions about the NZ residential construction sector (Table 5.2).

Table 4.2: Sample group demographics in this study (Author's work)

Age groups (Years)	Frequency (Percent)	Industry occupation	Frequency (Percent)	Industry experience (Residential)	Frequency (Percent)	Highest level of education	Frequency (Percent)
20-29	25 (23.5%)	General manager	18 (16.9%)	2-5 years	30 (28.3%)	Certificate	39 (36.8%)
30-39	21 (19.6%)	Construction manager	20 (18.8%.)	6-9 years	33 (31.1%)	Degree	25 (23.6%)
40-49	30 (28%)	Project manager	21 (19.8%)	10+years	43 (40.6%)	Diploma	38 (35.8%)
50-59	12 (12%)	Site manager	22 (21%)			Postgraduate	2 (1.9%)
60 (+)	18 (16.9%)	Subcontractor	25 (23.5%)			Other	2 (1.9)
Total	(N) 106 (100%)		(N) 106 (100%)		(N) 106 (100%)	Total	(N) 106 (100%)

5.4.2 Spearman's Rho factor correlations

This study used the Spearman Rho correlation coefficient (Table 5.3) to assess relationships among nine variables affecting NZ residential construction productivity. The analysis included demographic factors like age, industry experience, occupation, QMS, QM, and industry culture focused on time and cost over quality, organisational culture, and specifications. Results indicated positive correlations between age and organisational culture, QMS, and industry culture, but a negative correlation between age and QM. Additionally, negative associations were found between industry occupations and perceptions of QM, QMS, and construction productivity policy. Mixed results were noted for associations between industry experience and QMS and specifications regarding their impact on productivity. Significant correlations are displayed below at the 0.05 level (2-tailed).

5.4.3 Age and organisational culture

Table 5.3 shows the results derived by applying Spearman's Rho correlation to determine the relationship between respondents' age and organisational culture in improving construction productivity. The analysis revealed a medium, positive, statistically significant bivariate association between the two ordinal variables, which suggests that the observed results could be representative of the general population. The correlation coefficient (r) was .212, with a p-value of 0.029.

5.4.4 Age and QMS (ISO 9000)

The study utilised Spearman's Rho correlation to measure the association between respondents' age and utilising global standards for QM (ISO 9000) to enhance NZ residential construction productivity. The results (Table 5.3) revealed a small, positive, statistically significant correlation between the two ranked ordinal variables, which may be typical of the general population. The correlation coefficient (r) was .239, with a p-value of p 0.013.

5.4.5 Age and quality management

The study employed the Spearman-Rho correlation (Table 5.3) to evaluate the association between age and QM as determinants in improving NZ residential construction productivity. The statistical analysis highlights a small, negative, yet statistically significant bivariate association between the two ordinal variables, which suggests that the observed results could be representative of the general population. The correlation coefficient (r) was -.242, with a p-value of 0.013.

5.4.6 Age and cost and time over quality.

Table 5.3 shows the results derived by applying Spearman's Rho correlation to determine the relationship between age and whether the industry focuses more on time and cost than quality. The analysis revealed a small, positive, yet statistically significant bivariate association between the two ordinal variables, which suggests that the observed results could be representative of the general population. The correlation coefficient (r) was $.426^{**}$, with a p-value of $< .001$.

5.4.7 Occupation and QMS (ISO 9000)

This research used Spearman's Rho correlation to measure the association between respondents' current occupation and using global standards for QM (ISO 9000) to enhance residential construction productivity (Table 5.3). The findings revealed a small, negative, statistically significant bivariate association between the two ranked variables that may reflect the general population. The correlation coefficient (r) was -.205, with a p-value of 0.035.

5.4.8 Occupation and quality management

The study employed the Spearman-Rho correlation to evaluate the connection between respondents' occupations and using QM as a factor in improving residential construction productivity. The statistical analysis (Table 5.3) highlights a small, negative, yet statistically significant bivariate association between the two ordinal variables, which suggests that the observed results could be representative of the general population. The correlation coefficient (r) was -.246**, with a p-value of < .001.

5.4.9 Occupation and CP as a Strategic Organisational Policy

This research utilised Spearman's Rho rank correlation to determine the relationship between respondents' current occupation and whether residential construction productivity improves if it is a strategic organisational policy (Table 5.3). The findings revealed a small, negative, statistically significant bivariate association between the two variables that may reflect the general population. The correlation coefficient (r) was -.246, with a p-value of p .011.

5.4.10 Experience and QMS (ISO 9000)

The study utilised Spearman's Rho correlation to determine the relationship between respondents' industry experience (years in industry) and utilising global standards for QM (ISO 9000) to enhance residential construction productivity (Table 5.3). The results revealed a medium, positive, and statistically significant correlation between the two ranked ordinal variables, which may be typical of the general population. The correlation coefficient (r) was .204, with a p-value of p .037.

5.4.11 Experience and complete design and specifications.

This research utilised Spearman's Rho correlation to determine the relationship between participants' experience and complete design and specifications, improving NZ residential construction productivity (Table 5.3). The results revealed a medium, negative, statistically significant bivariate association between the two variables that may mirror the general population. The correlation coefficient (r) was .-193, with a p-value of p .048.

5.5 Discussion

This research utilised the Spearman-Rho method to examine the relationships between variables that could enhance NZ residential construction productivity (Kirby et al., 2024). International studies highlight the significance of thorough design in boosting construction productivity (El-Gohary & Aziz, 2014; Gurmu, et al., 2016; Hasan et al., 2018; Jarkas, 2015; Makulsawatudom et al., 2004). This study highlights the impact of design changes and project complexity on productivity, as identified in previous NZ research (Ghodrati, Wing Yiu, et al., 2018; Page, 2010). The study found a negative correlation between industry experience and adequate design. This correlation suggests systemic issues within the industry related to innovation, adaptability, experience bias, and the need for continuous learning. However, further investigation is warranted regarding its impact on design practices. Globally, the advantages of QM in enhancing construction productivity are well-documented (BRANZ, 2021a; Deming, 1986; Latham, 1994; Ruales Guzmán et al., 2019; Seadon & Tookey, 2019; Small et al., 2021). In NZ, Seadon and Tookey's productivity model stresses quality as a critical factor in improving sector performance. This study identified a negative correlation between age groups and QM in enhancing NZ residential construction productivity (Table 5.3). As age increases, perceptions or implementation of QM practices may diminish, necessitating contextual consideration. Potential differences in QM practices between older and younger professionals may stem from resistance to new technologies, educational differences, and industry history. Challenges include knowledge transfer issues, evolving market demands, and the physical demands of the profession, which affect older professionals' adaptability to new QM standards. Further research is necessary to understand the industry's underlying reasons and implications.

The ISO 9000 QMS enhances QM and productivity, offering a competitive advantage applicable at the policy level (Brooks et al., 2021; Khatatbeh, 2022; Patel & Pitroda, 2021; Prada, 2018; Shaikh & Sohu, 2020). This study shows a negative correlation between industry occupations and the utilisation of ISO 9000s to enhance NZ residential construction productivity (Table 5.3), suggesting that increased representation of occupational groups may lead to reduced ISO 9000 implementation. This resistance might be rooted in the nature of their work. This negative correlation highlights systemic or cultural issues within the industry affecting ISO 9000 QMS adoption. However, a positive correlation was found between age groups and ISO 9000 QMS use to enhance productivity in NZ residential construction (Table 5.3). Older professionals are more likely to employ ISO 9000 QMS for productivity improvements, possibly due to their extensive experience and preference for structured approaches. Therefore, leveraging the expertise of older workers and educating younger employees on ISO 9000 QMS benefits, purpose, and use could help bridge the generational gap in QM practices. Love (2002) and Naoum (2016) identified the adverse effects of leadership as absent skill levels, expertise, and experience. This study found a positive correlation between industry experience and using ISO 9000's QMS to improve productivity in NZ residential construction. Suggesting that experienced individuals or organisations are more likely to effectively implement ISO 9000's QMS standards, indicating that extensive industry experience significantly boosts successful QMS implementation and productivity in NZ residential construction. Several studies (Davies, 2021; Doni et al., 2021; Unegbu et al., 2024) suggest that organisational culture in construction benefits companies by promoting sustainability and enhancing performance. Maqsoom et al. (2021) and Khahro et al. (2023)

found that age influences workers' perceptions and responses to productivity factors. This study found a positive correlation between age groups and the perception that the NZ residential construction sector prioritises time and cost over quality. This indicates that older individuals consider immediate actions regarding time and cost to be more critical for productivity, reflecting a traditional approach to construction management. Prior research suggests that QM in NZ's residential construction is seen as reactive, highlighting a culture where defects are accepted as routine, fostering poor quality (Georgiou, 2010; Kirby et al., 2024; Rotimi et al., 2015). This study identified a positive correlation between age groups and organisational culture in enhancing productivity, indicating that older individuals possess a more favourable view of the impact of organisational culture. The analysis suggests that extensive experience among older age groups leads to a better understanding of teamwork, communication, and employee engagement in driving productivity.

Manoharan et al. (2022) and Mustapha et al. (2024) identify architects, quantity surveyors, civil engineers, builders, as well as project and site managers as key stakeholders in the implementation of productivity strategies in construction. Researchers (Dwyer, 2002; Fundin et al., 2018; Sheoran & Thakur, 2023; Shojaee et al., 2022) note that QM systems are beneficial to construction firms but require strategic planning and leadership. This study finds a negative correlation between industry occupations and QM in enhancing NZ residential construction productivity. It suggests that an increased focus on QM inversely affects its perception or adoption among certain occupational groups. This resistance may arise from differing priorities, aversion to change, inadequate training, or cultural factors, which undermine QM's effectiveness in boosting productivity. Several scholars (Ghodrati et al., 2018; Hwang et al., 2020; Robbertse & Amoah, 2022) argue that management strategies are essential for increasing construction productivity. This study also found a negative correlation between occupational groups and construction productivity as an organisational policy, suggesting that perceived support for these strategies may decline as productivity strategies become more prominent. This indicates the need for tailored communication strategies to better engage these groups with productivity initiatives.

Table 4.3: Spearman Rho Correlation Table (Author's work)

Variable		Age groups	Industry time /cost over quality	Iso 9000's as a qms	R08 factor qm	Occupation	Industry experience	Cp improves if an Org policy	Adequate design improves cp	Org culture
Age groups	Spearman Rho correlation	1	.426**	.239	-.242					.212
	Sig (2 tailed)		<.001	.013	.013					.029
	N	106	106	106	106					106
Industry focus time cost over quality	Spearman Rho correlation	.426**	1							
	Sig (2 tailed)	<.001								
	N	106	106							
Iso 9000's as a qms	Spearman Rho correlation	.239		1		-205	.204*			
	Sig (2 tailed)	.013				.035	.037			
	N	106		106		106	106			
R08 factor quality management	Spearman Rho correlation	-.242			1	-.246**				
	Sig (2 tailed)	.013				<.001				
	N	106			106	106				
Occupation	Spearman Rho correlation			-205	-.246**	1		-.246*		
	Sig (2 tailed)			.035	<.001			.011		
	N			106	106	106		106		
Industry experience	Spearman Rho correlation			.204*			1		-.193*	
	Sig (2 tailed)			.037					.048	
	N			106			106		106	
Cp improves if it is an org policy	Spearman Rho correlation					-.246*		1		
	Sig (2 tailed)					.011				
	N					106		106		
Complete design and spec and cp	Spearman Rho correlation						-.193*		1	
	Sig (2 tailed)						.048			
	N						106		106	
Org culture	Spearman Rho correlation	.212								1
	Sig (2 tailed)	.029								
	N	106								106

*Correlation is significant at the 0.05 level (2 tailed) **Correlation is significant at the <.001 level (2 tailed)

This study elucidates the associations of QM and QMSs, such as ISO 9000, with culture across age groups, experience levels, and occupations to understand how these factors can be strategically applied within the construction ecosystem to enhance residential construction productivity in NZ. A cross-comparison indicates that focusing on training, leveraging experienced personnel, and fostering a positive organisational culture while balancing perceptions of quality, time, and cost can improve productivity in NZ's residential construction sector. A common finding is the necessity for increased awareness of QM’s strategic value in enhancing productivity within NZ's residential construction. An organisational strategy emphasising QM will also encompass culture and address time and cost concerns, thus boosting productivity. These results highlight the need for a sectoral shift in perspective and the pivotal role of QM in NZ's residential building industry. Nonetheless, further research is required to fully comprehend the associations among the factors discussed in this study. A diagrammatic summary of these associations is provided for additional reference (Table 5.4). The heat map illustrates the various strengths and directions of the monotonic associations as measured by Spearman’s Rho coefficient using SPSS. The heat map ranges from red (negative association) to green (positive association), with the intensity of colour changing according to the strength of the association coefficient.

Table 4.4: Spearman’s rho correlation heat map (Author’s work)

Dependent variables	Independent variables					
	Experience		Age		Occupation	
Adequate design and specifications	-0.193	0.048				
ISO 9000 QM system	0.204	0.037	0.239	0.013	-0.205	0.035
Quality management			-0.242	0.013	-0.246	0.001
Time and cost over quality			0.426	0.001		
Organisational culture			0.212	0.029		
Productivity as a strategic policy					-0.246	0.011

5.6 Conclusion

This study examines the relationships between demographic factors and variables that enhance productivity in New Zealand's residential construction sector. It identifies connections between ISO 9000's QMS, QM, and culture across different age groups, experience levels, and occupations to strategically understand productivity enhancement. The research reveals significant correlations that elucidate a nuanced picture of the sector's dynamics. Findings indicate that training, experienced staff, a positive organisational culture, and a balanced approach to quality, time, and cost can improve sector productivity. The positive association between age and the tendency to prioritise time and cost over quality suggests a generational disparity in approach. The positive link between industry experience and the use of ISO 9000 QM Systems underscores the value of seasoned professionals in implementing quality standards. Conversely, the negative correlations between certain occupational groups and QM practices highlight potential areas of resistance or implementation challenges. The study underscores a multidimensional approach and emphasises the strategic importance of QM in enhancing performance. Findings suggest that transitioning towards QM initiatives as a strategic objective could enhance time, cost, and productivity. Further research should comprehensively investigate the relationships among these factors and develop tailored engagement and communication strategies to address demographic disparities. Despite key insights on QM's role, the reliance on self-reported data from 106 professionals may introduce bias, limiting broader applicability. Future research could include a more extensive and diverse participant demographic and consider human behaviour and organisational psychology to reflect productivity strategies accurately. Additional studies could explore integrating ISO 9000 QMS across age groups to bridge generational gaps in QM practices and examine the relationship between occupational groups and ISO 9000 QMS for broader QM practice acceptance.

5.7 Chapter conclusion

This study investigates the influence of demographics (age, experience, occupation) on productivity factors in New Zealand's residential construction sector.

Using Spearman's Rho correlation, this research challenges traditional assumptions and provides insights for industry, policy, and academia regarding the perception and implementation of productivity strategies.

This study demonstrates the impact of age and occupation on QM adoption. It highlights the need for multifaceted productivity strategies (experienced personnel, training, and a balanced focus on quality, time and cost). Furthermore, addressing a critical gap by providing context-specific insights for tailored efficiency improvements in New Zealand's residential construction.

5.7.1 Original contribution and realisation of aims, questions and objectives

This study uniquely examines the interplay between demographics and productivity factors, including QM, within the New Zealand residential construction sector, offering a holistic and contextualised understanding of productivity.

This chapter contributes to a more in-depth understanding of the research problem by examining the demographic influences on QM's effectiveness in enhancing productivity. The paper examines how age, experience, and occupation influence QM and productivity, providing crucial insights into the contextual factors affecting QM strategies. This directly addresses ‘how’ and under ‘what’ conditions QM is effective.

The findings reveal correlations between ISO 9000 use and experience, strategic QM practices, and occupation, aiding in understanding QM implementation variations. This chapter addresses RO2 and RO3 by analysing demographic relationships with productivity factors. Additionally, Table 5.5 showcases the effectiveness of this chapter in addressing this study’s research objectives and questions.

Table 4.5: Research outputs achieved (Author’s work)

Research aim	To determine what effect QM has as a strategy for improving New Zealand residential construction productivity	
Manuscript title	An investigation into QM systems and factors affecting construction productivity: The New Zealand residential construction industry (Approved Conference Paper NZBERS 2025)	
Objective	**Research questions**	**Outputs achieved**
RO2. To establish the common factors that positively affect construction productivity in the NZ residential sub-sector	RQ2. What are the common factors that positively affect construction productivity in the NZ residential construction sector	The findings reveal associations between ISO 9000 use and experience, strategic QM practices, and occupation
RO3. To validate the effectiveness of a developed strategy for QM in residential construction	RQ3. How effective is the developed strategy for QM in the residential construction sector	It highlights its strategic importance of demographic associations with key variable in effectively using productivity improvement strategies within the NZ residential context

5.7.2 Final considerations

The insights derived from this study present a tangible pathway for overcoming the pervasive productivity challenges in New Zealand's residential construction. Furthermore, the research suggests that applying demographic factors strategically can enhance QM practices and adoption, consequently improving efficiency and quality in the local sector.

The evidence-based recommendations provide a foundation for targeted policy initiatives and guide industry leaders toward a culture of quality, innovation, and continuous improvement. The potential impact of the research extends beyond New Zealand residential construction and informs global efforts to overcome productivity barriers and build sustainable and equitable construction environments. The next chapter takes a multi-dimensional approach to evaluating the effectiveness of QM strategies in enhancing New Zealand residential construction productivity.

The quantitative findings of the previous chapters, particularly the correlational analysis in Chapter 5, have established two critical precursors for the study’s’ final strategy:

1. **Strategic focus:** QM is confined as a priority factor for New Zeaand residential construction productivity.
2. **Implementation constraint:** the effectiveness an adoption of QM is significantly constrained by demographic and occupational factors, suggesting a deep- seated cultural resistance that requires qualitative explanation.

Therefore, to move beyond statistical association and achieve a holistic understanding, the research now executes phase 2 of the mixed methods design, the integrated data analysis. Chapter 6 undertakes A multidimensional analysis by systematically combining:

- The quantitative prioritisation data mean value and ranking from the survey.
- The qualitative contextualisation provided by thematic analysis of the open-ended survey questions.

The integration is necessary to transition from observing what factors are perceived as important to understanding why these perceptions and implementation challenges exist. The synthesis of quantitative and qualitative data in Chapter 6 provides the rich contextual evidence required to identify the final specific strategies supported by industry practitioners. Thereby effectively realising the remaining research objectives RO2 and RO3 within the NZ context.

Chapter 6

A multidimensional analysis of strategies for improving New Zealand residential construction productivity

Overview

Despite its economic importance, New Zealand's residential construction sector faces productivity challenges, exacerbated by demographic factors such as an ageing workforce, labour shortages, and poor quality. This chapter evaluates QM strategies for enhancing productivity in the sector and provides evidence-based recommendations for industry and policy. This study addresses the existing knowledge gap concerning the influence of QM on productivity in New Zealand's residential construction industry.

It examines factors, barriers, and strategies pertinent to achieving sustainable productivity improvements. Grounded in the Theory of Constraints, these insights contribute to a deeper understanding of QM and productivity theory, thereby underscoring the importance of QM.

The findings underscore the effectiveness of quality-focused strategies in the residential sector, aiding policymakers, industry experts, and organisations in developing strategies to address productivity challenges.

This chapter is based on the following published Journal article [4]:

Kirby, M., Rotimi, F. E., & Naismith, N. (2025). A multidimensional analysis of strategies for improving New Zealand residential construction productivity. *Ain Shams Engineering Journal*, *16*(3), 103274. https://doi.org/10.1016/j.asej.2025.103274

Abstract

The New Zealand residential construction sector faces significant quality-related challenges that hinder its productivity despite its significant impact on the national economy. This study uses a mixed methods approach to evaluate the effectiveness of QM as a strategy in improving New Zealand residential construction productivity. Data were collected from 106 of 305 questionnaires distributed by construction industry bodies. Key findings emphasised three improvement strategies: (1) implementing a productivity certification and training scheme. (2) addressing the industries, prioritising time and cost over quality and (3) enhancing QM practises. The study confirms the ISO 9000 QM standards and Lean construction methods are widely supported as strategies for improving productivity. This study highlights the need for greater awareness of QM, strategic value and the importance of governmental support and enhanced organisational leadership. Recommendations include gradually implementing ISO 9000 QM standards and establishing an industry-wide productivity training program. This study uniquely investigates New Zealand residential construction productivity, providing novel insights and recommendations for policymakers, industry professionals, organisations, and construction practitioners to align with global demand and improve productivity through enhanced quality.

6.1 Introduction

The global construction sector, which constitutes approximately 13% of the worldwide Gross Domestic Product (GDP), operates within diverse contexts and is characterised by adversarial relationships and complex value chains. The World Economic Forum observes that global construction productivity lags behind other industries, growing only 1% annually compared to 2.8% in manufacturing (McKinsey & Company, 2024; Schwab, 2020). Common industry challenges encompass an ageing workforce (Australian Constructors Association, 2023; Farmer, 2016), poor quality, a lack of skilled workers (Kazaz et al., 2005; McKinsey Global Institute, 2020; Montague, 2018; NZIER, 2023; Tran & Tookey, 2011), slow technological adoption and ineffective procurement and contracting methods, which impede productivity improvement (Australian Constructors Association, 2023; Bittharia & Tiwari, 2021; Helmold, 2023) and compromise sector performance, all despite technological advancements, continued research, and legislative policy (McKinsey Global Institute, 2017). Furthermore, this global issue is exacerbated by the economic burden of poor quality (Bealing & Morel, 2020, 2020; Egan, 1998; Gyles, 1992; Kakitahi et al., 2014; Kazaz et al., 2005; Montague, 2018; Pheng &

Teo, 2004), highlighting the necessity for effective QM strategies to ensure industry standards and operational efficiency (Ghansah & Edwards, 2024; Montague, 2018; Rotimi et al., 2015). It follows that QM systems, including Total Quality Management with its focus on continuous improvement, Lean Construction, which aims to minimise waste, the Plan Do Check Act cycle's iterative problem-solving approach, and ISO 9000 standards for QM, have been increasingly adopted globally due to their demonstrated efficacy in enhancing productivity and quality. In developed nations, QM addresses construction inefficiencies (McKinsey Global Institute, 2020; Ministry of Business, Innovation & Employment, 2024); however, its effectiveness is influenced by local factors such as regulatory frameworks, workforce competencies, market dynamics, and political cycles (Green, 2016; Hasan et al., 2018).

While QM principles are universally applicable, their integration necessitates contextual adaptation, particularly in sectors with high variability, such as residential construction (Ramadan et al., 2024). This implies that their effectiveness varies regionally, thus necessitating localised research (Gupta & Khitoliya, 2020; Mills et al., 2009; Zhao et al., 2024). New Zealand's residential building sector presents a unique case as localised research in this international context, exemplifying widespread global issues and specific local factors. The industry is critical to addressing the nation's pressing housing crisis, with estimates suggesting a yearly shortage of over 20,000 homes (Huang et al., 2024). This shortage is compounded by systemic inefficiencies in construction processes, including high material costs (Australian Constructors Association, 2023; Bittharia & Tiwari, 2021; Farmer, 2016; Helmold, 2023), skilled labour shortages, (Kakitahi et al., 2014; Mustajab & Irawan, 2023), an ageing workforce (Australian Constructors Association, 2023). As well as continual delays, and poor quality, (Kazaz et al., 2005; Montague, 2018; NZIER, 2023; Tran & Tookey, 2011) all contribute to widening the gap between housing supply and demand, placing immense pressure on the sector to improve its productivity.

New Zealand faces unique challenges compared to larger economies. An Organisation for Economic Co-operation and Development (OECD) report (New Zealand Productivity Commission, 2023) highlights this predicament, noting that New Zealanders have been working longer hours for more than five decades yet producing less per hour. Productivity growth has declined since the 1970s, creating one of the OECD's least efficient economies (New Zealand Productivity Commission, 2023).

Adding further context, despite a national quality standard (Standards New Zealand, 2024), New Zealand's substandard residential construction quality incurs an annual cost of NZD 2.5 billion (BRANZ, 2021). Consequently increasing consumer expenditure, reducing housing affordability, and lowering living standards (Davis, 2007; Juran, 1988). This suggests that QM in this industry is perceived as a reactive compliance tool rather than a proactive competitive advantage (Deming, 1986).

Regulatory, market, cultural factors and traditional resistance to formal practices hinder the adoption of QM systems, favouring pragmatic, experience-based methods over more formal approaches (Elsokhn & Ezeldin, 2022; Vishe, 2024; Wong et al., 2020). Insufficient workforce education and training on QM's benefits exacerbate resistance, indicating a need for compelling rationales to motivate stakeholders to adopt structured tools (Elsokhn & Ezeldin, 2022; Vishe, 2024). This suggests a preference for practical, on-site problem-solving over formalised quality control, explaining the nation's substantial economic burden from poor quality. The industry's adherence to traditional methods that may not meet contemporary standards is an enduring problem that necessitates tailored solutions for local industry limitations.

Consequently, due to the industry's economic and social importance (BRANZ, 2021; Chowdhury et al., 2019; Davis, 2007; Deming, 1986; Ghodrati et al., 2018; Seadon & Tookey, 2019; Tran & Tookey, 2011) research highlights the urgent need to improve quality and productivity in the local context. While numerous studies have explored productivity in construction globally, there remains a knowledge gap regarding how QM strategies specifically influence productivity within the New Zealand residential context. Previous research has focused primarily on broad frameworks, models, productivity factors, management strategies, alternative industries, and other less holistic views, leaving a critical need for evidence tailored to the unique characteristics of the New Zealand residential construction sector. A commonality in previous research is that quality is often considered a secondary factor in productivity improvement, not a primary approach (Kirby et al., 2024).

This study aims to fill the identified gap in the literature by examining the effectiveness of QM strategies in the local sector. It offers novel, evidence-based insights into enhancing productivity within New Zealand's residential construction sector and provides actionable insights for industry practices and policymaking to improve overall industry performance.

6.2 Literature review

The modern concept of QM, introduced by Shewhart, Deming, Juran, Crosby, Feigenbaum, and Ishikawa in the early nineteenth century, offer distinct QM models (Crosby, 1979). Quality is generally defined as achieving product excellence (Feigenbaum, 1956), meeting or exceeding customer expectations, providing value for money (Juran, 1974) and being "fit for purpose" (Deffenbaugh, 1993). These pioneers share the themes of continuous improvement, customer satisfaction, and employee involvement in achieving sustainable quality standards, advocating for a proactive, systematic approach to QM. Deffenbaugh (Deffenbaugh, 1993) simplifies the explanation for the construction industry by emphasising measurable continuous improvement and customer satisfaction.

Recognised in manufacturing in the 1960s and widely adopted in the twentieth century (Pheng & Teo, 2004), QM enhances organisational competitiveness (Crosby, 1979). Despite the benefits observed in other industries that use models such as Total QM, Lean production, Six Sigma, and ISO 9000, the construction industry lags in adoption. Potentially due to perceived high costs and a prolonged industry culture that tolerates defects (Bakar et al., 2011; Josephson et al., 2002). Nevertheless, QM strategies are crucial for project and organisational success in construction firms (Small et al., 2021).

When applied strategically, these practices prevent defects, reduce quality costs, maximise resources, and enhance customer satisfaction, implying that the benefits of QM systems outweigh the perceived implementation costs (Arditi & Mochtar, 1996; Georgiou, 2010; Ghansah & Edwards, 2024). Consequently, QM has developed into a strategic business function (Arditi & Mochtar, 1996; Josephson et al., 2002) and a sustainable organisational strategic approach associated with improved productivity (Gupta & Khitoliya, 2020).

However, research highlights that globally, costs of poor quality constitute 2-21% of contract values, indicating persistent issues with ineffective QM and a reactive rather than proactive approach to managing quality (Ghansah & Edwards, 2024; Lundkvist et al., 2014; Oakland & Marosszeky, 2017; Pheng & Teo, 2004). This underscores the need for improved industry knowledge to understand the effectiveness of QM strategies in the global construction sector, both in terms of strategic importance and practical application. Despite varied outcomes, numerous QM strategies are employed globally to improve quality, including Total Quality Management, ISO 9000, Lean Construction and the Plan Do Check Act model. Research shows these models can be used individually or in combination, allowing for integration with organisational needs (Pheng & Teo, 2004; Small et al., 2021).

6.3 Quality management frameworks and models

6.3.1 Total Quality Management

Total Quality Management emerged in the mid-1980s as an integrated global management philosophy that promoted its competitive advantage (Oakland & Marosszeky, 2017). As a systematic QM approach, Total Quality Management has evolved slowly in the construction industry, regardless of the socioeconomic context (Arditi & Mochtar, 1996; Mills et al., 2009). Gupta and Khitoliya (Gupta & Khitoliya, 2020) suggest that Total Quality Management effectively addresses economic trends and organisational needs. Moreover, its positive impact on competitiveness, customer service, productivity, and organisational culture (Arditi & Mochtar, 1996; Asfandiyar & Cheema, 2023; El Jazzar et al., 2021). Many studies highlight the widespread international examination of the models' effectiveness in improving profits, safety, quality, customer relations, productivity. Additionally, reducing rework and delays, although stressing the need for a cultural shift towards a "learning organisation" model to realise the benefits fully (Josephson et al., 2002; Murali & Ponmalar, 2017; Sheoran & Thakur, 2023).

Turner et al. (2020) define Total Quality Management as an ongoing, organisation-wide effort to ensure high-quality, customer service and satisfaction. Helmold, (2023) notes that Total Quality Management aims to enhance processes across all departments to produce superior products and services, which could improve productivity in the New Zealand residential construction sector. A 2021 study on Malaysian industrialised building system (IBS) projects, cited by Alawag et al. (2023) identified leadership as crucial for effective Total Quality Management implementation. Their research proposed a theoretical framework based on critical factors to help stakeholders apply Total Quality Management in IBS projects, indirectly boosting residential construction productivity (Alawag et al., 2023).

Conversely, a study on the Cooperative of State Employees (CSE) in Lebanon found that while Total Quality Management significantly improved financial performance, it had little impact on managerial performance (Ayash et al., 2020). This challenges the assumption that Total Quality Management universally enhances all aspects of organisational performance. Further supported by others who suggest that Total Quality Management may negatively impact organisational performance due to misaligning requirements (Curkovic et al., 2000; Sharma & Gadenne, 2002).

However, barriers to implementing Total Quality Management in residential construction include managerial, organisational, and personnel-related issues (Curkovic et al., 2000; Lundkvist et al., 2014; Mills et al., 2009). Larger firms in developed countries may find Total Quality Management more viable because of their capacity to bear training and compliance costs and access to a more skilled workforce. The existing literature suggests that Total Quality Management can improve construction quality and efficiency; however, further studies are needed to confirm its direct effects on residential construction productivity. Understanding these barriers is crucial for successful TQM implementation (Tey & Ooi, 2014).

6.3.2 ISO 9000

International standards for QM ISO 9000, established globally in 1987, have been widely adopted because of their flexibility (Manders, 2015). Motivations for ISO 9000 certification include enhancing the company image, meeting customer requirements, and improving construction quality and efficiency (Wali & Hamadameen, 2019). The benefits of ISO 9000, including improved QM, productivity, competitive advantage, and its strategic governmental role, are well-documented (Brooks et al., 2021; Khatatbeh, 2022; Patel & Pitroda, 2021; Prada, 2018). Shaikh and Sohu demonstrate that ISO 9000 benefits construction firms by increasing employee satisfaction and project acquisition rates, reducing material waste, and enhancing quality and productivity, thereby improving its global market reach. The ISO 9000 certification signals quality, often becoming a prerequisite for clients and tendering processes and aiding market expansion (Kakouris & Sfakianaki, 2018; Shende et al., 2022).

However, Kakouris & Sfakianaki, (2018) suggested minimal organisational benefits in terms of financial gain from using the ISO 9000 framework. Conversely, others disagree and highlight that most studies found a benefit between ISO 9000 implementation and various dimensions of organisational performance (Aba et al., 2015; Prajogo et al., 2022; Sfreddo et al., 2021; Siougle & Dimelis, 2020).

Unlike other QM systems, ISO 9000 offers a general framework that enables organisations to develop industry-specific quality assurance systems (Wali & Hamadameen, 2019). Implementation challenges include management attitudes, organisational maturity, regulatory absence, and poor-quality culture (Ofori & Gang, 2001). In contrast, technical barriers, such as concerns over audit quality and the lack of mandatory government regulations, hinder effective ISO 9000 adoption (Ofori & Gang, 2001; Prada, 2018; Shaikh & Sohu, 2020).

The necessity for construction-specific modifications to the ISO 9000 framework to facilitate its application in the residential sector is acknowledged (Kirby et al., 2022). Adopting QM models, such as Total Quality Management or Lean Construction, could lessen these issues by promoting collaboration, streamlining processes, increasing transparency, and emphasising process control (Vorobyova et al., 2022; Willar et al., 2016). Despite its potential to enhance customer service, quality, competitiveness, and innovation, challenges such as regulatory decoupling highlight the gap between QM systems intent and actual site quality (Shende et al., 2022; Willar et al., 2016). Ultimately, the effectiveness of ISO 9000 as a QM system in the residential construction sector depends on cultural adaptation and alignment with sector-specific standards (Arditi & Mochtar, 1996; Taufik, 2020).

6.3.3 Demings, Plan-Do-Check-Act model (PDCA)

Deming's Plan Do Check Act model is a widely recognised four-step management method to continuously improve processes and products across sectors. The iterative Plan Do Check Act cycle is particularly vital for refining processes in construction, with its dynamic control of scheduling, quality, and cost underscoring its effectiveness in residential construction (Rosni et al., 2022). Meiling et al. (2014) showed that applying the Plan Do Check Act cycle in residential construction enhanced quality and performance through planning, execution, monitoring, and continuous improvement. Enabling companies to promptly identify improvement areas, address issues, and elevate project quality, emphasising the importance of systematic QM (Lundkvist et al., 2014).

Nguyen et al. (2023) substantiated the efficacy of the Plan Do Check Act approach in residential construction projects, elucidating its advantages, such as minimising defects, enhancing management efficiency, facilitating the learning process for new employees, and improving overall quality and productivity. Taufik (2020) observed that the Plan Do Check Act methodology and its variants augmented productivity and quality across diverse industries, including the Sri Lankan residential construction sector. This evidence suggests that the Plan Do Check Act cycle is a relevant and effective tool for continuous improvement and enhanced productivity and quality in the residential construction sector.

Nguyen et al. (2023) agree with Meiling et al. (2014) and confirm the Plan Do Check Act's effectiveness in industrialised and less industrialised housebuilding processes, demonstrating the Plan Do Check Act's applicability and success in both. However, Lundkvist et al. (Lundkvist et al., 2014) identified the shortcomings of QM practices in residential construction and proposed a proactive Plan Do Check Act-based framework to enhance defect management, quality, and efficiency. This framework aims to improve project outcomes by addressing ambiguous data and a lack of standardisation. The results suggest that the Plan Do Check Act's systematic problem-solving and quality improvement approach can benefit the New Zealand residential construction sector. Nevertheless, research efforts highlight the challenges of this model in acquiring sufficient data and the need for specific data analysis expertise, which may hinder practical implementation in residential construction.

Like other QM models, implementation barriers include institutional and organisational rigidities, varied construction activities, quality control issues, complex industry dynamics, and a need for more understanding and commitment to quality frameworks. Technical and systemic challenges such as industry support and stakeholder buy-in also present obstacles. Addressing these factors is essential for applying the Plan Do Check Act's continuous improvement processes in the sector. However, unlike manufacturing, identifying and addressing root causes in construction is often seen as costly and resource-intensive. This may deter implementation in smaller organisations (Franz, 2018; Oakland & Marosszeky, 2017) in the New Zealand residential sector. This might imply that the Plan Do Check Act model may face some challenges in adapting to construction contexts relevant to the nature of project-based construction versus the process-based nature of manufacturing. However, recent studies indicate that the Plan Do Check Act cycle and ISO 9000 standards are closely interrelated and can be effectively combined to enhance organisational performance (Lundkvist et al., 2014; Mustajab & Irawan, 2023). It is worth noting that the Singaporean government addresses this adaptation issue in smaller organisations through incentivisation and industry training (Pheng & Abeyegoonasekera, 2001; Pheng & Teo, 2004).

6.3.4 Lean construction

Lean construction is derived from manufacturing and targets process inefficiency. Franz (Franz, 2018), Oakland and Marosszeky (Oakland & Marosszeky, 2017) and Sacks et al. (Sacks et al., 2017) affirmed that adopting Lean construction reduces waste and enhances safety, quality, and efficiency. Techniques such as the pull approach, work standardisation, visualisation tools, and integrated project delivery (JiT) can further improve waste reduction, client satisfaction, communication, and task management (Franz, 2018; Priyadarshana et al., 2023).

Although the last planner system has been widely adopted, the results vary owing to industry instability (Priyadarshana et al., 2023). Integrating Lean principles with building information modelling (BIM) enhances construction performance, efficiency, quality, collaboration, costs, and client satisfaction (Hamza Khan et al., 2024; Lekan et al., 2022) implying the Lean methodology significantly enhances residential construction efficiency.

Confirmed by Lekan et al. (Lekan et al., 2022) who suggest combining the Internet of Things (IoT) with Lean methods and Industry 4.0 for a measurable QM system in housing projects. Adamu and Adulhamid (Adamu & Adulhamid, 2016) observed a 17.24% productivity increase and a 6-week earlier completion of Nigerian housing projects using lean techniques. Cairampoma-Caro et al. (2022) found that lean tools improved efficiency in Latin American social housing by 50%, reducing construction time by 20% for annual projects of 150-200 houses. These studies confirm the efficacy of Lean construction in enhancing residential project efficiency, particularly in social housing, indicating its potential for broader application in diverse settings, including the New Zealand sector. However, Lean construction doesn't explicitly target improved quality.

The challenges in adopting lean construction include quality control issues, cultural and organisational issues, technical and resource-related difficulties, lack of knowledge, technical expertise, long-term philosophy, cultural resistance, financial constraints, high transactional costs from misaligned parties' interests, and inadequate management support (Al Balkhy et al., 2021; Asadi et al., 2021b; Howell, 1999; Lee et al., 2011; Likita et al., 2021). Conversely, there is a trend towards integrating Lean methodologies with ISO 9000 standards to attain enhanced benefits (Vanichchinchai, 2021). Implementing ISO 9000 guidelines facilitates organisations in establishing Lean manufacturing processes and advancing towards sustainability (Zenchanka & Malchenka, 2017).

Hence, a comprehensive approach to addressing these barriers through education, training, cultural change, and organisational commitment to lean principles is essential for effective implementation.

6.3.5 Emerging trends in quality management

Global QM trends in construction involve integrating digital technologies, sustainability practices, and advanced data analytics. For instance, Bittharia and Tiwari (Bittharia & Tiwari, 2021) emphasised using technology to evaluate QMS to enhance resource utilisation and prevent defects early, thus avoiding structural failures. Adopting advanced BIM improves QM and offers a high ROI through model-driven quality assurance (QA) and quality control (QC) approaches (Lee et al., 2011). Enhanced Internet of Things (IoT) applications and intelligent sensors enable real-time monitoring and better decision-making during construction planning and execution (Chowdhury et al., 2019). Sustainability trends prioritise green building certifications and energy-efficient practices linked to QM (Kibert, 2016) alongside Lean construction principles focused on waste reduction and process efficiency (Mostafa et al., 2016). Data analytics and AI are also used to predict risks, optimise resources, and improve QC during construction (Ahmed et al., 2005; Brooks et al., 2021).

Robotics in construction offers innovative solutions to productivity enhancement. However, Iqbal et al. (2017) assert that the construction sector trails other industries in leveraging robotic applications. Casini (2021) highlights advancements in prefabrication and modular construction as critical drivers of robotics integration in construction. Robotics in Construction

(RiC) now encompasses additive manufacturing, deep learning, and building information modelling (BIM).

Zhai et al. (2023) suggest recent innovations in construction robotics can potentially revolutionise the industry. The field is shifting from innovation to broader implementation, with single-task robots, on-site and off-site robots, and automated construction sites becoming essential for efficiency and sustainability. Additionally, research shows (Ivanov-Kostetskyi et al., 2021) that these technologies can improve productivity, reduce labour and safety risks, and enhance construction quality in residential projects (Zhai et al., 2023). Ivanov-Kostetskyi et al. (2021) agrees with Casini (2021) and Zhai et al. (2023) that AI-enabled construction robotics, such as IronBOT, TyBOT, and Newmetrix Vinnie, are rapidly advancing. Prieto et al. (2024) suggest that multi-agent robotic systems with human-robot collaboration can effectively address construction challenges. Hence, the ageing construction demographic presents unintended opportunities for improvement in the New Zealand sector.

Xiao et al. (2022) confirm the direction of future research involves deeper levels of BIM and robotics integration, near-site robotic fabrication, flexible environment adaptation via deep reinforcement learning, and advanced robot-to-robot collaboration. These advancements and cloud-based robotics are expected to address productivity and quality issues in the construction industry, especially in rapidly urbanising countries and ageing workforces (Kineber et al., 2023).

6.3.6 Quality management strategies - New Zealand residential construction

Economic conditions in the mid-1970s meant QM was primarily unknown to New Zealand businesses, and the rapid economic policy restructuring by the New Zealand government in 1984 coincided with some corporate QM acknowledgement. (Houston & McKean, 2002). Quality management was once a national focus for New Zealand, in line with the USA, Japan, and Australia in the 1980s; however, the shift to a "free-market" economy in 1984 reduced government involvement, limiting QM's progress to a struggling industry (Ball et al., 1999; Moshood et al., 2024).

Nevertheless, QM is still relevant to the modern New Zealand residential construction sector, and several strategies could be beneficial. For example, Plan Do Check Act, Total Quality Management, ISO 9000, and Lean Construction face similar implementation challenges in the New Zealand residential sector. Governmentally, the "free market" economic model hinders necessary government intervention and policy changes conflict with the New Zealand government's aim for a sustainable and high-performing construction sector. Governmental intervention is required to enhance benefits and drive industry-wide quality and productivity improvements for a sustainable approach (Ball et al., 1999; Deming, 1986). Thus, aligned with government objectives, there is a need for increased awareness and understanding of the role of QM strategies and their applications at the industry level (Moshood et al., 2024).

The New Zealand residential construction industry, mainly consisting of change-resistant micro-companies, adopts a reactive stance towards QM (Bakar et al., 2011; Davis, 2007). Despite the limited commitment, standardising QM practices and implementing frameworks are essential for optimisation (Maradzano et al., 2019). Industry fragmentation impedes the stakeholder buy-in necessary for cultural change (Seadon & Tookey, 2019). Quality management's standardisation is perceived as complex and costly and requires ongoing training. However, regulatory decoupling highlights inconsistent commitment (Brooks et al., 2021) to quality practices. Specific statistical models (Plan Do Check Act) are symbiotic with the ISO 9000 framework; however, they require specialised skilled resources, with the demand for trained data analysts posing significant challenges (Lundkvist et al., 2014). The industry profile requires more organisational maturity, complicating its implementation (Seadon & Tookey, 2019). Organisational culture necessitates alignment with QM principles and strategic change (Lakhey & Tuladhar, 2023). Models such as Total Quality Management, ISO 9000, and Plan Do Check Act require collaboration and a shift in management approach (Murali & Ponmalar, 2017; Priyadarshana et al., 2023). Poor employee culture, regulatory decoupling, and inconsistent QM practices add to project-level complexity (Brooks et al., 2021). Therefore, an increased awareness of QM's strategic purpose is needed.

Regardless, ISO 9000 is considered the most adaptable and comprehensive QM strategy in the construction industry and can be integrated with internal organisational processes, such as Plan Do Check Act, Total Quality Management, and lean construction. Additionally, the ISO 9000 framework can guide industry objectives at the government level. Thus, New Zealand policymakers and industry leaders might consider broadly implementing ISO 9000 QM standards through a gradual and structured approach, such as in other countries (Kirby et al., 2022; Pheng & Teo, 2004). QM strategies improve quality and productivity by ensuring that projects meet standards and reduce errors and rework; however, economic implications and stakeholder preferences complicate the critical relationship between QM and productivity. Effective QM requires a multifaceted approach that, when implemented correctly, can significantly improve the New Zealand residential construction sector performance (Choi et al., 2016; Sogaxa et al., 2021; Usmen & Vilnitis, 2015).

However, systematically addressing known barriers enhances QM effectiveness, fosters industry integration, and promotes sustainable improvements.

6.3.7 A geographic comparison of productivity improvement strategies

Research shows that global construction sectors share common challenges, indicating that productivity improvement hinges on addressing core industry aspects (Farmer, 2016). Key issues include an ageing workforce (Farmer, 2016), poor quality (Kazaz et al., 2005; Montague, 2018; NZIER, 2023; Tran & Tookey, 2011) shortage of skilled labour (Kakitahi et al., 2014; Mustajab & Irawan, 2023) and slow technological adoption (Australian Constructors Association, 2023; Mustajab & Irawan, 2023; Zhao et al., 2024). Ineffective procurement models and adversarial contracting methods are prevalent in Australia, New Zealand, and the UK (Australian Constructors Association, 2023; Bittharia & Tiwari, 2021; Farmer, 2016; Helmold, 2023) construction sectors.

Hence, globally, many countries have adopted various strategies to boost the construction industry's productivity, yielding mixed results. The following presents a comparative analysis of productivity improvement strategies that can offer New Zealand valuable insights.

6.3.8 United Kingdom productivity strategies

The British government formulated an industrial strategy to enhance productivity within the construction sector, aligning with five key areas: workforce, infrastructure, innovation, business environment, and regional development. This approach addresses strategies focused on artificial intelligence, data-centric economies, future transportation, sustainable development, and demographic ageing (Farmer, 2016; Mustajab & Irawan, 2023). The UK administration has proposed legislative amendments prioritising investments in research and development, technology, innovation, workforce education, and sustainability. A crucial policy initiative examines productivity and expansion in small and medium-sized enterprises to address the need for improvement and provide valuable government assistance (Farmer, 2016; Mustajab & Irawan, 2023). This approach is considered beneficial in the New Zealand sector.

6.3.9 Australian productivity strategies

Introduced in 2015, the National Innovation and Competitiveness Agenda (Australian Constructors Association, 2023) is a component of the Productivity Roadmap governed by the Productivity Commission. It aims to enhance the construction industry's productivity through innovation, collaboration, skill development, and industry research. The 2021 Productivity Commission report (Commission, 2020) highlights promising outcomes from digital technologies (e.g. BIM) and Lean construction in improving project timelines and cost reduction (Commission, 2020). Nevertheless, further productivity enhancement is required. The Australian Constructors Association (Australian Constructors Association, 2023) has proposed a National Construction Strategy to improve productivity by 2033 significantly. This 10-step plan, overseen by national policy, involves shared responsibility among government levels, industry stakeholders, and trade unions. It encompasses specific strategies for procurement methodologies, adversarial contracting, technology, and standardised documentation. Similar to policies in the British sector, the strategy addresses the challenges of an ageing construction workforce.

6.3.10 Productivity strategy comparison - New Zealand

The construction industry shares similarities globally, and international methods could boost New Zealand's construction productivity. Addressing an ageing workforce, technology, AI, small to medium enterprise support, and better procurement methods could benefit New Zealand. Unlike Australia and the UK, New Zealand has stopped initiatives like productivity roadmaps and sector accords, necessitating more government support. This leaves productivity improvements solely to the struggling industry. The authors agree with (Australian Constructors Association, 2023; Farmer, 2016) that government commitment to construction productivity for long-term societal benefits is a common challenge. However, the construction sector is crucial to New Zealand's economy and living standards and should be a national priority. Singapore exemplifies significant productivity gains through legislative support and industry collaboration, emphasising quality and productivity nationally.

Continual productivity improvement in construction is vital due to its economic impact (Kirby et al., 2024), requiring sector-specific issue resolution. Notably, QM is absent in the strategies of compared countries despite the costs of poor quality. This implies that governments undervalue QM for productivity enhancement. However, Singapore's integrated approach has been more effective than other nations' fragmented efforts (BRANZ, 2021; Kirby et al., 2024). The authors argue that construction productivity should be a national priority, with government intervention as a positive catalyst for change.

6.4 Methodology

Aligning with some (Cherryholmes, 1992; Helmold, 2023; Wilkinson, 1998) who advocate for a systematic approach to ensure rigorous qualitative research findings, this study employs a mixed-methods (MM) approach grounded in a pragmatic worldview (Cherryholmes, 1992). A survey link was disseminated via five industry organisation membership websites (Nowell et al., 2017; Rowley, 2014) to recruit participants. These organisations typically list members' occupations on a "membership scorecard”, showing the five prevalent roles: project manager, company/managing director, quantity surveyor, construction manager, and site manager. Thus, organisations were chosen based on their members' alignment with the target population. Primary data were collected through an online questionnaire to examine QM's effectiveness in improving residential construction productivity. This method was selected for its speed, efficiency, and versatility, particularly in data management and reducing transfer errors (Regmi et al., 2017). A-priori power analysis using G*Power 3.1.9.7 determined a sample size of 305 participants for adequate statistical power. Of the 121 responses received, 15 were invalid, resulting in 106 valid responses. Empirical data suggest a sample rate of 25% is adequate for robust analysis (Hedlin, 2020; Rowley, 2014).

Probability sampling requires detailed knowledge of the sample population. This study achieves this by mirroring (Table 6.1) the broader industry population (Rowley, 2014), confirming that a cross-functional sample group captures more diverse and in-depth responses (Collins et al., 2007). Therefore, probability sampling was used to select participants (Table 6.1) from various roles in the New Zealand residential construction industry (Collins et al., 2007).

Table 5.1: Sample size representativeness (Author’s work)

Industry Profession	PM	CM	SM	GM	SUB
N	21	20	22	18	25
Total N	106				

Collins et al. (Collins et al., 2007) propose that validity can be assessed by utilising criterion, content, face, and construct validity. Face and content validity were employed in this study and are crucial during questionnaire development and pretesting, which entails frequently evaluating the presentation and relevance of questionnaire items through expert judgment (Vaske et al., 2017). Vaske et al.'s seminal work, published in 2017, (Vaske et al., 2017) emphasised that reliability assesses the consistency of instrument measurements. Cronbach's alpha was utilised to determine reliability. A Cronbach's alpha coefficient of 0.720 confirmed the suitable internal consistency of the Likert-scale questions (Table 6.2). A pilot study (n=7) involving construction professionals from comparable professions within the New Zealand residential sector was conducted to assess the research instrument's validity and reliability (Collins et al., 2007; Roopa & Rani, 2012). Following empirical recommendations, a random sample of approximately 5–10% of the final sample (n106) size was selected (Collins et al., 2007; Roopa & Rani, 2012). Consequently, a pilot study (n=7) involving construction professionals within the New Zealand residential sector was conducted to identify and resolve potential issues and further assess the validity and reliability (Collins et al., 2007; Roopa & Rani, 2012). The respondents provided feedback on the wording and usability of the questionnaire, resulting in minor adjustments.

Table 5.2: Cronbach's Alpha Analysis (Author's work)

Reliability Statistics		
Cronbach's Alpha[a]	Cronbach's Alpha based on standardized items	N of Items
.720	.765	14

a. Listwise deletion based on all variables in the procedure

The Qualtrics-developed online questionnaire includes two Likert scales containing 14 statements on construction productivity and QM, along with three open-ended questions employing mean value analysis and weighted average methods. The Likert scale assesses attitudes or opinions on a five-point scale (Jebb et al., 2021). Statistical Package for the Social Sciences (SPSS) was used to evaluate data normality using the Kolmogorov-Smirnov test, which indicated a non-parametric distribution. Group differences were examined using the Kruskal-Wallis test, and thematic analysis was conducted on open-ended questions using Microsoft Excel v16.85 (Meyer & Avery, 2008).

However, online surveys encounter challenges in tracking response rates, non-responders, and over-representation (Nayak & Narayan, 2019), affecting data interpretation and research applicability. Groves & Peytcheva, (2008) emphasise that non-respondents in online surveys often differ in engagement, accessibility, or interest. Non-respondents typically include individuals with lower motivation, time, or trust in the research process. Their meta-analysis (Groves & Peytcheva, 2008) found that response rates are unreliable survey quality predictors. Studies concur that although increasing nonresponse rates are a concern, higher rates do not necessarily result in more significant nonresponse bias, and high-quality surveys can still yield reliable data despite lower response rates (Groves & Peytcheva, 2008; Hedlin, 2020). Researchers should consider survey design and implementation factors to minimise potential bias. Other studies (Dey, 1997; Dillman, 1991; Krosnick, 1999)
indicate that even with low return rates, bias can be avoided if respondents' characteristics are representative of non-respondents.

This study tackled key methodological issues through appropriate sampling, data analysis, and research design. Following empirical research, (Cook et al., 2000; Groves, 2006) representativeness was prioritised over response rates to reduce non-response bias. The sampling methods accurately reflected roles in the New Zealand residential construction industry, as shown in Table 20. The final sample was closely distributed, with 106 participants. Thematic analysis was used for open-ended questionnaire responses. Inductive thematic analysis identifies patterns and themes in qualitative research. Fuchs (2023) emphasised its systematic approach of deriving themes from data through iterative reading, note-taking, and coding. This method's versatility across qualitative designs enhances its effectiveness (Fuchs, 2023). Proudfoot (2023) indicated that combining inductive thematic analysis with quantitative methods in mixed-method research can bridge methodological gaps and generate new theories through abductive reasoning. The method's adaptability and theoretical independence are widely applicable (Majumdar, 2022).

This research follows Braun & Clarke (2006) six-stage framework for thematic analysis, which can be inductive or deductive, producing semantic or latent themes. Coding was undertaken using Microsoft Excel v16.85. The inductive process starts with data familiarisation and crucial text coding (Na et al., 2007; Nowell et al., 2017).

Themes were initially identified before applying an interpretive lens to reveal deeper latent factors (Rowley, 2014). This method allows the narrative to unfold organically, which is suitable for exploratory research (Wilkinson, 1998). The study presents thematic findings in Tables 6.5 - 6.7. An ethics application was submitted and approved (Autec 24/77) for this study. This research evaluated the effectiveness of QM strategies in enhancing New Zealand residential construction productivity.

6.5 Results

6.5.1 Demographic survey results

The nationwide questionnaire targeted New Zealand's residential construction sector. Table 6.3 highlights the demographic data of 106 participants, including their age groups, professions, industry experience, and education levels. The sample group characteristics (Table 6.3) suggest that feedback is reliable and valuable in drawing valid conclusions regarding the New Zealand residential construction sector (Table 6.3).

Table 5.3: Sample group Demographics in this study (Author's work)

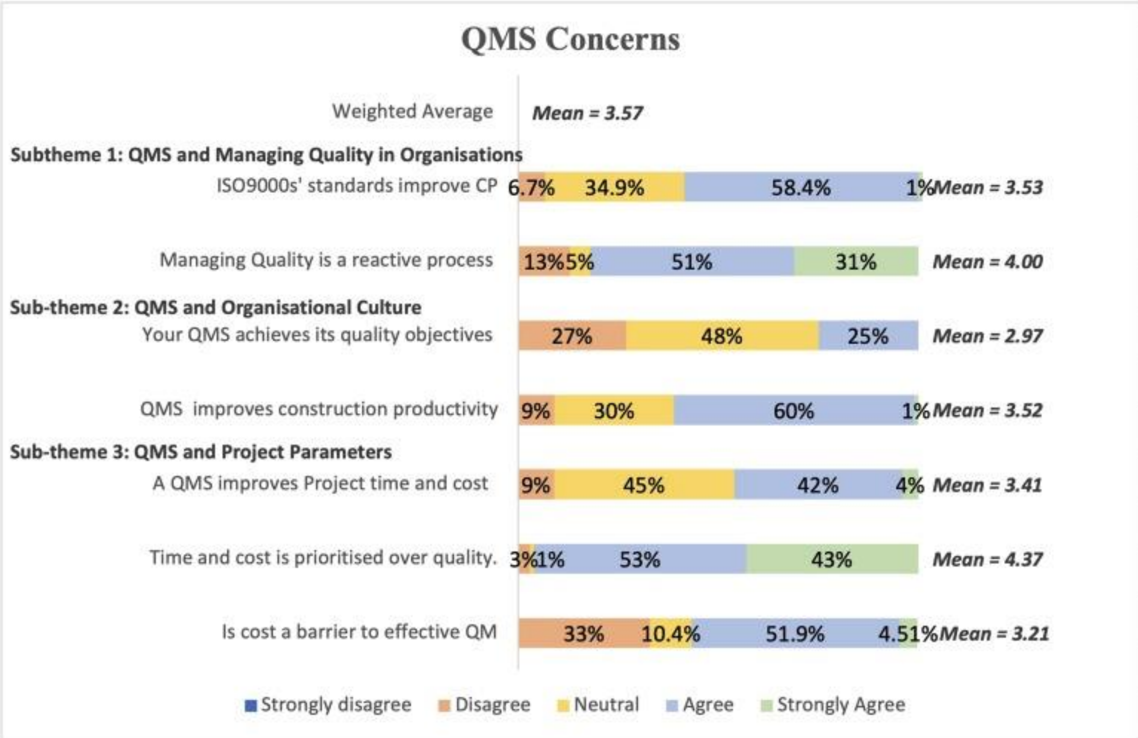
Age Groups (Years)	Frequency (Percent)	Professions	Frequency (Percent)	Industry Experience (Residential)	Frequency (Percent)	Highest level of Education	Frequency (Percent)
20-29	25 (23.5%)	General Manager	18 (16.9%)	2-5 years	30 (28.3%)	Certificate	39 (36.8%)
30-39	21 (19.6%)	Construction Manager	20 (18.8%.)	6-9 years	33 (31.1%)	Degree	25 (23.6%)
40-49	30 (28%)	Project Manager	21 (19.8%)	10+years	43 (40.6%)	Diploma	38 (35.8%)
50-59	12 (12%)	Site Manager	22 (21%)			Postgraduate	2 (1.9%)
60 (+)	18 (16.9%)	Subcontractor	25 (23.5%)			Other	2 (1.9%)
Total	(N) 106 (100%)		(N) 106 (100%)		(N) 106 (100%)	Total	(N) 106 (100%)

6.5.2 Quality management concerns

Participants (N106) were asked seven questions on a 5-point Likert Scale regarding the effectiveness of QM in the New Zealand residential construction sector.

Figure 6.1 confirms three sub-themes: QMS and managing quality in organisations, QMS and Organisational culture, and QMS and project parameters. The weighted average of the seven statements is 3.57

Figure 5.1: QMS subthemes and mean value indicators (Author's work)



6.5.3 Sub-theme 1: QMS and managing quality in organisations

A mean score of 4.00 indicates that participants predominantly view QM as reactive in New Zealand's residential construction sector, with 81% agreeing or strongly agreeing. While 58% believed that ISO 9000 could boost productivity, the mean score of 3.53 reflects a slightly lower perception. The results highlight the need for greater organisational clarity on the benefits, use, purpose, and understanding of QM Systems (QMS) in New Zealand residential construction (Figure 6.1).

6.5.4 Sub-theme 2: QMS and organisational culture

Most respondents (61%) believed that an organisational QMS could enhance New Zealand residential construction productivity, while 30% expressed disagreement, resulting in a low mean score of 3.52 (Figure 6.1). However, only 25% of the participants concurred that their organisational QMS fulfilled quality objectives, with 75% either disagreeing (27%) or remaining neutral (48%), yielding a low mean score of 2.97.

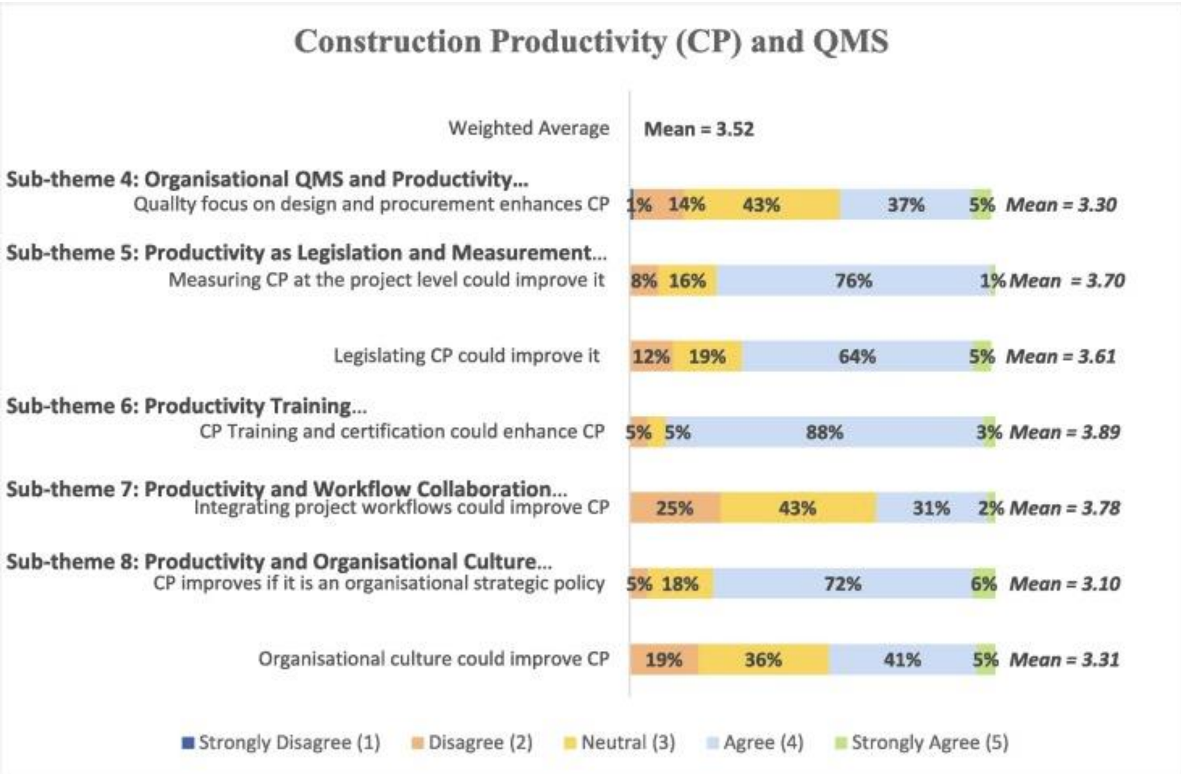
6.5.5 Sub-theme 3: QMS and project parameters

A mean score of 4.37 indicates participants believe the New Zealand residential construction industry prioritises time and cost over quality, with 96% of respondents agreeing (53%) or strongly agreeing (43%). However, a mean score of 3.41 suggests a low perception that QM enhances time and cost outcomes. The results confirm that 46% agree that QM enhances time and cost outcomes, and 54% disagree or remain neutral. Moreover, a mean score of 3.21 reflects a low perception of cost as a barrier to implementing a QM system. The results showed that 51.9% of participants agreed, and around 44% disagreed (33%) or were neutral (10.4%) (Figure 6.1).

6.6 Construction productivity and QMS

Participants (N106) were asked questions on a 5-point Likert Scale regarding strategies for enhancing construction productivity in the New Zealand residential construction sector. Figure 6.2 identifies five subthemes: Organisational QMS and Productivity, Productivity Training, Productivity as Legislation and Measurement, Productivity and Workflow Collaboration, and Productivity and Organisational Culture. The weighted average (Figure 6.2) of the seven statements is 3.52.

Figure 5.2: Construction productivity and QMS sub-themes with mean value indicators. (Author's work)



6.6.1 Sub-theme 4: Organisational QMS and productivity

A mean score of 3.30 confirms participants' low perception (Figure 6.2) of improving NZ residential construction productivity by including QM in Project design and procurement phases. Moreover, results highlight that approximately one-third (42%) of the participants agreed (37%) or strongly agreed (5%). Conversely, 43% were neutral in their responses, and only 15% disagreed or strongly disagreed with this statement.

6.6.2 Sub-theme 5: Productivity as legislation and measurement

According to Figure 6.2, a mean score of 3.70 indicates a high perception among participants that New Zealand residential construction productivity can be improved if measured at the project level. The results show that 76% of the participants agree (75%) or strongly agree (1%). Conversely, 24% disagreed (16%) or strongly disagreed (8%). Additionally, a mean score of. 3.61 indicates that participants' high perceptions of productivity, such as health and safety, could improve if legislated. Moreover, 69% agreed (64%) or strongly agreed (5%), whereas 31% either disagreed (12%) or remained neutral (19%).

6.6.3 Sub-theme 6: Productivity training

According to the findings presented in Figure 6.2, a mean score of 3.89 demonstrates participants' high perception and support for an industry-wide scheme to train and certify construction professionals on improving productivity. Approximately 90% of participants agreed (87%) or strongly agreed (3%) with this statement. On the other hand, only 10% of the respondents disagreed (5%) or were neutral (5%) regarding this statement.

6.6.4 Sub-theme 7: Productivity and workflow collaboration

The mean score of 3.78 signifies participants' high perception regarding the importance of incorporating project stakeholder workflows to enhance New Zealand residential construction productivity. Approximately one-third of respondents agreed (31%) or strongly agreed (2%) with this statement. Conversely, approximately two-thirds (67%) of respondents demonstrated neutrality (42%) or disagreement (25%). This finding suggests a disconnect at the project level regarding the benefits of integrated workflows (Figure 6.2)

6.6.5 Sub-theme 8: Productivity and organisational culture

Participants' perceptions of improving construction productivity as a strategic organisational policy are low, as indicated by a mean score of 3.10. Nevertheless, 78% of the respondents agreed (72%) or strongly agreed (6%) with this statement, only 5% disagreed, and 19% remained neutral. Similarly, a mean score of 3.31 reflects a low perception among respondents that organisational culture could enhance New Zealand residential construction productivity. Only 41% of the participants agreed, 5% strongly agreed with this statement, 35% remained neutral, and 19% disagreed (Figure 6.2).

6.7 The Kruskal-Wallis test

Upon analysing the participants' responses, it was essential to determine whether there were different perspectives among the five groups of research participants. Consequently, a Kruskal-Wallis test was conducted (Table 6.4) based on the following hypotheses:

- H0 (null hypothesis): The independent samples have the same central tendency.
- H1(alternate hypothesis): At least one independent sample will not exhibit the same central tendency.

A Kruskal-Wallis test examined differences in mean ranks among professional groups on a Likert-scale statements/strategies. The results (Table 6.4) indicated significant differences between the two groups of construction professionals, H (4) = 12.511a, (P=0.14); hence, the null hypothesis was rejected (P=.05). Post hoc comparisons with Bonferroni correction revealed a significant difference between general managers (88.25) and subcontractors (42.10) (P=0.04). No significant differences were found among the project managers (57.47), construction managers (61.42), and site managers (51.48). These results provide crucial insights into enhancing productivity in New Zealand residential construction.

Table 5.4: Independent samples Kruskal-Wallis (Author's work)

Test Summary

Total N	106
Test Statistic	10.884[a]
Degree of Freedom	4
Asymptotic Sig (2-sided test)	0.014

a. The test statistic is adjusted for ties

6.8 Thematic analysis of open-ended questions responses

In addition to structured questions at the outset of the survey, participants were allowed to propose suggestions for improvement through open-ended enquiries. The inductive Thematic analysis revealed 26 themes with various subthemes, generating unexpected insights from the three open-ended questions. The analysis had six recurring themes: Lean Construction Methods, Adequate Supervision, Skilled Workers, Culture, Collaboration, and Procurement Methods, are discussed below.

6.8.1 Question 1 - analysis of project level productivity improvement strategies in the NZ residential sector

The analysis of Question One reveals 12 themes (Table 6.5), with 92 participants responding to project-level strategies for enhancing construction productivity. The top five themes were Lean Construction Methods (1), productivity training and education (2), QM (3), stakeholder collaboration, adequate supervision and collaboration (4), and incentivisation schemes and skilled workers (5). Lean Construction Methods, a delivery process using lean methods to maximise stakeholder value and minimise waste is considered the most effective project-level strategy, accounting for 22% of the responses and includes ten subthemes (Table 6.5). Additionally, 49 respondents believed Lean Construction could be used individually or in combination to boost productivity. Productivity training and education were identified by 15% of the participants, with 29 advocating specific training and 14 recommending stakeholder education. This study highlights the need for greater strategic emphasis on QM, although agreement on its role in improving productivity is limited. The participants confirmed that a collaborative project environment could enhance productivity, with 28 respondents supporting improved stakeholder supervision. Other themes included incentivisation schemes and skilled workers (8%), technology adoption (6%), procurement methods, culture and communication (3%), and comprehensive design (2%).

6.8.2 Question 2 - Analysis of quality management strategies to improve NZ residential construction

Eight themes emerged from analysing the second open-ended question, with 82 participants discussing QM strategies to improve residential construction productivity (Table 6.6). The five most common themes are Lean Construction Methods (29%), focusing on maximising customer value and minimising waste, with sub-themes like QM checklists, inspections, audits, stakeholder collaboration, and continuous improvement; Plan Do Check Act (26%) for continuous process improvement; ISO 9000 standards (19%) for quality and productivity enhancement; CONQA quality assurance system (QAS) (7%) for organisational quality assurance; and inspection test plan (ITP) checklists (6%) for productivity improvement. Other themes, including project management software, Kaizen, and Total Quality Management, received less attention (13% combined), likely due to participants' limited understanding of their benefits.

6.8.3 Question 3 - analysis of organisation strategies used to improve NZ residential productivity

The analysis of question three reveals 13 themes (Table 6.7), with 87 participants responding. The five most prevalent strategies for improving construction productivity were Lean Construction (1), collaboration (2), QM (3), communication (4), and adequate supervision (5). Lean Construction was utilised by 22% (48) of participants. Inspections and audits are the least-utilised lean strategies. Enhancing collaboration, primarily through contractor workflow coordination meetings, was reported by 14% (38) of the participants as an effective strategy.

One-third (35) employed QA tools, such as QM checklists and audits. Notably, 10% (26) reported that their organisations lack productivity improvement strategies. Less frequently mentioned strategies include adequate trade supervision (7%) (19) and employing skilled workers (6%, (17), fostering an organisational culture (4%, (12), training, project management software, incentive schemes (3%, (9), procurement methods (2%, (6), and adequate design, the least effective strategy (1%).

6.8.4 Key findings summary

This study assessed the impact of QM strategies on New Zealand's residential construction productivity. Results revealed a consensus among participants on the effectiveness of Lean construction and ISO 9000 in enhancing quality and productivity. However, only 20% of respondents considered ISO 9000 standards the best strategy despite recognising their productivity potential. Enhancing local effectiveness requires a better understanding of QM principles, governmental support, and modern industry leadership. This is further confirmed by the Kruskal-Wallis test in this study, suggesting differences between general managers' and subcontractors' views regarding productivity improvement strategies. Bridging these gaps through education, targeted application, and regulatory support can boost QM's impact on productivity.

Table 5.5: Respondent strategies for enhancing NZ residential construction productivity (Author's work)

Q1. Project level strategies to improve construction productivity

ID#	Theme	Responses	Percentages
1	Incentivisation schemes	24 Participants confirmed that monetary incentivisation schemes (contractor bonuses and higher levels of remuneration) could be used as a strategy for trades and employees to help improve project level productivity	8%
2	Adequate design	7 Participants confirmed that a Buildable design (coordinated and complete) combined with improved use of BIM modelling could be used to improving project level productivity	**2%**
3	Communication	9 Participants confirmed that effective communication between all stakeholders could be used as a strategy for improving project level productivity	**3%**
4	Collaboration	30 Participants confirmed that a sharing information in a more collaborative project environment at might help improve project level productivity	**10%**
5	Culture	9 Participants confirmed that organisational culture in particular employee motivational schemes could be used as a strategy to improve project level productivity	**3%**
6	Procurement methods	9 Participants highlighted that procurement methods such as Early Contractor Involvement (ECI) might be used strategically to help improve project level productivity	**3%**
7	Productivity training and education	29 Participants confirmed that specific training to improve productivity could be used as a strategy to improve project level productivity. 14 Participants confirmed that providing education to stakeholders on methods for improving productivity could provide strategic benefit used to improve project level productivity	**15%**
8	Quality management	30 Participants confirmed that QM could be used as a strategy for improving productivity at project level	**12%**
9	Adequate Supervision	28 Participants confirmed that improving supervision of trade workers could be used as a strategy to improve productivity at the project level	**10%**
10	Lean Construction Methods	49 Participants confirmed that Lean Construction Methods (process improvement, minimising defects, improved leadership, continuous improvement, hold points, Last planner and third party inspections and audits, improved scheduling) could work as a strategy for improving project level productivity. Six Participants confirmed that alternate construction methods like offsite construction and prefabricated components could be used strategically to improve productivity at the project level	**22%**
11	Technology	11 Participants confirmed that using more technology as a strategy (project management software. automation and robotics) can create a safer and more efficient construction environment for all stakeholders contributing towards improved productivity	**4%**
12	Skilled workers	23 Participants confirmed that strategies around the use of skilled workers as human capital could be used for improving productivity at the project level	**8%**

N(92) participants answered

Table 5.6: QM strategies for improving NZ residential construction productivity (Author's work)

Q2. Quality management strategies for improving construction productivity			
ID#	**Theme**	**Responses**	**Percentages**
1	Lean Construction Methods	14 Participants confirmed that using Lean Construction Methods as an organizational strategy to manage quality might improve construction productivity • According to 10 participants, implementing continuous improvement throughout organizational processes as a measure of quality assurance could be used strategically to enhance construction productivity • 22 Participants confirmed that using checklists to manage quality assurance (QAS) as an organizational strategy could improve construction productivity	29%
2	Plan Do Check Act	41 Participants confirmed that using Plan Do Check Act as an organizational strategy to manage quality assurance might enhance construction productivity	26%
3	CONQA	11 Participants confirmed that using an industry known quality assurance system (QAS) such as CONQA as an organisational strategy might improve construction productivity	7%
4	Total Quality Management	According to 4 participants, using management philosophies like Total Quality Management as an organizational strategy might enhance construction productivity	3%
5	Kaizen	According to 8 participants, using management philosophies like Kaizen as an organizational strategy might improve construction productivity	5%
6	Inspection Test Plan (ITP) Checklists	According to 9 participants, implementing ITP checklists as an organizational strategy towards quality assurance might improve construction productivity	6%
7	ISO9000	28 Participants confirmed that using ISO9000 standards for QM (QMS) as an organizational strategy might improve construction productivity	19%
8	Technology -PM Software	8 Participants confirmed that using quality assurance checklists within Project management software (Procore and Aconex) as an organizational strategy could enhance construction productivity	5%
N(82) participants answered.			

Table 5.7: Strategies for improving NZ residential construction productivity **(Author's work)**

Q3. Strategies organizations use to improve construction productivity

ID#	Theme	Responses	Percentages
1	Adequate supervision	19 Participants confirmed that adequate supervision of trade workers is a strategy used to improve project level productivity	7%
2	Collaboration	38 Participants confirmed that workflow coordination meetings is a strategy used to help improve project level productivity	14%
3	Communication	32 Participants confirmed that effective communication (meetings and checklists) is used a strategy used among stakeholders to improve project level productivity	12%
4	Quality management	According to 35 participants quality assurance tool such as QM checklists and QM Audits can be used as a strategy for improving productivity at the project level	13%
5	Skilled workers	17 Participants confirmed that strategies in human capital like using skilled and experienced workers are strategically effective in improving productivity at the project level	6%
6	Training	According to 9 participants, staff and contractor Training can be used as a strategy to improving productivity at the project level	3%
7	Culture	12 participants confirm that organizational culture can have a positive effect on productivity and can be used as a strategy to improve productivity at the project level	4%
8	Adequate design	2 participants highlight the use of Design factors like Building Information Modelling (BIM) helps improve constructability producing a more buildable design and can have a positive effect on productivity at the project level	1%
9	Incentivisation schemes	According to 3 participants, incentivising staff and contractors can be a successful strategy for improving productivity at the project level	3%
10	Lean construction methods	According to 48 participants used lean construction tools to strategically improve productivity at the project level. Of this 48 responses; 10 participants focus on minimising defects and reworks. 18 participants highlight continuous improvement 13 participants identified using hold points 7 participants used inspections and Audits 12 participants highlight improvements in programming to encompass more detail can be used to improve productivity at the project level	22%
11	No strategies	26 participants confirm they don't use any strategies to improve their productivity	10%
12	Project management software	According to 7 participants using production checklists within project management software helps improve productivity at the project level	3%
13	Procurement Methods	6 participants confirm Procurement methods (preferred suppliers, ECI and adequate pay for contractors) can be used strategically to improve project level productivity	2%

N(87) participants answered.

6.9 Discussion and recommendations

The mixed methods approach addresses this research aim. Fourteen strategies to enhance New Zealand residential construction productivity were grouped into two Likert scales: QM systems and construction productivity, with corresponding subthemes. Mean value indicators and percentages reflect respondent choices, confirming the participants' agreement levels. The thematic analysis (Tables 6.4 - 6.6) examines three open-ended questions on productivity improvement strategies and QM systems. The qualitative results support the quantitative findings, enhancing the study's validity and reliability. This methodological approach instils confidence in the accuracy and relevance of the research. The distribution of themes and strategies underscores that improving productivity is a collaborative effort involving multiple stakeholders (Seadon & Tookey, 2019) and is not confined to any particular construction stage. Strategies to enhance construction productivity are presented at the legislative, industrial, organisational, and project levels.

This study agrees with international research that productivity is a vital performance indicator in the construction industry and requires effective measurement (Archchana & Pan, 2023; Neyestani, 2016). The authors argue that traditional productivity measurement methods are crucial but often time-consuming, labour-intensive, and error-prone (Archchana & Pan, 2023). Aligning with this study's findings, it may confirm a lack of productivity measurement in the local context.

According to recent research, influential organisational culture significantly impacts productivity in the residential construction sector (Alsya & Ubaidillah, 2024; Bittharia & Tiwari, 2021; Helmold, 2023). The importance is highlighted in the Vietnamese construction sector, where research (Thi Ngo et al., 2024) affirms that organisational culture is crucial for employee productivity in the construction industry (Alsya & Ubaidillah, 2024; Bittharia & Tiwari, 2021; Helmold, 2023). However, participants contradict international studies and disagree that organisational culture can improve construction productivity, highlighting the disconnect between QM principles and their more comprehensive benefits.

Respondents have diverse views on the benefits of integrating stakeholder workflow. At the same time, global studies highlight the critical role of workflow collaboration in boosting construction productivity (Adamu & Adulhamid, 2016; Cairampoma-Caro et al., 2022)

The Nigerian housing sector and Latin American social housing detail the effects of collaborative workflow, improving project performance and productivity, with a 17.24% productivity increase and a reduction of up to 50% in construction timeframes, highlighting the clear benefits to the New Zealand residential sector (Adamu & Adulhamid, 2016; Cairampoma-Caro et al., 2022).

Research (Mohammed, 2023) highlights the importance of QM in residential construction's design and procurement phases. While participants disagree about its impact on improving productivity, international studies (Mohammed, 2023; Oluwaseun Ebenezer Olowolayemo et al., 2024) confirm that effective QM in these stages is crucial for project success, affecting both time and cost. This underscores the gap between local QM practices and their broader implications, indicating industry-wide training and education needs.

Results confirmed industry support for a programme certifying and training construction professionals to boost productivity, aligning with research linking high-quality vocational training to socioeconomic mobility and regional development (Mustajab & Irawan, 2023). Multiple studies (Doerr & Novella, 2024; Manoharan et al., 2022; Maqbool et al., 2023) noted significant improvements in performance from targeted training initiatives, demonstrating their efficacy in enhancing residential productivity. However, programmes are less effective in addressing skilled shortages among an ageing workforce (Maqbool et al., 2023), a current local sector issue. This highlights the benefit of specific and targeted training initiatives for the regional sector.

Training initiatives could be implemented through a comprehensive productivity strategy involving legislative collaboration. For instance, this study finds that legislation could enhance New Zealand's residential construction productivity and concurs with empirical research suggesting that optimising regulatory measures supports improved productivity (Adeyemi et al., 2022; Sujani et al., 2022; Tembo et al., 2023). However, some researchers (Sujani et al., 2022; Tembo et al., 2023) observe that while specific regulations aim to improve project quality and productivity, they can also present challenges such as time constraints, bureaucratic processes, and increased human resource requirements.

Empirical studies discuss the positive association between strategic leadership and achieving desired cultural attributes within construction organisations. However, participants disagree that productivity can be enhanced through a strategic organisational policy. Conversely, research from Singapore supports productivity as a strategic management policy in construction organisations (Ofori et al., 2020). Studies indicate that leadership is reflected through organisational culture and can significantly impact productivity in the residential construction sector (Bittharia & Tiwari, 2021; Helmold, 2023) confirming the benefits to the New Zealand industry.

However, New Zealand residential construction professionals prioritise timely and budgeted project completion over quality, reflecting an industry culture that may undermine confidence in QM’s efficacy (Kirby et al., 2022). This research aligns with recent international literature (Böhme et al., 2018; Hatakeyama, 2019; Pheng & Abeyegoonasekera, 2001; Pheng & Teo, 2004) highlighting the residential sector's struggle to balance productivity and quality linked to this prevalent culture. The Brazilian construction sector (Hatakeyama, 2019) suggests that incorporating quality as a core element in productivity efforts is essential for sustainable progress in residential construction. However, other studies (Böhme et al., 2018; Zhang, 2024) argue that enhancing productivity does not necessarily compromise quality.

The Kruskal-Wallis test (Table 6.4) further supports the absence of a quality culture by highlighting the differences in perspectives between general managers and subcontractors. The observed variations in the central tendencies imply a lack of effective leadership by general managers in New Zealand residential construction companies. This is crucial for successfully implementing a QM system and cultivating a “quality culture.” The divergent views on QM reveal a disconnect between management's idealised conception of QM and productivity ("work as imagined") and the practical realities experienced by subcontractors ("work as done") in this research.

The findings indicate that QM in New Zealand's residential construction sector is predominantly reactive, aligning with international research highlighting this approach (Bakar et al., 2011; Davis, 2007). Similar experiences are observed in the Spanish (Mesa Fernández et al., 2016) and Malaysian construction sectors. Despite the increased use of QM control systems, significant deficiencies persist, resulting in end-user claims and complaints, suggesting that quality control remains reactive. Regulatory decoupling is a common issue, reflecting an inconsistent commitment to QM (Brooks et al., 2021) where problems are identified post-construction rather than prevented during the building process, thus reducing productivity.

This study confirms over half of the participants believed that QM systems, such as ISO 9000, could enhance productivity. This aligns with research (Ghansah & Edwards, 2024; Parmar, 2024; Zhao et al., 2024) from the Philippines, India, and Sri Lankan construction sectors. Which assert that QM systems lower costs, boost productivity, and enhance market share, improving project outcomes, customer satisfaction, and efficiency. However, conflicting views highlight that participants disagree that a QM system improves time and cost efficiency, possibly due to a lack of understanding of the purpose and intent of QM systems. In contrast, research shows the global use of QM strategies like Total Quality Management, ISO 9000, Lean Construction, and Plan Do Check Act can enhance construction time, cost, and quality (Pheng & Abeyegoonasekera, 2001; Pheng & Teo, 2004)

Many respondents view QM systems' implementation as costly, likely because of the prevalence of micro companies in the New Zealand industry (Seadon & Tookey, 2019). This may also contribute to the high annual cost of poor quality (BRANZ, 2021; Love & Holt, 2000). However, participants don't view cost as a barrier to implementing QM systems. This aligns with international studies that agree that although QM systems implementation incurs high initial costs. The long-term benefits like reduced rework, increased efficiency, client satisfaction, and profitability often surpass these costs (Ruales Guzmán et al., 2019; Small et al., 2021). This emphasises the importance of raising awareness about QM's strategic value and implies that significant governance and change are required.

Thematic analysis identified 12 practical strategies for enhancing residential construction productivity in New Zealand, with Lean Construction, productivity training and education, collaboration, supervision, and QM as the top strategies. Some of these strategies align with quantitative findings, such as the need for an industry-wide scheme to certify and train construction professionals (Mustajab & Irawan, 2023) and the importance of QM (Brooks et al., 2021; Khatatbeh, 2022). Unexpectedly, participants viewed incentivisation schemes, culture, communication, procurement methods, technology, and skilled workers as less critical.

Thirteen productivity improvement strategies were identified, with the five most prominent being Lean Construction, QM, improved collaboration, and communication. Empirical research supports the idea that a collaborative culture enhances performance (Cui, 2023). Participants agreed that workflow coordination meetings at the project level are vital for improving performance. Notably, 10% reported their organisations lacked productivity improvement strategies, indicating room for enhancement. Project management software, procurement methods, incentivisation schemes, adequate design, training, culture, supervision, and skilled workers were deemed less significant.

Five primary QM strategies were identified: Lean Construction Plan Do Check Act, ISO 9000, CONQA, and Inspection Test Plans. Plan Do Check Act or Lean Construction can be used with ISO 9000, relevant at organisational and government levels, as an effective combined QM solution. However, ISO 9000 is the only comprehensive QM system among the suggested strategies, aligning with quantitative findings and previous research highlighting its effectiveness (Aba et al., 2015; Prajogo et al., 2022; Sfreddo et al., 2021; Siougle & Dimelis, 2020). Other strategies focus narrowly on QC and QA, indicating a need for a better understanding of the use of QM systems at the industry level.

A critical analysis revealed commonalities across construction sector levels. Quality Management , a global industry standard (ISO 9000) since 1987, consistently links quality and productivity (Adrian, 1987; Arditi & Mochtar, 1996; Lam et al., 2008). It is part of a comprehensive model for sustainably improving New Zealand construction productivity (Seadon & Tookey, 2019). Governments in Australia, Hong Kong, and Singapore have used QM to guide industry quality objectives since the 1980s (Abdullah & Tari, 2012; Chan & Chan, 1999a; Nasir et al., 2016; Ofori et al., 2020). At the organisational level, QM as a strategic policy ensures consistent quality and product delivery) and enhances construction performance (Hwang et al., 2020; Leong et al., 2014; Nasir et al., 2016). Directly driving improved productivity at the project level (Ministry of Business, Innovation & Employment, 2024).

Quality management must transition from a reactive tool to a strategic function to improve New Zealand's residential construction performance (Small et al., 2021). Tailored training enhances supervision and training but remains limited. Adopting the ISO 9000 standard fosters a "quality culture" (Ofori & Gang, 2001) integrating communication, collaboration, supervision, and training strategies across the supply chain and government, ensuring a comprehensive approach to boost productivity. The documented benefits of at legislative, (Abdullah & Tari, 2012; Chan & Chan, 1999; Nasir et al., 2016; Ofori et al., 2020), organisational (Hwang et al., 2020; Leong et al., 2014) and project levels (Dixit et al., 2019; Hasan et al., 2018) are rarely considered collectively for enhancing productivity. About 10% of respondents indicated their organisations lacked productivity improvement strategies, and less than half agreed their QM systems met quality objectives, highlighting the need for change. A broader strategy can significantly enhance organisational and industry performance, benefiting society (Australian Constructors Association, 2023). New Zealand policymakers and industry leaders should consider broad-scale ISO 9000 implementation as practised in other nations.

The study proposes a five-step approach (author's work):

1. Industry research: Evaluate current QM practices.
2. Stakeholder Engagement: Raise awareness and form a task force of industry experts, government representatives, and academic researchers.
3. Implementation Framework: Develop training, pilot programmes, gradual rollout, and certification support.
4. Monitoring and Evaluation: Establish metrics for quality and productivity, with continuous evaluation and adjustment.
5. Change Management: Address SME challenges with grants, subsidies, transparent communication, staff involvement, and success stories.

Sector-specific resources, such as digital handbooks, can mitigate barriers to ISO 9000 implementation by translating standards into actionable steps for construction firms (Ramadan et al., 2024). Long-term success requires leadership commitment and government support (Brooks et al., 2021; Khatatbeh, 2022; Patel & Pitroda, 2021; Prada, 2018; Shaikh & Sohu, 2020). Collaborative networks in other countries have facilitated the exchange of best practices (Shaikh & Sohu, 2020). Regular follow-ups, government assistance, and an industry-wide QM network are advantageous.

This study highlights the need for an affordable, accessible, and certifiable industry-wide training program to improve productivity. The Singaporean Building Construction Authority (BCA) Academy (*Building and Construction Authority (BCA)*, n.d.) could be an adaptable model. The BCA promotes construction quality and productivity through incentives and legislation that foster innovation (*CONQUAS*, n.d.). BCA Academy provides ongoing education and training, including fundamental courses (Building and Construction Authority, 2024; *CONQUAS*, n.d.; *Price Quality Method (PQM) Framework*, n.d.; The Building and Construction Authority, n.d.). Courses like "Basic concept in construction productivity enhancement (BCCPE)" for small and medium enterprises and advanced programs such as the “Advanced certificate in construction productivity (ACCP)” and specialist diplomas. These courses cover productivity improvement, quality enhancement, management skills, value engineering, technological advancements, and new construction technologies. The "Certified construction productivity professional (BCA CCPP) scheme" recognises experts leading productivity initiatives (Building and Construction Authority, 2025) and "The good industry practices" course disseminates best practices via digital books (*Good Industry Practices Guide Books*, n.d.).

The BCA's incentivisation strategies and legislative support with accessible training options merit consideration for the local sector. These training options highlight the importance of QM and its link to productivity. They showcase government-led programs suitable for New Zealand's construction industry within a broader productivity enhancement framework. Combined with the ISO 9000 standards, these programs can be adapted locally. They offer structures to enhance industry knowledge on quality and productivity, potentially raising New Zealand's productivity standards and industry culture.

Research confirms (BRANZ, 2021) that improving the quality of residential construction in New Zealand boosts productivity and performance, leading to new growth and consumption opportunities. This study shows that enhanced quality results in an annual economic increase of $112 million in residential construction output, a 1% yearly rise in capital investment, and a 1.3% wage increase. Additionally, the downstream effects suggest a NZD 2.5 billion increase in New Zealand GDP as production costs decrease. Providing households an extra NZD 1.4 million for goods and services, thereby raising living standards and societal well-being (BRANZ, 2021).

Increased construction productivity in New Zealand has a societal impact beyond economic benefits. Reducing project timelines is crucial for addressing housing shortages, increasing housing availability, and enabling more families to access affordable homes sooner, potentially decreasing homelessness. Green building practices that enhance productivity promote sustainable methods, such as using eco-friendly materials, renewable energy, and energy-efficient designs, thus improving housing standards. The construction sector could address housing deficits by incorporating lean, environmentally sustainable practices.

Moreover, efficient resource and waste management are essential for environmental sustainability. These advancements support ecological goals and enhance residents' quality of life, fostering a healthier, more stable, and equitable society. As New Zealand faces housing and sustainability challenges, improving construction productivity is vital for achieving these societal objectives.

Love et al. (2018) noted that rework constitutes 10–30% of total construction costs. Thus, implementing QM practices can reduce defects, lower end-user costs, and boost productivity. For example, a housing firm constructing ten homes annually at NZD 1 million could save NZD 100,000 per home by reducing rework costs from 20% to 10%. Achieving 10% greater efficiency lowers end-user costs, enhances housing affordability, and improves living standards. Additionally, improved efficiency allows the firm to produce one extra home yearly with the same resources, increasing productivity. Enhanced QM leads to more efficient production at lower costs, demonstrating the strategy's societal benefits.

These points advocate for a multifaceted approach to improving construction productivity, addressing the industry's evolving demands. The findings highlight the need for increased awareness of the strategic value of QM systems and substantial governance and change. The discussion identifies practical strategies to enhance New Zealand residential construction productivity. Emphasising QM as the primary strategy is vital for future improvements in New Zealand's construction sector. Although strategies can be applied individually or collectively, a multidimensional approach is most comprehensive.

6.10 Implication to theory and practice

Research indicates that, despite various strategies and governmental initiatives, New Zealand's construction productivity has stagnated for over thirty years (New Zealand Productivity Commission, 2023). This study's findings are significant for New Zealand's residential sector. The six primary strategic themes identified were QM, training and education, collaboration, Lean construction, and adequate supervision. These themes provide insights from legislative, organisational, and project levels for improving residential construction productivity. A key implication is the association between QM and enhanced productivity, emphasising the strategic importance of QM investments and potential industry-wide improvements by policymakers.

The findings also highlight the crucial role of worker training in improving productivity. Accessible and specific training initiatives that enhance productivity skills and knowledge can significantly improve worker productivity and project outcomes. These strategies are essential for improving New Zealand residential construction productivity, benefiting all stakeholders.

This research investigates New Zealand's residential construction industry, providing insights that could inform global theories. Contextual studies are vital for adapting universal theories to specific sectors, highlighting the importance of this research. Grounded in the Theory of Constraints (TOC), it enhances theoretical development and integrates QM and productivity, bridging both with detailed empirical knowledge. The TOC posits that only at any one time there is one fundamental limitation hindering an organisation's progress (Goldratt, 1984; Rahman, 1998; Vasudevan, 2021). The construction industry integrates QM with TOC to improve quality and productivity by systematically addressing these limitations (Vasudevan, 2021). TOC aligns with QM's focus on identifying and eliminating bottlenecks: workflow delays compromising quality and productivity.

However, TOC requires further integration with frameworks like Total Quality Management, Six Sigma, and ISO 9000 to address the complexities of New Zealand's construction industry (Rahman, 1998; Vasudevan, 2021). Such integration could fully realise TOC's potential, advancing academic research and practical innovation. The relationship between TOC and QM systems (Total Quality Management, Six Sigma, ISO 9000) is evident when addressing bottlenecks (Goldratt, 1984; Vasudevan, 2021). Highlighting that quality assurance protocols identify limitations to facilitate corrective actions that improve the system rather than address isolated symptoms (Vasudevan, 2021).

This study highlights the importance of targeted quality enhancements to boost productivity, proposing that QM should be a primary strategy within a comprehensive productivity plan. Combining QM frameworks (ISO 9000, Lean construction, and Total Quality Management) with TOC ensures continuous improvement, aligning QM practices with productivity objectives. Managing constraints effectively prevents defects, reduces rework, improves processes, and fosters continuous improvement, leading to efficient construction practices and better project outcomes. Integrating QM with TOC offers a robust theoretical framework for addressing challenges in the modern local construction industry (Vasudevan, 2021).

This study challenges the notion that alternative productivity improvement methods are preferable to QM. It presents a multidimensional analysis within a robust theoretical framework, showing how QM strategies can drive productivity improvement and enrich existing theories with empirical insights. Through empirical evidence, this research contributes to the existing body of knowledge on QM and productivity in New Zealand's residential construction sector.

6.11 Conclusion

There is yet a universal solution to improving productivity in the construction industry. This study employs a novel methodology to explore the perspectives of the New Zealand residential construction industry on productivity enhancement. It offers unique findings and strategies for policymakers and professionals and guides future research.

The Theory of Constraints underpins this research, providing a theoretical lens that enhances its academic rigour and relevance. The findings bridge the gap between QM and productivity theory, demonstrating the effectiveness of QM in improving productivity in New Zealand's residential sector. Thus, they advance academic understanding.

This study categorises productivity enhancement strategies into six main themes: training, productivity assessment, QM, industry culture, communication, and stakeholder collaboration. These themes can be applied individually or collectively at legislative, industry, organisational, and project levels to improve industry performance. Secondary themes like adequate design, technology, procurement methods, incentive schemes, and human capital are important but less critical.

Findings suggest that New Zealand's residential sector's persistent underperformance indicates deep-rooted issues that require substantial time to address. Enhancing productivity requires a multidimensional approach, including improved QM, regulatory changes, better industry cultures, and training. Given the sector's socioeconomic significance and the link between quality and productivity, the authors advocate for regulatory changes that prioritise these aspects nationally.

Key findings highlight the need for an industry training scheme to boost construction productivity, aligning with Singaporean research, where government-led training focuses on QM and productivity improvement. This approach could benefit New Zealand's broader construction sector, including commercial and industrial sectors. The results stress the importance of enhancing workforce skills, improving QM, addressing an ageing workforce, prioritising labour-reducing innovations, and advocating supportive government policies. Immediate impacts are possible through lean construction, supported by this study as a strategy to optimise processes, reduce waste, and shorten schedules, leading to better performance and sustainable practices. However, Lean construction methods do not explicitly aim to improve quality.

The study advocates integrating Lean construction with ISO 9000 standards to boost productivity. Findings highlight the importance of QM as a global benchmark for raising industry standards. Participants agree on the efficacy of ISO 9000 standards in enhancing New Zealand residential construction productivity. ISO 9000 implementation can foster a quality-oriented culture, improving communication, collaboration, and training, thereby increasing productivity. The framework's flexibility allows for integrating other organisational policies to improve business performance, presenting a comprehensive strategy for productivity enhancement and sustainable performance gains. The study suggests that focused QM drives productivity, recommending a strategic reorientation within the sector.

However, current QM efficacy in New Zealand's residential sector requires improvement through better understanding, government support, and enhanced leadership. The study notes differing views on productivity improvement strategies between general managers and subcontractors. Addressing these differences through education, targeted application, regulatory support, and training can strengthen QM's impact on construction productivity.

Quality management emerges as a holistic and universal strategy for enhancing productivity in New Zealand's residential construction sector at organisational, industry, and policy levels. Coordinated efforts are needed to improve the quality and productivity of residential buildings in New Zealand. Implementing these findings requires significant shifts in stakeholders' mindsets, attitudes, and behaviours.

Future research could investigate the application of these approaches in other construction areas and the impact of digital technologies, such as further integrating BIM with lean construction techniques, within New Zealand's building industry.

6.12 Limitations/implications

This study highlights QM’s role in improving residential construction productivity in New Zealand but faces limitations. These include reliance on self-reported data from a small sample (N=106) of construction professionals, possibly causing non-response bias and limiting generalisability. While demonstrating QM’s effectiveness, broader samples, human behaviour, and organisational psychology should be considered for a comprehensive understanding. Future data analysis methods should balance strategy complexities that affect productivity. Future research should use larger samples and longitudinal studies to validate these findings practically. Although valuable, caution is needed when generalising results to the broader construction industry.

The researchers acknowledge potential limitations in the study's methodology, particularly the objectivity of findings due to self-reported data. The involvement of industry professionals may introduce bias, compromising research validity. These professionals might present their practices overly favourably, overstating positive results or downplaying negatives. Additionally, cognitive biases like optimism bias could affect participants' evaluations of their experiences or the industry's overall state. Triangulating self-reported data with objective measures, observational studies, or administrative data could enhance future study validity. The authors also note that a small sample size can reduce the reliability and generalisability of findings. Fewer participants increase the likelihood that the sample does not represent the heterogeneous nature of the construction industry's diversity, raising the margin of error and resulting in unstable estimates. Consequently, findings from a limited sample may not apply to a larger, more representative population in future studies. Despite these limitations, this study lays a foundation for future research.

6.13 Chapter conclusion

This study examines the effect of QM strategies on New Zealand’s residential construction productivity with the aim of improving performance in the local sector.

The study examines the persistent industry challenges and provides insights and recommendations that serve as a roadmap for the sector to realise its potential by adopting formal QM systems and practices.

An approach that aligns global best practices with local industry through promoting QM's universal appeal of directly optimising project performance, leading to improved socioeconomic benefits. Thus, the findings of this study aim to drive positive change and position the sector for sustainable growth.

6.13.1 Original contribution and realisation of aims questions and objectives

This research connects the synergistic relationship between QM and productivity theory, demonstrating the effectiveness of quality-focused approaches in New Zealand's residential construction sector, thereby addressing the primary research objective. This was achieved by providing a unique, mixed-methods evaluation within the New Zealand context; identifying key improvement strategies, such as productivity certification and training, time/cost prioritisation, and enhanced QM practices. Validating the effectiveness of ISO 9000 and Lean construction; and highlighting the importance of strategic awareness, government support, and organisational leadership.

This chapter directly answers research questions (RQ) 2 and 3. Specifically, it identifies strategies and confirms existing QM practices as positive factors affecting New Zealand's residential sector construction productivity. It also provides evidence supporting the effectiveness of ISO 9000 and Lean construction highlighting the need for a comprehensive, multidimensional strategy that includes training, cultural change, governance, and leadership.

Furthermore, Table 6.8 illustrates the success of this chapter in addressing Research Objectives RO2-RO5 and contributing to research questions RQ2-RQ5.

Table 5.8: Research outputs achieved (Author's work)

Research aim	To determine what effect QM has or improving New Zealand residential construction productivity	
Manuscript title	An investigation into QM systems and factors affecting construction productivity: The New Zealand residential construction industry (Published Journal Article -Ains Sham Engineering Journal 2025)	
Objective	**Research questions**	**Outputs achieved**
RO2. To establish the common factors that positively affect construction productivity in the New Zealand residential sub-sector	RQ2. What are the common factors that positively affect construction productivity in the New Zealand residential construction sector	Identification of the top factors for improving construction productivity in the NZ residential sector
RO3.To validate the effectiveness of a developed strategy for QM in residential construction	RQ3. How effective is the developed strategy for QM in the residential construction sector	This study empirically supports QM as a strategic productivity enhancer in the NZ residential sector
RO5. To suggest ways to improve construction productivity through QM strategies	RQ5 What QM strategies can be suggested for improving productivity within construction residential sector?	This study recommends productivity certification and training, enhanced QM practices, and gradual ISO 9000 and Lean implementation

6.13.2 Final considerations

This chapter's findings recommend targeted interventions, including gradual implementation of QM systems and practices. Specifically, it highlights the importance of ISO 9000, Lean construction and comprehensive industry-wide training, to enhance productivity through improved QM.

This research further emphasises the need for an industry-wide productivity training program to address skill gaps, a cultural shift and policy interventions to address time/cost prioritisation over quality. The importance of enhanced organisational leadership and government support for effective QM practices. The findings of this study suggest the importance of establishing industry standards, training programs, and policies specifically aimed at enhancing quality and productivity in New Zealand's residential sector. Construction companies can utilise these insights to refine their QM practices and optimise project outcomes.

By fully embracing QM principles, the New Zealand residential construction sector gains a clear pathway to realise its full potential, aligning with global industry best practices. The strategic alignment promises substantial benefits for both the national economy and societal living standards. Consequently, these findings serve as a catalyst for positive transformation, strategically positioning the sector for enduring and sustainable growth.

Chapter 7

Unlocking productivity: The power of quality culture in New Zealand housing

Overview

Amid rapid urbanisation and rising housing demands for quality housing, the New Zealand residential construction sector stands at a critical juncture in an era defined by sustainable development and the ongoing pursuit of improved quality and efficiency. Within the dynamic landscape of New Zealand's residential construction industry, the imperative to build better, faster, and with a reduced environmental footprint has never been more pronounced.

New Zealand's residential construction industry has historically faced significant challenges related to productivity and quality. These challenges substantially affect project timelines, costs and client satisfaction, ultimately leading to suboptimal industry outcomes. Addressing these challenges is crucial for enhancing industry performance. Concurrently, the government's commitment to fostering a sustainable and resource-efficient built environment necessitates innovative solutions that transcend current trends and conventional wisdom.

Hence, this study embarks on a comprehensive exploration of a powerful synergy. It leverages qualitative methods to explore expert opinions on the strategic integration of QM principles and practices to catalyse significant productivity gains and contribute meaningfully towards the United Nations Sustainable Development Goals (UNSDGs).

This research posits that QM, traditionally perceived through a reactive lens focused on defect reduction, has the potential to be transformative in addressing this embedded cultural problem. Through a rigorous examination of the efficacy of QM as an organisational productivity improvement strategy, this study aims to furnish a robust, evidence-based understanding of its impact within the unique context of the New Zealand residential construction industry.

Furthermore, it seeks to elucidate the tangible connections between quality-driven practices and the attainment of key UNSDGs, illustrating how a commitment to excellence can facilitate a more sustainable and resilient future for the industry. This forward-looking investigation invites industry stakeholders, policy makers, and scholars to reconceptualise the possibilities when quality is central to construction practices. The study aims to provide valuable insights for industry practitioners, academics and policymakers, delineating a clear path to a more productive construction sector that supports a globally sustainable future.

This prelude sets the stage for a compelling exploration of how quality-driven productivity can reshape the industry, promising enhanced performance, sustainability, and societal benefit.

This chapter is based on the following manuscript currently under review in the Journal of Construction Economics and Building [5]:

Kirby, M., Rotimi, F. E., & Naismith, N. (n.d)[5]: Unlocking productivity: The power of quality culture in New Zealand housing (Construction Economics and Building)

Abstract

Globally, the construction sector faces persistent challenges in terms of quality and productivity. In New Zealand, the residential construction sector is characterised by particularly low productivity and poor quality, posing a significant socio-economic concern. Empirical data underscores the link between QM (QM) and productivity improvements, yet their application in New Zealand's residential sector remains understudied. This research examines the effectiveness of QM as a strategy in improving New Zealand residential construction productivity, addressing a critical knowledge gap in the context of New Zealand's unique construction landscape.

The study employs a rigorous qualitative approach, utilising semi-structured interviews with industry experts (N = 15). Data is analysed thematically to explore in-depth perspectives on the effectiveness of QM as a strategy for improving New Zealand's residential construction. Industry experts emphasise that strategic integration of QM systems with complementary approaches, including training, communication, and design, is crucial. However, cultivating a pervasive quality culture emerges as a foundational element for sustainable productivity gains. The ISO 9000 standards, combined with the Plan-Do-Check-Act or Lean construction methods, are recommended for optimal results.

This study offers a novel and nuanced understanding of productivity enhancement in the New Zealand residential construction sector, yielding distinct insights applicable at the organisational, policy, and industry levels. The findings highlight the critical role of QM, particularly the ISO 9000 framework and a robust quality culture, as key enablers of sustainable productivity improvements, suggesting a need for a shift in industry priorities.

Keywords - quality management, Productivity, Residential construction, ISO 9000, New Zealand.

7.1. Introduction

Despite its pivotal role in economic and urban development, the global construction sector faces persistent quality and productivity challenges (McKinsey and Company, 2024;

McKinsey Global Institute, 2020). Consequently, these challenges impede the industry's contribution to sustainable development (World Commission on Environment and Development, (1987, p.15). Recognising this, strategic QM implementation is increasingly seen as a driver for sustainable improvements (Ruales Guzmán et al., 2019; Small et al., 2021), offering a potential solution to enhance productivity. Additionally, QM contributes to sustainability through effective resource utilisation, minimising environmental impact, and promoting socially responsible practices (Antony et al., 2023). This holistic view of QM, which embraces systems thinking (Senge, 2006; Wu, 2015) to optimise interconnected processes, is gaining prominence as a pathway to comprehensive industry enhancement. By integrating critical elements across the construction life cycle, QM serves as a powerful tool for improvement and a strategic framework for aligning operational goals with productivity and quality (Venkatraman et al., 1993; Wu, 2015).

However, the effectiveness of QM varies across contexts, (Brooks et al., 2021) contingent on factors like organisational culture, regulatory and political landscapes, human capital, and industry structure (Asfandiyar & Cheema, 2023; Ataseven et al., 2014; Mills et al., 2009; Ramadan et al., 2022). This contextual variability necessitates tailored approaches and context-specific research (Ramadan et al., 2024). Crucially, this variation underscores how embedded organisational culture (Coelho et al., 2022; Schein, 2010) shapes QM perceptions and implementation, influencing employee motivation (Bandura, 1977; Rojas & Aramvareekul, 2003) and learning (Argyris & Schön, 1997; Chan et al., 2023).

While Japan and Singapore, for example, have demonstrated high construction-sector performance by integrating QM principles (Carnerud et al., 2018; Liao et al., 2019; Sahmi & Abbadi, 2024), a different scenario unfolds in the context of New Zealand, particularly in the residential segment. Even with the governmental vision for *"A thriving, fair, and sustainable construction sector for a better Aotearoa New Zealand"* (New Zealand Construction Sector Accord, 2022), deeply entrenched productivity and quality issues persist within the industry. These include persistent inefficiencies, poor labour use, substandard workmanship, and recurring defects, (BRANZ, 2021; Ministry for Building and Construction, 2024; New Zealand Productivity Commision, 2021; Pricewaterhousecoopers, 2009; Rotimi et al., 2015; White et al., 2017) contributing to ongoing housing shortages and affordability concerns (Ministry for Building and Construction, 2024; New Zealand Productivity Commission, 2023). These issues manifest as inefficient processes, rework from defects or substandard design, inadequate quality control and project delays (Ministry of Business, Innovation & Employment, 2024; Rotimi et al., 2015). The consequences of poor quality and low productivity in New Zealand's residential construction sector extend beyond economic costs, carrying significant social and environmental implications that undermine the sector's contribution to sustainable development. For instance, rework increases the sector's carbon footprint by necessitating additional materials and labour, while premature building degradation due to poor quality can lead to more frequent replacements and further resource depletion. From an operations management perspective, (Sizirici et al., 2021; Slack et al., 2010) these inefficiencies represent significant waste, aligning with lean construction principles (Womack & Jones, 1997), highlighting the need for continuous improvement that optimises processes and reduces costs. (Ali & Johl, 2021; Deming, 1986).

Factors such as industry fragmentation, skills shortages, and regulatory complexities contribute to the New Zealand residential sector's productivity challenges. Given the prevalence of micro/small to medium-sized enterprises (Seadon & Tookey, 2019) , financial and human resource constraints often hinder implementing formal QM systems, a situation exacerbated by reliance on practical, on-the-job learning (Cruz et al., 2016; Jaafari, 1996; Nwankwo, 2000). From a resource-based perspective (Barney, 1991; Rotjanakorn et al., 2020), it highlights how capabilities and resources, including human capital (Becker, 1964; Fleming, 2017) and effective leadership, are critical for competitive advantage. For instance, transformational leadership (Bass & Bass Bernard, 1985; Mach et al., 2021) can inspire teams, provide clear direction, and foster a shared understanding of quality standards, contributing significantly to this competitive edge.

Deficiencies in construction quality are further highlighted by issues like the 'leaky home crisis' and significant ongoing costs of poor residential construction sector quality, estimated at NZD2.5 billion annually (Ghose et al., 2017; Riggs et al., 2021; Rotimi et al., 2015). The prevalence of such problems often stems from an ingrained industry culture, where institutional norms (Arz, 2017; DiMaggio & Powell, 1983) prioritise short-term gains, creating competing priorities (March & Simon, 1993; Zhao et al., 2016) that frequently lead to a myopic focus on immediate costs and overlook long-term quality benefits. This phenomenon is consistent with prospect theory, (Kahneman & Tversky, 1979) where the perceived pain of upfront investments can outweigh less certain future gains (Li & Ahlstrom, 2019). Inherent tension can also manifest as divergent views regarding the most impactful drivers for productivity, where the perceived holistic scope of QM may be debated against the primacy of other critical elements such as design or communication (Senge, 2006).

Although the potential for enhanced QM in New Zealand has been acknowledged (Doan et al., 2020; Ghodrati et al., 2018; Rotimi et al., 2015; Seadon & Tookey, 2019), the adoption and effectiveness of QM practices in the New Zealand residential sector remain understudied. This gap is significant, especially considering widely adopted frameworks like the ISO 9000 QM systems, which are designed to provide a comprehensive approach to quality across various industries, often explicitly integrating communication protocols (ISO, 2022). However, its impact can be contingent on implementation factors (Fiedler, 1967; Naveh & Marcus, 2004). Furthermore, effective collaboration among diverse stakeholders (Freeman et al., 2010; Wu et al., 2023) through interorganisational cooperation (Gulati, 1998) is crucial for success, yet it is often challenging in fragmented sectors. This challenge is exacerbated by the industry's frequently loosely coupled nature (Dubois & Gadde, 2002), where robust communication, as underscored by communication theory (Daft & Lengel, 1986), becomes a foundational prerequisite for effective collaboration and overall productivity.

This study addresses this gap by assessing the effectiveness of QM as a strategy for improving productivity in the New Zealand residential construction sector. Three key research questions provide guidance. Firstly, what common factors positively affect construction productivity in the New Zealand residential construction sector? Furthermore, how effective is the developed strategy for managing quality in the New Zealand residential construction sector? Lastly, what QM strategies can be suggested to improve New Zealand's residential construction productivity? The study's findings will contribute to the broader discourse on construction productivity and offer practical recommendations for enhancing the performance of the New Zealand residential construction sector.

Given the ongoing productivity challenges in New Zealand's residential construction industry, effectively implementing QM strategies is vital for its improvement. With its unique characteristics and challenges, this sector presents a compelling and essential case for examining QM strategies in enhancing productivity. Hence, this research aims to investigate the effectiveness of quality management as a strategy in improving New Zealand residential construction productivity. Thereby, bridging the gap between theoretical understanding and practical application of QM principles in the specific context of the New Zealand residential building industry. Ultimately, this research contributes to the sector's efficiency, quality, and overall performance and seeks to understand "What insights industry experts can provide regarding the applicability and impact of the proposed quality management strategies on residential construction practices".

7.2 Methodology

This study aligns with the interpretivist approach, which emphasises an understanding of social phenomena through the perspectives and experiences of participants, while recognising that reality is subjective and socially constructed (Pulla and Carter, 2018). By prioritising semi-structured interviews, the interpretivist approach enables a deeper exploration of the complex meanings that participants attribute to their actions (Santosh et al., 2021). Thus, this approach is employed to uncover the latent motivations, beliefs and values that shape participant behaviours and actions, seeking to develop a more holistic understanding of the research problem.

A qualitative methodology, specifically semi-structured interviews, was chosen to explore industry professionals' nuanced experiences with QM in New Zealand's residential construction sector (Almujibah, 2023). This approach is well-suited (Onwuegbuzie & Leech, 2005; Sapeciay et al., 2017) for construction management research, facilitating rich data collection and theme probing (Koskey et al., 2016). An iterative interview guide informed by prior empirical research (Kirby et al., 2022, 2024) and a narrative review (Creswell & Poth, 2016) comprised open-ended questions (Roberts, 2020). Interviews were conducted online via Microsoft Teams from August to October 2024 (Frey & Bloch, 2023; Wakelin et al., 2024).

A purposive sampling strategy targeted professionals with deep insights into the research phenomenon (Tongco, 2007). Diverse occupations (e.g. project managers, construction managers, general managers, subcontractors and site managers) within the New Zealand residential construction sector were selected via industry membership portals (Collins et al., 2007; Rowley, 2014; Wright, 2005). Inclusion criteria required at least 5 years' relevant industry experience and active involvement with the research problem, thereby identifying expert informants (Wilson-Poe et al., 2024). Ultimately, 15 self-selected professionals met this criterion and participated, proving robust for this qualitative inquiry. Theoretical saturation, where no significant new themes emerged, was observed mainly after 12 interviews (Galvin, 2015; Guest et al., 2006). Data collection continued to ensure adequate representation from diverse professional roles (e.g. project managers and subcontractors) and organisational contexts, enhancing comprehensiveness (Collins et al., 2007). Consistent with typical qualitative study sizes (Kvale & Brinkmann, 2009) and construction management precedents (Hurlimann et al., 2018; Sacilotto & Loosemore, 2018). Three research questions guided the interview process. Firstly, what common factors positively affect construction productivity in the New Zealand residential construction sector? Furthermore, how effective is the developed strategy for managing quality in the New Zealand residential construction sector? Lastly, what QM strategies can be suggested to improve New Zealand's residential construction productivity?

Participants hailed from New Zealand's principal cities: Auckland, Christchurch, and Wellington. They represented large organisations (20+ employees) and SMES (<20 employees), including three micro organisations (MBIE, 2022). Table 7.1 details participant characteristics, illustrating the diverse professional expertise (Rowley 2014)

Table 6.1: Industry experts sample group representativeness. (Author's work)

Participant ID	Professional role	Organisation size	Organisation location	Years in NZ residential construction	Highest educational qualification
#1	Project Manager	SME	Auckland	5	Degree
#2	Construction Manager	SME	Auckland	25	Post Grad
#3	Site Manager	SME	Auckland	7	Diploma
#4	Project Manager	Large	Auckland	15	Degree
#5	Project Manager	SME	Wellington	6	Diploma
#6	Construction Manager	SME	Auckland	14	Degree
#7	Subcontractor	Micro	Auckland	7	Certificate
#8	General Manager	SME	Auckland	9	Post grad
#9	Site Manager	Large	Christchurch	5	Certificate
#10	Construction Manager	SME	Auckland	12	Diploma
#11	Site Manager	SME	Auckland	6	Certificate
#12	Subcontractor	Micro	Auckland	9	Diploma
#13	General Manager	Large	Christchurch	22	Degree
#14	Project Manager	SME	Auckland	8	Degree
#15	Subcontractor	Micro	Auckland	12	Certificate
	Totals	(n) 15			

Following Braun & Clarke's, (2006) six-phase framework, inductive thematic analysis identified, analysed, and reported data patterns and themes (Nowell et al., 2017). This process involved data familiarisation, inductive coding, theme searching, review and refinement, definition, and narrative production. Microsoft Excel v16.85 managed the coding process (Neyeloff et al., 2012). An interpretive perspective uncovered latent factors and deeper meanings (Rowley, 2014), allowing for organic narrative development (Wilkinson, 1998). Member checking was performed with slight wording adjustments for clarity (Culver et al., 2003; Hagens et al., 2009). The University Ethics Committee (AUTEC) approved Ethics Application# 24/77. Participants granted informed consent, ensuring anonymity during the peer review process.

The researcher employed reflexivity to mitigate potential bias from prior industry experience. This involved maintaining an audit trail of analytical decisions and regularly peer debriefing (Sandelowski, 1993). Open-ended questioning and limited follow-up prompts (for clarification only) were used to represent participants' lived experiences while maintaining epistemological neutrality (Bhandari & Hallowell, 2021; Shenton, 2004). This aligns with the study's post-positivist epistemology (Shannon-Baker, 2016), enhancing the credibility and applicability of findings by acknowledging subjective influences while striving for robust, generalisable insights (Bhandari & Hallowell, 2021).

7.3 Results and discussion

This section presents and discusses the findings of thematic analysis from expert interviews. It examines the effect of QM on enhancing productivity within New Zealand's residential construction sector. Five key themes emerged, providing a comprehensive overview of expert perspectives: QM as a Holistic Strategy for Productivity Enhancement, Top Productivity Factors, ISO 9000 QM System and Productivity, Effectiveness of Key Strategies for Enhancing Productivity and QM, and QM Propinquity and Productivity.

To ensure full rigour and transparency of the thematic analysis discussed in this section, the complete Coding Matrix, which details the inductive generation of themes and their final mapping to the research objectives, is provided in "Appendix E".

7.4 Quality management as a holistic strategy for productivity enhancement

Experts provided opinions on QM as a holistic strategy to enhance productivity in New Zealand's residential construction. Results are presented under three subthemes: Core Role of QM, Dynamic and Adaptive Nature**.** Varied Perspectives and Alternative Drivers.

7.4.1 Core role of quality management

Consistent with Empirical research (Ruales Guzmán et al., 2021; Seadon & Tookey, 2019; Small et al., 2021), experts strongly perceived QM as a central and highly impactful strategy for enhancing New Zealand residential construction productivity. This overarching view was powerfully articulated. Most experts (#2-15) echoed QM's holistic reach, conceptualising it as a pathway to comprehensive industry enhancement (Wu, 2015). Experts noted it's the "only factor useable everywhere" (#14) with "unique applicability across the entire residential industry" (#8,11). Its foundational importance was emphasised by its ability to "integrate with other critical elements" (#3,14), leading Interviewee (#3) to label it a "powerful tool". Indeed, for some, QM was at the "heart of any improvement strategy" (#8), underscoring its fundamental role. Experts (#2-15) emphasised QM's ability to 'integrate with other critical elements', positioning it as an overarching framework for process management. This aligns with systems thinking (Hossain et al., 2020; Senge, 2006), which views phenomena as interconnected parts. QM establishes the relationships and interactions between design, communication, supervision, and other elements, ensuring synergistic function rather than isolation. The systemic perspective highlights that QM-guided improvements in one area can cascade across the construction process, enhancing overall productivity. Consequently, QM's systemic role in improving productivity is illustrated by its flexibility in standardised procedures that can impact communication protocols and tools that enable feedback across interconnected processes (Asfandiyar & Cheema, 2023;. Ramadan et al., 2024).

7.4.2 Dynamic and adaptive nature

Interviewees (#6,10) highlighted "the importance of continuous improvement", noting that QM inherently "emphasises this approach", (Asfandiyar & Cheema, 2023;. Ramadan et al., 2024) through fostering a continuous learning culture (#1,2,6,10). However, focusing on the continuous improvement of various factors can be dynamic, shifting with each construction phase (#11). For instance, communication may be more important than QM depending on the construction phase (#1,11). Nonetheless, these elements are "interconnected in every aspect of constructing", underscoring the complex nature of construction and the need for a holistic approach to productivity improvement (Ruales Guzmán et al., 2019; Small et al., 2021).

The need for an adaptive QM system aligns with contingency theory (Fiedler, 1967), which posits that effective management is situationally dependent. For instance, a QM system might prioritise rigorous design reviews early, where errors significantly impact downstream. It then shifts to stringent on-site quality control during execution. The changing significance of factors across construction phases underscores a crucial challenge for a static, one-size-fits-all approach to QM (Palumbo & Douglas, 2023). Naveh & Marcus, (2004) also agree, highlighting formal QM systems' contingent effectiveness, confirming that benefits depend highly on contextual factors such as organisational culture, leadership, and implementation strategies. In constructions, dynamic and complex phases, an adaptive QM system (e.g., prioritising communication early and quality control during execution) could consistently enhance productivity (Naveh & Marcus, 2004).

7.4.3 Varied perspectives and alternative drivers

Expert interviews revealed divergent opinions regarding the primary drivers of productivity. One perspective (#7) positions "*QM is a unifying factor,*" while others identified alternatives. Specifically, (#9) proposed that "*design and specification, communication, adequate supervision, organisational training, and employee motivation could be managed under QM*," implying its holistic scope. Conversely, (#2) asserted that "*design and specification are a better driver,*" simplifying, "*QM is just the implementation of specifications.*" Interviewee #2's assertion aligns with the front-end loading principle that 'design and specification are better drivers for productivity', implying upfront investment for downstream efficiency (Womack & Jones, 1997). This perspective suggests a 'designed in' rather than a 'managed in' later QM model (Palumbo & Douglas, 2023). Experts holding this view may have experienced poor initial designs causing significant rework, overshadowing QM benefits. This highlights sequential dependencies and upstream design's impact on downstream productivity, irrespective of the QM framework.

Furthermore, (#11) suggested that *"communication could be used holistically",* disagreeing that QM is the sole encompassing factor. Interviewee #11's emphasis on 'communication' as a holistic driver resonates with communication theory (Daft & Lengel, 1986), vital in the construction industry's loosely coupled nature (Brooks et al., 2021), where breakdowns cause inefficiencies. This suggests that robust communication might be a foundational prerequisite for productivity, potentially underpinning QM's effectiveness. However, viewing communication as more holistic than QM overlooks established frameworks like ISO 9000 that explicitly integrate communication protocols (ISO, 2022). This suggests that the perceived dichotomy might arise from a narrow understanding of contemporary QM systems.

Highlighting this diversity, (#12) implied that "*adequate supervision and training are strategies that could be used holistically",* underscoring the varied perspectives on key productivity drivers. Interviewee #12's implication strongly resonates with human capital theory (Becker, 1964), emphasising the importance of employee knowledge and skills. From this view, a competent workforce is a core organisational capability driving productivity, potentially even more effectively than formal QM systems alone, aligning with organisational development principles (Schein, 2010). Coelho et al., (2022) supports this, highlighting employees' proactive skills investments directly enhance their value, improving productivity and overall socio-economic well-being. Regardless, empirical literature on ISO 9000 emphasises competence-based training (ISO - ISO 9000 Family - Quality Management, n.d.), indicating a potential disconnect in the industry's understanding of QM's intent.

The divergent perspectives on the primary holistic productivity driver gain context from Theme 7.6's findings on ISO 9000. While design and communication were proposed as overarching, Theme 7.6 reveals a strong consensus that ISO 9000's comprehensive framework explicitly integrates these elements. This suggests that ISO 9000, as perceived by most, offers a structured and implementable pathway to holistic productivity enhancement, potentially serving as the 'unifying factor' by encompassing rather than competing with other critical drivers.

7.5 Top productivity factors

Experts were asked for their opinions on whether using a QM System, such as the ISO 9000 for QM, fosters a culture of quality, communication, design, training, supervision and quality. The results are presented under three subthemes:

Strategic Integration and Synergy, Operational Excellence and Quality Assurance, Human Capital and Leadership.

7.5.1 Strategic integration and synergy

Industry professionals (#1-15) agree that QM is key to enhancing productivity by integrating "design and specifications, communication, QM, organisational training, adequate supervision, employee motivation, and skilled workers." This suggests strategic alignment, positioning QM as a framework for aligning operational elements with productivity and quality goals (Venkatraman et al., 1993). A robust QM system facilitates (#5,7,8) the strategic deployment and synergistic combination of valuable resources, like skilled workers' training programmes. and communication channels, creating a competitive advantage in productivity and quality (Barney, 1991). This aligns with organisational communication principles (Daft & Lengel, 1986), where formalised systems within QM can create clear channels, reduce ambiguity and ensure the accurate conveyance of design specifications. Encouraging feedback loops is vital for continuous improvement and to prevent productivity losses from misunderstandings (Asfandiyar & Cheema, 2023;. Ramadan et al., 2024).

7.5.2 Operational excellence and quality assurance

Experts (#3,4,5,6,7,8,15) emphasised that "QM can differentiate a company in a competitive market" and leads to "greater client satisfaction and maybe repeat business." QM leads to "less rework" (#8), aligning with principles of lean construction (Womack & Jones, 1997) and Total Quality Management (TQM) (Deming, 1986). Both prioritise waste and defect elimination (Deming, 1986; Womack & Jones, 1997). Effective QM systems achieve this through proactive error prevention in standardised processes, checklists, training and a quality culture. Root cause analysis, a cornerstone of TQM, identifies the fundamental reasons for errors, preventing recurrence and minimising future rework. However, the perception that *"QM might be costly"* (#3,6,8) could stem from a myopic focus on the immediate costs. Experts (#3,4,5,6,7,8,15) frequently identified QM as central to improvement, with (#8) emphasising its role in identifying enhancements, streamlining processes and reducing rework, ultimately improving costs.

Experts also highlighted the synergistic relationship between the well-defined processes and human factors. For instance, (#4) noted that when "*designs are well considered and* *documented, there is less likelihood of encountering design issues leading to better performance"*. Suggesting that robust QM practices can enhance productivity and quality design. Similarly, a combination of factors was deemed crucial, with (#2,3,8) asserting that "organisational training and employee motivation can be used together as a driver for productivity". Further highlighting the interconnectedness of adequate supervision and a skilled workforce, suggesting that combining "*good supervision with a motivated employee might do the trick"* in improving overall outcomes. However, a contrasting view emerged from (#3,6,8), who, despite acknowledging the benefits, asserted that *"QM might be costly"*. This emphasis on workforce capability aligns with human capital (Becker, 1964; Deming, 2022), highlighting the significance of employee expertise and abilities.

While most experts highlighted QM's advantages regarding client satisfaction and reduced rework, its perceived potential cost was a recurring concern from (#3, #6, #8). This paradox, where long-term rework benefits are acknowledged (#8), yet a financial obstacle is perceived, warrants further examination. This perception might stem from an unclear understanding of the costs associated with poor quality versus QM's return on investment. Future research could explore specific cost-benefit analysis in the NZ context to clarify this perceived trade-off.

7.5.3 Human capital and leadership

Participant insights consistently underscored the pivotal role of workforce capability and supervisor quality. For instance, (#7) highlighted that "*having skilled workers is critical to achieving high quality outcomes,"* a sentiment echoed by (#3), who noted that "*if you have a skilled workforce, the supervision will decrease because you can trust your worker."* This emphasis aligns with human capital theory (Becker, 1964; Deming, 2022), which posits that investments in workforce skills and knowledge drive organisational performance. Reduced supervision with skilled workers, as suggested by (#3), implies that effective QM systems foster trust and autonomy through training and competency development (ISO, 2022). This aligns with the principles of TQM and Lean thinking, where competence leads to greater self-management (Deming, 1986; Liu et al., 2019; Womack & Jones, 1997).

Furthermore (#8) emphasised the necessity of "qualified supervisors", positing "supervisors who are well trained in technical skills and QM principles could provide better oversight." This suggests leadership embedded in QM knowledge guides teams more effectively toward best practices, proactively addressing issues, and fostering accountability. This aligns with transformational leadership theory, which posits that leaders inspire teams by providing clear direction and promoting a shared understanding of quality standards. Integrating QM principles into supervisory roles can thus be a key mechanism for embedding a quality-focused culture.

QM's perceived ability to integrate with key productivity factors like design, communication, and supervision (Theme 7.4) finds further support here. Expert perspectives on skilled workers and qualified supervisors demonstrate how QM, through human capital development and leadership training, provides a practical mechanism for realising this holistic potential. Theme 7.6 will explore how the ISO 9000 framework is a key structure for inherently addressing and ensuring these elements.

7.6 ISO 9000 and productivity

Experts were consulted on whether factors such as design and specifications, communication, QM, organisational training, adequate supervision, employee motivation, and skilled workers can be applied individually or collectively to enhance organisational responses to productivity improvement. The results are presented under five subthemes: ISO 9000 as a Comprehensive quality framework, Impact of ISO 9000 on Organisational Culture and Performance, Training and Skill Development within ISO 9000, Limitations and Alternative Perspectives on ISO 9000, Contextual Factors and Current State of QM.

7.6.1 ISO 9000 as a comprehensive quality framework

Experts strongly agreed (#2-15) that ISO 9000 ensures "quality culture, communication, design, training, quality and supervision." Many (#3,5,6) further suggested that "ISO 9000 provides a structural framework at the organisational level for integrating quality into everyday operations," implying a systemic approach. This aligns with systems theory (Hossain et al., 2020; Senge, 2006), emphasising the interconnectedness of organisational elements and the need for a holistic framework. Indeed, contemporary scholarship Wu, (2015) further elaborates on this by demonstrating how effective integration of systems thinking with QM principles is crucial for realising enhanced productivity and quality outcomes across diverse international contexts, underscoring the necessity of context-specific implementation for optimal results. Consequently, experts (#4,6,12) noted that "integrating QM into design ensures regulatory and client standards are met," highlighting its practical application. Several experts (#4,6,9,10,12,14) believed that "ISO 9000 principles are essential for future New Zealand construction, offering a solution to many problems," and can improve engagement, accountability and performance. Further solidifying its perception as a comprehensive quality framework for positive organisational change.

7.6.2 Impact of ISO 9000 on organisational culture and performance

Interviewee (#6) highlighted that "a strong quality culture encourages proactive problem solving and the ability to improve continuously," suggesting that ISO 9000 can foster this mindset. This aligns with organisational learning theory (Argyris & Schön, 1997; Chan et al., 2023), where a focus on quality encourages reflection, error identification, and corrective actions. Building on this, recent research (Chan et al., 2023) demonstrates that structured organisational learning, through frameworks like the PDCA model, directly drives enhanced performance, innovation, productivity, and quality improvements in the construction sector. Furthermore, experts (#1,12) noted that "when employees at all levels understand quality's importance, they are more likely to take ownership and meet established standards." This suggests that ISO 9000 can positively impact employee behaviour and commitment through shared quality expectations. This resonates with social cognitive theory (Bandura, 1977; Salanova et al., 2011), where shared beliefs and values within an organisation shape individual actions. Empirical evidence Rojas & Aramvareekul,'s (2003) demonstrates that internal factors like management skills and manpower issues are more significant drivers of productivity than external conditions. This underscores how these capacities, often tied to employee motivation and a sense of efficacy fostered by organisational context, critically influence overall performance.

7.6.3 Training and skill development within ISO 9000

Several interviewees (#7,8) posited that organisational training is crucial for maintaining quality standards, "directly linking training to quality outcomes." Moreover, many (#4,9,11,13,14) believe that by "providing targeted ISO 9000 training, organisations enhance the capabilities of their workforce." This underscores the role of ISO 9000 as a driver of human capital development (Ataseven et al., 2014). Highlighting investments in employee skills and knowledge related to quality standards is seen as essential for achieving sustained quality performance (Becker, 1964; Deming, 2022).

7.6.4 Limitations and alternative perspectives on ISO 9000

Most experts (#2-15) agreed that ISO 9000 ensures a comprehensive approach to quality, aligning with research exploring the conditions under which ISO 9000 certification leads to performance improvement (Naveh & Marcus, 2004). The belief in its essential role for New Zealand construction likely stems from its potential to provide a quality framework. However, dissenting voices (#9,11,14) argued that 'it's not necessarily just the ISO 9000,' and not the 'only contributing factor,' potentially reflecting findings that ISO 9000 impact is contingent upon implementation factors (Naveh & Marcus, 2004). This suggests that ISO 9000 may enhance productivity, but this is not guaranteed and depends on context and implementation quality. Interviewees (#9,11,14) further proposed that this is "not necessarily just the ISO 9000 can enhance performance," suggesting that "any QM system should be able to do that." Experts (#9,10,11) acknowledged that while 'it will help improve by using a particular standardised ISO," it is "not necessarily the only contributing factor", as other contributory factors (#6,10,15) can influence the effectiveness of QM systems. Notably (#1) disagreed, positing that "ISO 9000s can improve all factors except communication." While others (#9,10,11,13,14) agreed that "ISO 9000 will help, though how much I'm not sure due to so many other factors." This divergence highlights the complexity of attributing performance improvements solely to ISO 9000 and suggests other organisational influences.

7.6.5 Contextual factors and current state of quality management

Some experts (#2, 10), critically suggested that "QM in New Zealand, in some cases, is like an ambulance at the bottom of the cliff," due to a lack of proactive quality measures. This analogy underscores possible challenges with the execution and timing of QM initiatives in the New Zealand sector. Experts (#7,8,10) emphasise that "human factors still significantly influence processes and systems outside this approach, requiring alignment." Underscoring the importance of integrating QM with broader organisational elements. While widely recognised, expert perspectives also acknowledge ISO 9000's limitations and the potential of alternative or complementary strategies (explored in Theme 7.7).

The preceding analysis of expert interviews reveals several key insights into the role of QM in enhancing productivity within the NZ residential construction sector. Notably, the study highlights the perceived holistic nature of QM, the importance of a supportive quality culture, and potential frameworks like ISO 9000 to drive improvement. These empirical findings have significant implications for existing theoretical understandings of quality and productivity in construction.

7.7 Effectiveness of key strategies for enhancing productivity and quality management

Experts were asked their opinions on the top three strategies for enhancing productivity in New Zealand's residential construction sector: Implementing a productivity certification and training scheme for construction professionals, Addressing the industry culture of time and cost over quality and enhancing QM practices. The results are presented under three subthemes: overall validation and core strategies, systemic and interdependent implementation, critical perspectives and potential challenges.

7.7.1 Overall validation and core strategies

Interviewees strongly confirmed the proposed strategies (#1,3-15), stating "Yes, I think the strategies offered are a good mix to improve productivity." Several (#8,9,12) endorsed the "top 3 strategies as essential," with (#12) noting they, "cover most aspects needed." However, "to get the best results," (#4,9,11,12,15), the "top 3 strategies should work together, not individually," with some (#3,6) further suggesting, "their combination with QM as the key driver for industry and organisational benefit."

The strong support for addressing the industry culture of prioritising time and cost over quality assumes a fundamental shift in values and norms will lead to more sustainable productivity improvements. This aligns with organisational culture change theories (Schein, 2010), underscoring the influence of deeply ingrained cultural priorities on decision-making and behaviour. Recent research (Coelho et al., 2022) highlights the complex interplay between organisational culture, QM and productivity and construction, revealing that while certain cultural types may prevail, the varying impact necessitates deliberate understanding and strategic shaping of culture to enhance quality practices and overall project performance. By fostering a culture that values quality alongside time and cost, the expectation is that practices leading to rework and inefficiencies will be reduced, ultimately enhancing overall productivity.

The widespread endorsement of a productivity certification and training scheme suggests an underlying belief that enhancing the knowledge and skills of construction professionals will directly translate into more efficient work practices. This aligns with human capital theory (Becker, 1964; Deming, 2022), which posits that investments in education and training increase individual productivity. Furthermore the adoption of a standardised certification process could foster social learning (Bandura, 1977; Salanova et al., 2011) by establishing recognised benchmarks of competence and encouraging the adoption of best practices across the industry, facilitating improved knowledge sharing and a more skilled workforce (Rojas & Aramvareekul, 2003).

The consensus on the importance of enhancing QM practices as a key strategy for productivity improvement suggests a belief that more robust and effectively implemented QM systems will streamline workflows, reduce errors, and improve overall efficiency. This aligns with principles of operations management, which emphasise the optimisation of processes to enhance productivity and reduce waste. Strengthening QM practices enables organisations to establish more precise standards, enhance communication, and implement proactive risk management, ultimately contributing to a more productive and error-free construction process.

Further, Sizirici et al., (2021), discuss the need for a holistic approach to operations management in construction, advocating for integrating TQM principles, IT support, and sustainable practices to enhance productivity and quality assurance. However, they highlight that challenges persist, particularly in addressing human factors and the communication process critical for effective implementation within the industry.

7.7.2 Critical perspectives and potential challenges

A dissenting voice from interviewee (#2) stating that "addressing the industry's culture of prioritising time and cost over quality, will be dangerous." Proposing that, "quality will suffer as a result of that change," and, "we are finding that now, so not that strategy."

This strong opposition highlights the deeply embedded nature of the current industry culture. It potentially represents an institutional norm (Arz, 2017; DiMaggio & Powell, 1983) driven by competitive pressures and client expectations, where prioritising speed and minimising upfront costs is seen as essential. This implies a perceived trade-off where disrupting this established equilibrium might have unintended negative consequences, potentially undermining the values of efficiency and cost-effectiveness that the current culture prioritises.

Interestingly, while generally supported, the strategy of addressing industry culture faced this strong contrarian view from Interviewee #2, who labelled it as "..dangerous" due to concerns about a detrimental impact on quality ("quality will suffer"). This opposition underscores a deeply ingrained belief that the current industry model necessitates a trade-off where prioritising time and cost is crucial for viability, and a significant shift towards quality might compromise this balance. Further research could explore the underlying economic models and contractual pressures within the New Zealand residential sector that contribute to this viewpoint and investigate successful models from other regions, reconciling quality with efficient time and cost management.

The endorsement of enhancing QM practices gains further significance when considering the findings of Theme 7.8, which highlights the propinquity of QM across various stakeholder groups. The widespread agreement on the importance of QM suggests fertile ground for successfully implementing these strategies and a shared understanding of its value.

7.8 Quality management, propinquity and productivity

Experts overwhelmingly concurred that QM exhibits high propinquity across most stakeholders. This widespread recognition of its value among clients, regulatory bodies, and contractors in the New Zealand residential construction sector suggests a convergence of interests driven by the increasing demands for higher quality, enforced standards, and the potential for quality as a differentiator and cost-saving measure through defect reduction, likely contributing to the acknowledged importance of QM across the industry.

7.8.1 Foundational principles of quality management

Experts consistently agreed on the fundamental principle that QM is a “shared responsibility and not solely the responsibility of any one group,” (#5,7,8,11), requiring input and commitment from all stakeholders (#8,11). This aligns with stakeholder theory (Freeman et al., 2010), emphasising groups' interconnectedness and collective involvement in achieving organisational goals. Reinforcing this, Wu et al. (2023) further emphasises stakeholder theory's crucial role in construction project management, highlighting its potential to enhance quality and productivity. However, they also identify a need for more research to fully unravel the complex interplay between stakeholder management, project performance and sustainability in this domain. Several interviewees (#5,7,8) proposed that “QM forces a collaborative environment where all parties align their goals and expectations,” suggesting that QM acts as a mechanism for fostering interorganisational collaboration (Gulati, 1998). Furthermore (#9), the notion that “If QM is embraced across the board, it could create a culture of shared accountability,” where (#8,11), everyone is “invested in achieving quality outcomes,” highlights the potential of QM to cultivate a strong organisational culture (Palumbo & Douglas, 2023) focused on quality. Experts (#6,11) also noted that “integrating quality among groups within a project setting helps standardise processes and expectations.” It facilitates *“*effective collaboration and communication,” (#8,11), asserting the need to “share the values of QM among all stakeholders,” (#8,11), to achieve cohesive quality outcomes.

7.8 2 Impact and application of quality management

Despite acknowledging QM is “vital for successful residential construction,” (#1,2,3,10,12,15), and, “often highly regarded,” these experts noted that the “level of defects,” indicates a “conflict of interest,” between espoused values and actual practices. Interviewee (#3) succinctly stated that while “QM is viewed as important, actions on site show otherwise.” Experts (#10,12,15) asserted that effective QM ‘can minimise reworks affecting multiple stakeholders,” ultimately concluding, “we can do better.” Interviewee (#12) suggests “a stronger commitment to quality enhances a builder’s reputation,” thereby “helping with competitiveness,’ rendering QM’s “propinquity high across a broad range of groups.”

Some (#9,11) suggest asserting that QM facilitates “improved feedback among stakeholders”, potentially indicating “the ability to improve continuously.” However, they also reflected on “how the industry doesn’t act on it,” suggesting a gap between the potential of QM for continuous improvement (Deming, 1986; Small et al., 2021) and its actual implementation. Interviewee (#11) contended that "QM aids in promoting collaboration and continuous improvement to improve outcomes." Furthermore, experts (#4,15) questioned "how clients perceive this," suggesting that, "customers feel the effect of poor quality„ and emphasising "even at the client face, it is essential, because they, too, need to be on the same page," in terms of quality.

7.8.3 Aspirations, gaps and reality

Despite the near-universal agreement on the higher propinquity of QM across diverse stakeholder groups, disillusionment with its implementation emerged. Several experts expressed this gap between aspiration and reality, with (#12) opining that "quality is not always that well managed," (#3) concluding "we can do better," and (#2) stating its implementation is "high in concept but average in actual practice." Potentially because (#15), "cost seemingly comes first."

This tension between the high perceived importance and its perceived suboptimal application of QM suggests a potential disconnect between espoused values and on-the-ground realities within the New Zealand residential construction sector. This paradox, explained by the resource-based view (Barney, 1991; Rotjanakorn et al., 2020), may stem from a lack of resources and capabilities within construction organisations. While QM's value is acknowledged, firms might lack the financial, skilled, or technological resources required for effective implementation. The deeply ingrained industry culture prioritising time and cost, as highlighted (Theme 7.7), may create competing priorities (March & Simon, 1993; Zhao et al., 2016), where the immediate pressures of deadlines and budgets overshadow the longer-term benefits of comprehensive QM.

However, this near-universal agreement on QM's propinquity provides a crucial foundation for future interventions. This shared recognition of its importance suggests potential receptivity within the industry to initiatives aimed at enhancing quality, thereby increasing the likelihood of successful adoption and impact of the key strategies identified in Theme 7.7. The consistent acceptance QM's propinquity reinforces the potential for QM as a holistic strategy for productivity enhancement (Theme 7.4). Initially increasing the likelihood of successful integration and implementation across all levels and aspects of residential construction, when its fundamental principles are widely recognised, valued and supported.

7.9 Conclusion

This research uniquely identifies a significant shift in New Zealand's residential construction industry: prioritising a robust quality culture as a primary driver for enhanced productivity.

This finding challenges the conventional emphasis on training and design as primary factors. It highlights the quality culture's under-recognised importance in driving productivity. This aligns with organisational culture theory (Coelho et al., 2022; Schein, 2010), suggesting a nuanced understanding of its impact on construction. Based on expert analysis, findings demonstrate that strategic QM integration, such as the ISO 9000 and Lean construction, remains crucial. However, cultivating a pervasive quality culture emerges as foundational for sustainable productivity gains. This emergent emphasis suggests reevaluating the industry's culture of prioritising time and cost over quality. Potentially requiring a renewed emphasis on cultivating shared values and attitudes that promote and prioritise quality at all levels. This ultimately contributes to more sustainable practices through reduced rework and optimised resource utilisation. This finding re-contextualises productivity enhancement in New Zealand and offers a valuable lens for understanding similar dynamics in other global construction sectors. This study underscores the critical role of deeply embedded cultural factors in the effectiveness of QM systems within complex project-based industries. Potentially extending existing models that often focus more on structural procedural elements. Future research should explore strategies for cultivating this robust quality culture and assess its long-term impact on productivity and quality outcomes. An immediate implication is the need for industry leaders to visibly champion initiatives to foster a quality-centric mindset across their organisations.

In conclusion, this study has successfully addressed its three research objectives. It identified key factors positively influencing productivity in New Zealand's residential construction sector. The study assessed the effectiveness of QM strategies. It also proposed actionable recommendations for industry stakeholders to improve productivity through enhanced quality practices.

7.10 Recommendations

7.10.1 Practical implications

The study's findings yield actionable recommendations for construction companies and policymakers. They foster a paradigm shift towards quality-driven productivity in NZ's residential construction sector. For construction companies, cultivating a pervasive quality culture is paramount, achievable through empowering initiatives like regular site-based 'quality circles' for proactive problem solving. Simultaneously adopting and adapting formal QM systems such as ISO 9000 should be prioritised, with SMES initially focusing on core principles via standardised processes. Furthermore, quality-focused training, such as mandatory defect prevention workshops, is essential for a skilled workforce. Finally, enhanced communication via regular stakeholder meetings and digital platforms will ensure precise quality requirements.

Key actions for policymakers and industry associations include promoting awareness of quality's benefits for productivity and sustainability. This involves targeted resources, and local success stories and incentivises QM adoption. Potentially, subsidies or streamlined permitting for SMES can drive uptake. Lastly, supporting the development of specific quality standards and guidelines for the New Zealand residential construction sector will provide a practical implementation framework for the industry.

7.10.2 Theoretical implications

The findings of this study offer several critical theoretical implications for the construction and QM domains. Firstly, the existing literature establishes a positive relationship between QM and productivity in general construction contexts. This research provides context-specific empirical evidence demonstrating nuanced QM operations within New Zealand's unique residential construction sector. Recognising that universalistic frameworks like the ISO 9000 series offer structural QM guidance. Findings, however, underscore quality culture's foundational role. This suggests extending existing theoretical models on QM in construction. It advocates for a more explicit integration of cultural dimensions to explain their effectiveness fully.

Secondly, the divergent perspectives on primary productivity drivers (Theme 7.3) offer an interesting theoretical tension. While some experts viewed QM as the overarching framework, others prioritised design, communication or human capital. This challenges the notion of a singular dominant productivity factor. It supports a more contingency-based theoretical approach. Different drivers' effectiveness may be context-dependent and influenced by project complexity, organisation maturity, and specific challenges. This research indicates QM's effectiveness lies in integrating and enhancing various drivers' positive effects rather than functioning as a separate solution. This suggests a necessity for more comprehensive theoretical models accounting for multiple drivers' interactions.

7.11 Limitations and future research

While this study provides valuable and novel insights into the critical role of quality culture in enhancing productivity within NZ's residential construction industry, several limitations warrant consideration. The qualitative methodology, primarily relying on semi-structured expert interviews at managerial levels, provides rich data but inherently offers a limited breadth of perspectives, potentially overlooking nuance from other key stakeholders like labourers and quantity surveyors. Furthermore, while providing valuable local understanding, the study’s specific New Zealand context necessitates cautious consideration regarding the generalisability of these findings to countries with differing regulatory and cultural landscapes. Finally, the cross-sectional design captures a single point in time, potentially not fully reflecting the dynamic evolution of the construction sector and shifting priorities.

Future research should address these limitations through longitudinal studies, including a broader range of stakeholder voices via diverse data collection methods and comparative analysis across international contexts to assist generalisability. Further exploration into specific mechanisms for fostering and sustaining a robust quality culture within construction organisations is also warranted.

7.12 Chapter conclusion

This chapter provided a comprehensive analysis of how QM enhances productivity within New Zealand's residential construction sector.

The study has revealed the critical importance of QM practices in addressing longstanding productivity challenges through expert interviews and rigorous analysis. The findings underscore the need for a holistic approach integrating QM with other key strategies, including effective communication, skilled labour development, and advanced training programs along with improved policy

The research highlights a significant shift in industry perspective, moving away from traditional training-centric approaches towards a quality culture. The study also emphasised the potential of standardised QM systems, notably ISO 9000, in providing a structured framework for quality enhancement and productivity gains. Change in industry perspective challenges established norms within the construction sector and provides new opportunities for enhancing productivity.

7.12.1 Original contribution and realisation of aims, questions and objectives

This study has made significant original contributions to the field of construction management while successfully realising its aims. Through a context-specific analysis of the effectiveness of QM in New Zealand's residential construction sector, this study addresses a gap in the existing literature.

The research breaks new ground, challenging existing industry thought on productivity drivers. The study advocates for a quality culture over traditional training and design-focused approaches. Thereby, offering fresh perspectives on productivity drivers in New Zealand’s residential construction that opens new avenues for industry improvement.

The study contributes a comprehensive framework for grasping the synergistic relationships among various productivity factors, highlighting the indispensable role of integrated QM. This holistic perspective clarifies how distinct components of the construction process collectively influence overall productivity. The research provides actionable insights for industry practitioners, policymakers and researchers, bridging the gap between theoretical knowledge and the practical application of QM principles.

The study has successfully identified and analysed common factors positively affecting construction productivity in New Zealand's residential sector, fulfilling one of its primary objectives.

Through rigorous analysis of expert interview data, this study assesses the effectiveness of QM in terms of productivity improvement in the New Zealand residential sector. Thus, it provides a clearer understanding of the industry's current state and areas for improvement. The research suggests specific QM strategies aimed at enhancing New Zealand's residential construction productivity. It emphasises the implementation of ISO 9000 and the development of a culture that is quality-focused.

These contributions are important for both industry and academia. They advance academic understanding in the construction management domain and have significant practical implications for the New Zealand residential construction industry.

The study presents evidence-based strategies and insights, highlighting the potential of this research to drive meaningful changes in industry practices, inform policy formulation, and guide future research directions. Ultimately, this academic work aims to improve both quality and productivity in the residential construction sector.

Through expert validation and in-depth analysis, the paper has provided comprehensive answers to the research objectives, offering valuable insights for improving productivity in New Zealand's residential construction sector through effective QM practices (Table 7.2).

Table 6.2: Research outputs achieved (Author's work)

Research aim	To determine what effect QM has as a strategy for improving New Zealand residential construction productivity	
Manuscript title	Unlocking productivity: The power of quality culture in New Zealand housing. (Journal Article under review)	
Objective	**Research questions**	**Outputs achieved**
RO2. To establish the common factors that positively affect construction productivity in the New Zealand residential sub-sector	RQ2. What are the common factors that positively affect construction productivity in the New Zealand residential construction sector	Validation of the top factors for improving construction productivity in the NZ residential sector
RO3. To validate the effectiveness of a developed strategy for QM in residential construction	RQ3. How effective is the developed strategy for QM in the residential construction sector	This study empirically supports QM ISO 9000 and Lean implementation and PDCA as effective QM strategies

RO4. To validate the findings through expert assessment	RQ4. What insights do industry experts provide regarding the applicability and impact of the proposed QM strategy on residential construction practices	This study validates previous phase 1 findings on the effectiveness of QM as a productivity improvement strategy in the NZ residential construction sector
RO5. To suggest ways to improve construction productivity through QM strategies	RQ5. What QM strategies can be suggested for improving productivity within construction residential sector?	This study recommends productivity certification and training, enhanced QM practices, and gradual ISO 9000 and Lean implementation and PDCA

In concluding this study, it is imperative to acknowledge that, despite the significant insights gained, several areas warrant further investigation to fully realise the potential of QM in enhancing productivity in New Zealand's residential sector.

The oversubscribed micro-organisations within the construction sector dominate the industry profile are crucial to the residential sector. They provide a compelling avenue for future research on QM practices and system implementation, suggesting that valuable insights for tailored implementation strategies may exist. It is imperative to understand the unique challenges and opportunities faced by these organisations when adopting QM systems and practices.

Moreover, the rapidly evolving landscape of construction technology offers exciting possibilities for enhancing QM practices. Emerging technologies like robotics and Building Information Modelling (BIM), have enormous potential and warrant further investigation. These digital tools could transform how quality is managed and monitored throughout the construction process, potentially leading to significant productivity gains.

There is a pressing need to develop frameworks that effectively encourage the widespread adoption of QM practices within the industry. This requires collaboration among researchers, industry leaders, and policymakers to create regulations and incentives promoting a culture of quality and continuous improvement.

Longitudinal studies are necessary to fully understand the impact of QM on the construction sector and should aim to quantify the economic and societal impacts of widespread QM adoption in the residential construction sector and broader society. Future research could provide strong evidence to encourage more investment and commitment to QM practices, ultimately leading to improved housing outcomes for New Zealanders. Opportunities exist for future research that can build upon the foundation of this study, further advancing our understanding and application of QM in the construction industry. This ongoing exploration is essential for advancing the New Zealand residential construction sector toward greater efficiency, sustainability, and quality. The preceding chapter has outlined several promising avenues for future research stemming from the findings of this study. Building upon the foundational understanding of productivity challenges, Chapter 8, presents the abstract for a forthcoming paper. The paper details a qualitative inquiry into how QM serves as a pivotal strategy for simultaneously improving productivity and contributing to sustainable construction practices within the New Zealand residential construction sector, aligned with both national and global sustainability imperatives and the United Nations Sustainability Design Goals.

Chapter 8

Sustainable productivity in New Zealand residential construction: Role of quality management

Overview

This chapter introduces a contribution to the International Conference of Design+Green+Intelligent Built Environment in December, 2025 (GDI Conference 2025), which explores the critical nexus of QM, productivity, and sustainability within New Zealand's residential construction sector. Responding to the global imperative for sustainable construction practices, this research empirically demonstrates how strategic QM initiatives can simultaneously address persistent productivity challenges and advance key United Nations Sustainable Development Goals within New Zealand's climate change agenda.

Abstract

Persistent productivity challenges in the New Zealand (NZ) residential construction sector hinder national sustainability goals. This research addresses this critical issue, by investigating quality management (QM) as a pivotal strategy to enhance productivity and contribute to sustainable practices concurrently. The study provides a nuanced understanding of QM's role through a focused thematic reanalysis of qualitative expert interviews (N=15). It explicitly links specific QM principles and practices, such as process control and a culture of 'doing it right the first time', to resource efficiency, waste reduction, and alignment with the United Nations Sustainable Development Goals (UNSDGs).

Findings reveal QM's potential as a key enabler for sustainable performance, despite a persistent culture implementation gap. The paper concludes by presenting actionable insights for policymakers and practitioners, positioning QM as a ready-made framework for fostering a more productive, resilient and sustainable New Zealand built environment.

Keywords: Quality management, Sustainability, New Zealand.

This chapter is based on the following accepted Green + Digital + Intelligent conference

Kirby, M., Rotimi, F., & Naismith, N. (2025). New Zealand**.** *Sustainable productivity in New Zealand residential construction*: Role of quality management. GDI 2025: Auckland, New Zealand.

8.1 Introduction

The global construction industry stands at a critical juncture, navigating rapid urbanisation with an urgent imperative for environmental stewardship and resource efficiency (Ochoa et al., 2024). Within this context, productivity extends beyond mere output, intricately linking to responsible resource utilisation, waste minimisation, and environmental impact (Guo et al., 2021). New Zealand's residential construction sector exemplifies this tension, grappling with persistent productivity challenges that hinder national sustainability objectives, despite its role as a vital socio-economic engine (Domingo et al., 2024). This paper argues that QM, often underestimated in its broader implications, offers untapped potential as a pivotal enabler for sustainable construction; by fostering a 'doing it right the first time' culture, QM inherently drives down resource consumption, minimises waste, and enhances overall process efficiency (Small et al., 2021). Through qualitative expert interviews, this research comprehensively examines QM's effectiveness for advancing sustainable construction and improving productivity in New Zealand. The findings are consistent with national governmental objectives and explicitly link their practices to the UNSDGs, offering actionable insights for practitioners and policymakers.

This research makes several explicit theoretical contributions. Firstly, by leveraging a thematic reanalysis of existing expert interviews, the study provides a novel methodological approach to re-examining established datasets for new insights, demonstrating a robust strategy for leveraging existing qualitative data. Secondly, it bridges a critical gap by providing a context-specific framework. That links QM practices directly to New Zealand's unique residential construction challenges. Extending the current literature, which primarily focuses on generic quality systems and large-scale projects. Thirdly, it offers a conceptual bridge between the technical application of quality management and the holistic principles of sustainability. Moving beyond the simple cause-and-effect relationship to argue that QM is not just a tool for compliance, but a strategic enabler for achieving specific UNSDGs whilst improving productivity. Within a fragmented industry, it has reframed the understanding of QM from a reactive project-level function to a proactive systemic strategy for national-level climate action and improved industry performance.

8.2 Literature review

The global construction industry, a primary engine for economic development, presents a critical paradox in an era of urgent sustainability imperatives due to its substantial resource consumption, waste generation, and carbon footprint (Alaloul et al., 2021). Consequently, much research advocates for transformative approaches to conventional construction management, fostering a more sustainable built environment.

Globally, sustainable construction is evidenced by the increasing adoption of green building certifications, such as Leadership in Energy and Environmental Design (LEED) in the United States (Pham et al., 2020) and the Building Research Establishment Environmental Assessment Method (BREEAM) in the United Kingdom (Wong et al., 2024). Policies advancing energy-efficient designs and robust waste management , such as the European Union's Waste Framework Directive, promote circular economy principles that include strategies like design for deconstruction and material reuse, which directly support waste reduction (Iwuanyanwu et al., 2024; Macarthur & Heading, 2019). However, a critical disconnect persists; despite these significant advancements in policy and technology, the global construction industry still struggles with profound productivity challenges (Almatari et al., 2023). Project delays, cost overruns, fragmented supply chains, and poor quality mark these (Moshood et al., 2024), indicating a lack of a comprehensive integrated approach. The primary challenge thus lies in unifying these diverse initiatives into a unified strategy capable of concurrently addressing productivity and sustainability, a role we argue Quality Management is uniquely positioned to fill.

Traditionally, QM in construction focused on compliance and defect prevention (Small et al., 2021). However, robust QM systems offer significant, often overlooked, benefits for sustainability and productivity outcomes (Javed & Alenezi, 2023). By fostering a 'doing it right the first time' culture, QM inherently reduces rework, a major waste source and cost overruns, enhancing process efficiency, material wastage, and resource utilisation (Sobti et al., 2024). Methodologies like Lean principles and standardised QM systems like the ISO 9000 and Total Quality Management are cornerstones in directly improving productivity and reducing environmental impact by streamlining workflows and reducing waste (S. Hasan et al., 2024). This continuous improvement encourages innovation towards sustainable material choices and energy-efficient practices, with global evidence from ISO 9000 and ISO 14001 integration demonstrating reduced waste, energy consumption, and support for sustainability's 'triple bottom line' (Zhao et al., 2022).

QM's profound relevance to global sustainability is evident through its direct alignment with the UNSDGs. It serves as a valuable framework for impact evaluation (Cosentino et al., 2024). Effective QM contributes to SDG 11 (Sustainable Cities and Communities) by ensuring safe, affordable housing and sustainable urban planning (Target 11.1, 11.3, 11.6). Its focus on resource efficiency and waste reduction strongly supports SDG 12 (Responsible Consumption and Production), through sustainable resource management and waste prevention (Target 12.2, 12.5, 12.6). Prioritising quality in design facilitates improved energy performance, aiding SDG 7 (Affordable and Clean Energy - Target 7.1, 7.3) (Javed & Alenezi, 2023). Furthermore, QM drives innovation and sustainable industrialisation under SDG 9 (Industry, Innovation, and Infrastructure - Target 9.4, 9.b) by encouraging the adoption of new technologies and efficient processes (Alawag, Alaloul, et al., 2023; Lekan et al., 2020). This integrated perspective is further supported by Alawag et al., (2023) who provide a framework for implementing TQM in sustainable industrialised building systems (IBS), demonstrating how a focus on quality is a key enabler for transitioning to more advanced, efficient, low-carbon construction methods. Raouf & Al-Ghamdi, (2023) also highlight how a robust QM approach ensures durable, resilient, and high-performing sustainable buildings that extend beyond completion offering a framework to evaluate quality performance in green building delivery during both the construction and operational stages. Lastly, by minimising rework and improving material efficiency, QM tangibly reduces embodied carbon, directly supporting SDG 13 (Climate Action - Target 13.3), positioning it as a strategic tool for advancing global sustainability agendas (Almusaed et al., 2024).

The discourse on robust QM systems often extends to the Total Quality Management (TQM) philosophy, which offers a holistic framework for organisational-wide commitment to quality (Samson & Terziovski, 1999). TQM goes beyond defect prevention to integrate quality as a core strategic objective by emphasising continuous improvement, employee involvement and a customer-centric focus (Samson & Terziovski, 1999). The principles of TQM are particularly relevant to the construction industry, where they have been shown to enhance productivity, reduce rework and improve project outcomes by fostering a collaborative environment (Alawag, Alaloul, et al., 2023). However, despite TQM's theoretical appeal, empirical evidence suggests a disconnect between its academic prominence and its practical adoption in specific market contexts (Kirby et al., 2025b). In a local New Zealand residential sector study, survey data revealed significantly less acceptance of TQM principles in formal QMS than the more widely recognised ISO 9000 standards (Kirby et al., 2025b). While the present study focuses on the practical application of QM, our findings implicitly highlight the need for TQM's systemic approach. For instance, expert insights revealing a significant culture implementation gap and a lack of shared responsibility highlight a fundamental challenge in achieving the organisational-wide commitment to the central TQM philosophy. Therefore, while the data does not allow for direct analysis of TQM, its principles serve as a valuable lens to interpret industry struggles and the potential for a more integrated, quality-driven approach.

New Zealand's residential construction sector grapples with persistent productivity challenges, marked by delays, cost overruns, and notable quality deficiencies, exemplified by the 'leaky building' crisis (BRANZ, 2021). This crisis refers to a widespread failure of buildings, primarily those constructed in the 1990s to 2000s, to prevent moisture ingress, leading to extensive timber rot, mould growth, and significant health and financial issues for homeowners. The crisis is widely attributed to systemic failures in quality control, building design and regulatory oversight (BRANZ, 2021), directly demonstrating the profound long-term impacts of neglecting quality management.

This highly fragmented industry, dominated by micro-organisations, has seen a ‘productivity flatline’ since the 1980s, severely impeding the nation's capacity to deliver affordable, high-quality housing and meet climate targets (Ministry for Building and Construction, 2024). Recognising these issues, the New Zealand government has increasingly prioritised sustainable construction as a core economic and environmental strategy (Moshood et al., 2024). Key objectives include reducing embodied carbon, improving energy efficiency, and fostering low-emission buildings. However, broader adoption of initiatives like Homestar, a voluntary national rating tool that evaluates the performance of homes and sets standards for energy efficiency, waste reduction, and water use, remains unmandated across all residential construction (Ministry for the Environment, 2023).

Despite these governmental commitments and the acknowledged benefits of QM in reducing rework and enhancing efficiency, a discernible gap persists in the literature. There is limited explicit examination of how QM, beyond its conventional scope, can serve as a direct, measurable strategy to address New Zealand's specific productivity challenges while simultaneously driving its governmental sustainability objectives. QM's direct and quantified contribution to waste reduction, resource efficiency, and alignment with the UNSDGs within this unique, fragmented sector remains underexplored. This research, therefore, seeks to bridge this critical gap, providing forward-looking and actionable insights for local practitioners and policymakers.

8.3 Methodology

This study uses qualitative interview data from 15 New Zealand residential construction industry experts collected between August and November 2024. These existing transcripts were subjected to a focused thematic re-analysis using Braun & Clarke, (2006) a framework to investigate the interplay between QM and sustainable building performance within the sector. This approach allowed for an in-depth exploration of how QM can act as a catalyst for sustainable development, leveraging rich existing data relevant to these new analytical objectives. The original data collection employed purposive sampling to recruit professionals (N=15) with extensive experience across various roles (e.g. project manager, construction manager, general manager, site manager, subcontractors) within New Zealand's residential construction sector. Participants represented diverse organisational sizes and were drawn from major urban centres, including Auckland, Christchurch, and Wellington, ensuring a broad industry perspective. All original interviews were semi-structured; audio recorded with informed consent and transcribed verbatim. Participants were coded numerically (e.g., #1, #2, #3) to ensure anonymity while allowing for direct attribution of quotes within the findings, referencing their respective interview transcripts.

The thematic reanalysis followed Braun and Clark's (2006) six-phase process: familiarisation with data, generating initial codes, searching for overarching themes, reviewing and refining the data, defining and naming themes, and producing a final report. This inductive approach allowed new patterns and insights related to QM and sustainability from the existing dataset. Microsoft Excel v16.85 was used to assist in organising and managing the coded data (Bree & Gallagher, 2016). Established qualitative measures upheld the research's trustworthiness. While it's a re-analysis, the original data collection ensured ethical approval (AUTEC application #24/77), participant informed consent, and maintained anonymity and confidentiality. The re-analysis process prioritises participant confirmability by directly grounding findings in participant data and utilising researcher reflexivity to acknowledge and mitigate potential biases stemming from prior industry experience.

Several validation measures were implemented to ensure the trustworthiness of this reanalysis further. The researcher conducted regular peer debriefing sessions with a second independent academic expert to critically discuss the generated codes and emergent themes. This process provided an external check on the researchers' interpretations, enhancing the study's credibility and confirmability. Furthermore, a detailed audit trail was maintained, documenting coding decisions and the rationale for thematic development. This transparent documentation ensures the findings are directly traceable to the raw data, thereby strengthening the rigour of the analysis approach.

8.4 Results /Discussion

This section presents the thematic findings from expert insights into QM within New Zealand's residential construction sector, critically examining its intricate relationship with sustainability. The findings reveal three overarching themes: QM's potential as an enabler of sustainable performance, the persistent cultural and implementation gaps hindering QM's full impact and the strategic opportunity presented by QM's widespread recognition across stakeholders. These themes collectively demonstrate how QM practices, by driving efficiency, reducing waste, and fostering collaboration, can directly contribute to New Zealand's commitments under UNSDG 7 (Affordable Clean Energy), UNSDG 9 (Industry Innovation and Infrastructure), UNSDG 11 (Sustainable Cities and Communities), UNSDG 12 (Responsible Consumption and Production) and UNSDG 13 (Climate Action), despite the industry's ingrained challenges.

8.4.1 Quality management as a key enabler for sustainable building performance

The findings from expert interviews on QM in New Zealand's residential construction underscore its profound, albeit often indirect, contributions to global sustainable development (Table 8.1). By addressing fundamental issues of efficiency, design, and continuous improvement, QM directly aids New Zealand in meeting several UNSDGs commitments, particularly within a sector historically grappling with productivity, waste, and performance challenges.

Table 7.1: Quality management as a key enabler for sustainable building performance (Author's work)

Sub theme	Key findings	UNSDG and the New Zealand context
Holistic and strategic integration	Experts (#2-15) affirm QM as a **holistic strategy** integrating design and communication, enhancing infrastructure quality, sustainability, and resilience (Small et al., 2021). It fosters a **continuous learning culture** and **adaptive QM systems** (#6-10), enabling innovation (e.g., modular construction, sustainable materials) for a low-carbon housing future. QM also facilitates upgrading infrastructure and retrofit industries for sustainability and resource efficiency.	Critical for meeting NZ's Building for Climate Change (BfCC) targets and improving existing housing stock (Ministry of the Environment, 2023) Enhances (**UNSDG9.1)**", sustainability quality and resilience of infrastructure" (**UNSDG 9.1**) (Zhao et al., 2022). Facilitates "upgrade of infrastructure sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies" (**UNSDG 9.4**)
Proactive quality assurance and design for sustainability	QM emphasizes **"designed-in" quality** (#2, 4) and its **"core role"** (#2-15) in preventing poor designs and rework. This ensures new and renovated properties are "safer, resilient and sustainable" (#4,9,12). It also reduces on-site errors and waste (Small et al., 2021).	Paramount for NZ public health due to housing quality issues. Supports **UNSDG 11 (Target 11.3)**: "enhancing inclusive and sustainable urbanisation" through durable, healthy, energy-efficient homes. Advances **UNSDG 11.6**: reducing urban environmental impact and waste management.
Operational excellence through waste and defect reduction	Given NZ's high construction waste to landfill, QM is a direct **enabler of systemic efficiency and waste reduction**. Its focus on **preventing defects** and a **"do it right the first time"** approach (#6,7,9) minimizes energy and carbon from rework, material production, and waste transport. It promotes **"less rework"** and **"holistic process management"**, addressing the "take, make, dispose" mentality. "	Powerful contribution to **UNSDG 12 (Target 12.5),** "Substantially reducing waste generation through prevention, reduction, recycling and reuse." Aligns with **UNSDG 12 (Target 12.2)**: "The sustainable management and efficient use of natural resources." "Designed-in" quality also ensures efficient material specification (Alaloul et al., 2021).

Adaptive capabilities for sustainable innovation	QM's operational efficiencies and waste minimization directly **reduce embodied carbon** (Alaloul et al., 2021). Ensuring **"doing it right the first time"** (#6,7,9) cuts energy/carbon from rework. The **"adaptive nature"** of QM (#1,11) enables faster integration of low-carbon materials and energy-efficient building technologies (e.g., insulation, passive design)	Critical for meeting NZ's H1 Building Code changes and broader climate goals. Addresses **UNSDG 13 (Target 13.2),** supporting national commitment to "Integrate climate change measures into national policies, strategies and planning" for the built environment (Ministry for the Environment, 2023).
Empowered human capital and collaborative practice	QM empowers human capital and drives collaborative practice. Experts underscore it as a **"shared responsibility"** (#5,7,8) and fosters a **"collaborative environment"** and **"shared accountability"** (#9) among all stakeholders (#8,11). It integrates communication, training, supervision, and skilled workers, facilitating **"standardised processes"** (#6,11) and **"effective collaboration"** (#8,11) for a competitive workforce to implement sustainable specifications (Sobti et al., 2024)	Directly supports **UNSDG 4** (Quality education) and **UNSDG 8** (Decent work and economic growth) by fostering skilled, greener jobs. Addresses **UNSDG 17** (Partnership for the Goals) via enhanced stakeholder collaboration. Crucial for addressing NZ workforce fragmentation and skills shortages, enabling consistent sustainable building practices (Zhao et al., 2024)

8.4.2 The culture-implementation gap: Hindering QM's sustainable impact

Despite QM's recognised importance, expert insights have revealed a significant and widespread gap between its stated value and actual implementation within the New Zealand residential sector. Next, Table 8.2 presents key findings and a discussion on cultural and practical factors, such as the dominance of time and cost over resource limitations. These factors often lead to prioritising immediate concerns over long-term quality.

Table 7.2: The culture-implementation gap hindering QM's sustainable impact (Author's work)

Sub theme	Key findings	UNSDG and The New Zealand context
Dominance of time and cost over quality	A deeply ingrained industry culture prioritises **"time and cost over quality"** (#2,15) and a cost-first mentality. This, coupled with a lack of resources, implies quality and sustainability might suffer (#2). This is further substantiated by survey data in the local market which indicated while practioners value quality, the formal systemic approach of Total Quality Management holds less relevance and acceptance than the ISO9001 standards. This preference for a more , compliance based model over a holistic , philosophical one reinforces the notion the QM, though **"high in concept"**, remains **"aspirational in actual practice"** (#2,3,12), leading to persistent defects and impacting client satisfaction (#4,15) (BRANZ, 2021)	This implementation deficit impedes **UNSDG 12** (Responsible/ production consumption) by increasing waste. It undermines **UNSDG 11** (Sustainable cities/communities) through lower quality, less resilient homes (Ministry for the Environment, 2023). It impedes **UNSDG 9** (Industry, innovation/ infrastructure) by resisting sustainable development/ technology and contributes to **UNSDG 13** (Climate action) via unnecessary embodied carbon from rework a pervasive issue in NZ, where affordability/rapid delivery overshadows long-term quality/sustainability and waste.
Disconnect between	**A "disconnect between advocated values and actual practices"** creates a critical QM implementation gap. Experts (#1,2,3,10,12,15) deem QM **"vital**	This gap directly undermines **UNSDG 12** (Responsible consumption/production) via inefficiency/waste from defects and missed optimization (Target 12.2 & 12.5). It negatively impacts **UNSDG 11** (Sustainable cities/communities) as inconsistent quality leads to homes

aspiration and practice	**for successful residential construction,"** yet **"persistent defects"** conflict with this. Expert #3 states, "QM is viewed as important, actions on-site show otherwise." This sub-optimal application hinders QM's **"continuous improvement"** (#9,11), meaning **"quality is not always well managed"** (#12) and remains **"high in concept but average in actual practice"** (#2), leading to customers experiencing poor quality (#4,15) (Sobti et al., 2024)	lacking durability, resilience, and environmental performance (Ministry for the Environment, 2023). (Target 11.1 & 11.3). In NZ, this disconnect is a profound challenge: prevalent defects and the **"we can do better"** (#3) sentiment indicate systemic issues causing significant rework costs and waste, impede consistent delivery of high-quality, sustainable homes.
Resource limitations and competing priorities	Practical **resource limitations** and **competing priorities** significantly impede effective QM, contributing to its **"high in concept, but average in actual practice"** (#2) implementation (Small et al., 2021). Firms frequently lack necessary **"financial, skilled or technological resources"**. **"Immediate pressures of deadlines and budgets overshadow the longer-term benefits"** (#4,7) of robust quality and sustainability practices. This short-term focus creates **"competing priorities"** (#2), hindering investment crucial for QM (Sobti et al., 2024).	This hinders **UNSDG 9** (Industry innovation/infrastructure) by restricting sustainable technology investment. It affects **UNSDG 8** (Decent work/economic Growth) by limiting skill development. It negatively impacts **UNSDG 12** (Responsible consumption/ production) by preventing resource-efficient methods. NZ's residential sector faces skills shortages and capital constraints from pressure for quick, affordable housing (Paul et al., 2020), reinforcing this short-term focus and posing a persistent challenge to higher quality and sustainable outcomes.

8.4.3 Leveraging QM's widespread recognition as a catalyst for sustainable transition

Beyond the identified implementation challenges, the analysis reveals that QM possesses a unique strategic advantage in its widespread recognition among stakeholders (Table 8.3). This final theme explores how QM's inherent propinquity can be leveraged as a powerful catalyst for sustainable transition, fostering collective action and providing a pragmatic entry point for broader sustainable building initiatives.

Table 7.3: Leveraging QM's widespread recognition as a catalyst for sustainable transition (Author's work)

Sub theme	Key findings	UNSDG and the New Zealand context
High propinquity and stakeholder consensus	Experts (#1-15) confirm QM's **"high propinquity across most stakeholders"** (clients, regulators, contractors), driven by its **"cost-saving measure through defect reduction"** and role in meeting **"increasing demands for higher quality standards"**. QM's **"convergence of interests"** supports **UNSDG 17** (Partnerships for Goals) by creating shared sustainable development objectives. High QM propinquity implies foundational receptivity in the local context and a crucial basis for multi-stakeholder collaboration towards sustainable development.	In **New Zealand**, this primarily supports **UNSDG 12 (**Target 12.5, 12.2) and **UNSDG 17** (Partnerships for Goals- Target 17.6, 17.7) by leveraging broad consensus for waste reduction, efficient resource use, and effective multi-stakeholder partnerships. Critical for driving **NZ's climate action goals** through collaborative industry initiatives. Collective buy-in positions QM as a powerful enabler for driving cohesive industry-wide initiatives vital for **NZ's climate action goals** (Moshood et al., 2024).

QM as a framework for shared responsibility and collective action	**"QM is a shared responsibility"** (#5,7,8,11). It **"forces a collaborative environment"** (#5,7,8), cultivating **"shared accountability"** (#9,8,11) where all are **"invested in achieving quality outcomes."** Empirical literature (Wu et al., 2023) highlights the **"complex interplay between stakeholder management, project performance, and sustainability"**. This supports **UNSDG 17** (Partnerships for Goals) fostering interorganizational collaboration (Target 17.16 & 17.17) for construction sustainability goals. It also contributes to **UNSDG 9** (Industry innovation/ infrastructure) promoting an integrated/efficient industrial base (Target 9.1).	Crucial for **NZ's fragmented construction sector**. Fosters inter-organizational collaboration for complex sustainability goals, directly supporting **UNSDG 17** (Target 17.16 & 17.17) and contributing to **UNSDG 9** (Target 9.1) by promoting an integrated, efficient industrial base (Moshood et al., 2024).

8.5 Conclusion

This paper contends that QM is a pivotal, often undervalued, strategy for enhancing sustainable productivity in New Zealand's residential construction sector. Expert-led thematic analysis revealed QM's inherent capacity to drive resource efficiency, minimise waste, and align directly with critical United Nations Sustainable Development Goals. Despite this clear potential, a persistent culture implementation gap, prioritising short-term gains over comprehensive quality, currently hinders its full impact. Nevertheless, the research also identified a powerful leverage point, the near-universal acknowledgement of QM's value across all industry stakeholders. The implications for New Zealand are significant; however, transforming the residential construction sector into a more sustainable and productive powerhouse requires a fundamental perspective shift. QM provides a ready-made framework for this evolution. Policy makers should consider incentives that integrate comprehensive QM standards as a core component of sustainable building certifications. Simultaneously, practitioners must foster organisational cultures that view “doing it right the first time” as a core tenet of environmental stewardship. As a preliminary analysis from ongoing doctoral research, this study lays a vital foundation. Future work should explore the development and piloting of integrated QM sustainability frameworks, rigorously assessing their impact through longitudinal studies. This research compels a clear message: QM is not merely about building better, it is about building sustainably, efficiently and responsibly, paving the way for a modern, resilient built environment for Aotearoa.

8.5.1 Original contribution and realisation of aims, questions and objectives

This chapter presented a contribution to the GDI Conference 2025, functions as a critical bridge in the thesis, moving the discussion from the empirical identifications of problems to the strategic validations of solutions. It formally demonstrates the strategic significance of QM by linking it to national sustainability imperatives, thus providing powerful validation for the thesis overall aim.

The key contribution of this chapter is the empirical confirmation that QM practices are not merely an internal operational function but a strategic enabler for achieving specific UNSDG's (SDG 7, 9, 11, 12, 13, 17) within the New Zealand residential construction sector. By utilising expert validation (RO4), the chapter reframes QM as a foundational tool for climate action, providing essential evidence that addresses the sustainability dimension of the thesis aim.

The following table 8.4 summarises how the research and insights contained within this chapter specifically address the initial research objectives and research questions ensuring full realisation of the thesis aim

Table 7.4: Realisation of Thesis Research Objectives and Research Questions and Manuscript Outputs (Author's work)

Research aim	To determine what effect QM has as a strategy for improving New Zealand residential construction productivity	
Manuscript title	Sustainable productivity in New Zealand residential construction: Role of QM	
Objective	**Research questions**	**Outputs achieved**
RO1. To determine the characteristics of QM systems that may be suitable for use in the New Zealand residential construction sector	RQ1.What QM systems do residential construction organisations use to improve construction productivity?	Addresses the suitability of QM systems by confirming structured principles like ISO 9000 and the foundational nature of the PDCA cycle as the core applicable mechanisms for improvement
RO2. To establish the common factors that positively affect onstruction productivity in the New Zealand residential sub-sector	RQ2. What are the common factors that positively affect construction productivity in the New Zealand residential construction sector	Extends the prioritisation of QM as a factor. It assigns new strategic weight by demonstrating QM's dual role in driving economic productivity and sustainable outcomes.
RO3. To validate the effectiveness of a developed strategy for QM in residential construction	RQ3. How effective is the developed strategy for QM in the residential construction sector	Assesses QM effectiveness by identifying the major hindrance the "cultural -implementation gap" which prevents NZ from achieving sustainable productivity goals.
RO4. To validate the findings through expert assessment	RQ4. What insights do industry experts provide regarding the applicability and impact of the proposed QM strategy on residential construction practices	This study validates the strategic link between QM and sustainable performance and confirmed the existence of the implementation gap
RO5. To suggest ways to improve construction productivity through QM strategies	RQ5. What QM strategies can be suggested for improving productivity within construction residential sector?	Addresses the need for targeted strategies by boosting QM as a "ready-made framework" and offering actionable insights for policy makers and practioners to foster cultural shifts and structural adoption

The findings presented in this chapter establish the critical necessity of QM as a strategic response to New Zealand's dual challenge of poor productivity and sustainability. The observed cultural implementation gap (Chapter 8) confirms the structural misalignment that prevents the adoption of sustainable practices.

The subsequent Chapter 9 : Discussion and Synthesis of findings, moves beyond the contextual and strategic justification presented here. It will delve into a comprehensive discussion of all empirical results, interpreting their significance in relation to the existing body of knowledge, and systematically addressing the research objectives posed at the outset. Crucially Chapter 9 uses the cultural constraint identified here as the foundational problem to construct the Holistic Enhancement Model (HEM). This HEM formally represents the thesis primary original contribution by providing a validated, four-element strategic roadmap for the NZ residential construction sector. Ultimately, Chapter 9 solidifies a deeper understanding of the effect QM has in enhancing productivity by demonstrating how to achieve effective implementation against the persistent cultural and institutional barriers identified in this chapter.

Chapter 9
Discussion
Overview
This chapter provides a comprehensive synthesis and critical discussion of the research findings, moving beyond merely reporting to construct a unified argument on the effectiveness of QM in enhancing productivity within the NZ residential construction sector.

Drawing on the narrative literature review, empirical surveys, correlational analysis, mixed-methods investigation, TOC diagnosis, and qualitative expert interviews. This discussion systemically addresses the research objectives outlined in Chapter 1. The analysis reveals a systemic failure termed the "QMS paradox," driven by an intangible cultural constraint. The discussion culminates in the development and justification of the transformative framework termed in this research as the "Holistic Enhancement Model (HEM). The HEM provides the evidence-based solution to resolve this constraint, establishing the thesis dual theoretical contribution and setting the foundation for the conclusions and recommendations.

9.1 Fulfilment of the research aim
This research aims to determine the effectiveness of QM as a strategy for improving New Zealand residential construction productivity. To achieve this, five research objectives were established as follows:

9.1.1 Research objective 1: Critical review of QM systems and suitability
The New Zealand residential construction sector's persistent productivity challenges often impede efficiency and quality, highlighting an intangible problem that escalates housing affordability. These challenges hinder overall industry advancement, directly undermining the government's ambition for a sustainable and efficient construction sector. Recognising this critical need, this research rigorously investigates the effectiveness of QM as a pivotal strategy for enhancing construction productivity.

The review systematically synthesised common productivity-enhancing factors from existing literature, including materials, supervision, workforce skills, tools/equipment, communication, and, significantly, QM (Dixit et al., 2019; Hasan et al., 2018; Naoum, 2016). This comprehensive synthesis provides a critical overview of productivity drivers, identifying QM as a significant catalyst for improvement and laying essential groundwork for deeper empirical investigation into its specific role and effectiveness. Theoretically, this review contributes to the ongoing debate regarding the effectiveness of QM systems (Ahmed et al., 2014; Moatazed-Keani & Sechi, 1999; Yeung et al., 2003), emphasising that suitability is context-dependent and necessitating consideration of factors such as company size, culture, and resource availability.

This section addresses the first research objective, "**what quality management systems do residential construction organisations use to improve construction productivity**?" It critically examines the suitability of established QM frameworks for the unique context of the New Zealand residential construction sector, particularly its predominance of micro-companies. The foundational narrative literature review (Kirby et al., 2022) established that ISO 9000, Total Quality Management (TQM) and Lean Six Sigma (LSS) represented the core QM landscape potentially applicable to the local context. This initial mapping was crucial for benchmarking the sectors needs against global best practise (Dixit, 2019, Hasan, 2018, Nasir, 2016). While the literature review did not yield entirely contradictory findings regarding the potential of QM, its emphasis on the contextual suitability of TQM or ISO 9001 for the micro-company-dominated New Zealand market presents a nuanced insight.

Globally, LSS is lauded as a powerful data driven methodology for process improvement, waste reduction and defect prevention, integrating lean principles with the variability reduction focus of Six Sigma (Nascimento et al., 2019, Ruben et al., 2017; Talapatra and Gaine, 2019). However, this study argues that the NZ context represents a crucial theoretical boundary condition for QM adoption. While LSS may be feasible for large scale projects in resource-rich environments (Anderson and Kovach, 2014), its resource intensive nature presents a significant barrier to the micro-company dominated New Zealand residential sector. Thereby, challenges its contextual suitability (Shamsi and Alam, 2018; Albliwi et al., 2014). Critically, the need for significant commitment, employee empowerment, and adaptation to complex cultural elements are cited as universal barriers to successful implementation (Francescatto et al., 2022; Galli and Kaviani, 2018).

This research contends that imposing such complex heavy frameworks leads to resistance and potential failure, making LSS incompatible with the principle of contingency theory. Contingency theory dictates that the effectiveness of any QM system must be contingent upon organisational size, resource availability, and specific industry structure (Green, 2016; Ibrahim,2024). This strategic assessment must be viewed alongside the philosophical objectives of each framework, while the primary goal of LSS is to achieve a breakthrough process improvement with measurable financial results (Ruben et al., 2017; Talapatra and Gaine, 2019). TQM focuses on pervasive cultural change for overall customer satisfaction (Arhin and Cobblah, 2024; Kristianto et al., 2012). Whereas ISO 9000 aims to establish a standardised certified QM system (Dissanayaka et al., 2001; Chini and Valdez, 2003). Given that, the persistent productivity issue in New Zealand is considered rooted in a deep-seated cultural constraint. Philosophical alignment of TQM is deemed far more relevant than the aggressive process optimization focuses of LSS for the sector.

Considering this, the study asserts that the lower barrier frameworks of TQM and ISO 9000 are the optimal strategic foundation for the NZ residential sector. The crucial structural integrity provided is necessary to standardise key processes and eliminate the ad hoc practises common in smaller firms. This adherence to an internationally recognised standardised framework offers a tangible path for establishing a consistent approach to quality improvement (Kirby et al., 2025c). Furthermore, the philosophical flexibility of TQM focusing on customer satisfaction and continuous improvement, allows the sector to prioritise necessary cultural change without the heavy financial and time burden of methodologies like LSS. Therefore, the initial empirical work concluded that strategic framework must be built upon the integration of TQM's cultural philosophy and the structural feasibility of ISO 9000 standards.

The choice between ISO 9000 and TQM as a structural organisational framework is resolved through industry dynamics and is justified by the contingency theory argument regarding its feasibility for micro firms (Green, 2016). In a micro-dominated construction sector, ISO 9000 provides a structured certifiable framework for quality that is cost effective, thus smaller firms can adopt incrementally (Chini and Valdez, 2003; Corbett et al., 2005). Most importantly it aligns with existing national quality systems (AS/NZS ISO 9000:2016). While TQM requires a deeper cultural transformation and long-term commitment that is harder to sustain in a fragmented, resource constrained industry (Moatazed-Keani & Sechi, 1999). Indeed, studies suggest that TQM success depends on embedding a "quality culture" throughout all levels of the organisation, with high commitment human resource strategies playing a critical moderating role (Bou and Beltrán, 2005; Raj and Attri, 2010).

Kirby et al., (2025a) provides insight into the deeply embedded resistance and demographic disparities revealed in the correlational analysis. Without this cultural mandate, the implementation of any structural solution is limited in its effectiveness. This integration is further essential as QMs holistic focus on process approach directly translates to reductions in material waste and reworks fulfilling both productivity aims and the national sustainability mandate (Chapter 8).

This objective was fulfilled by establishing the theoretical boundary conditions of QM adoption in the in New Zealand context. A crucial review, guided by contingency theory, confirmed the unsuitability of the resource intensive LSS methodology due to the financial/structural constraints of micro-firms. The review strategically identified ISO 9000 as the preferred structured base due to its certifiable nature and low barrier to entry but concluded that TQM's focus on culture was essential, leading to decision to integrate "cultural philosophy" with the ISO 9000 structure for the final strategic framework.

9.1.2 Research objective 2: Empirical validation of productivity factors

Building upon the foundational understanding of QM systems established in RO1 (Kirby et al., 2022), the subsequent empirical study (Kirby et al., 2024) utilised the Henry Garrett ranking technique to validate and prioritise key productivity enhancing factors within the local context.

This section addresses the second research objective, "**What common factors positively affect construction productivity in the NZ residential construction sector?"** It synthesises the empirical validation of key productivity drivers with nuanced correlational insights regarding demographic constraints, revealing that the effectiveness of QM is contingent not just on system design but on human capital factors (Kirby et al., 2024, 2025a).

Building upon the foundational understanding of QM systems established in the subsequent empirical study (Kirby et al., (2022), Kirby et al., 2024 utilised the Henry Garrett ranking technique to validate and prioritise key productivity-enhancing factors within the local context (Asadi et al., 2021; Manikandan & Vidhya, 2023). This analysis empirically revealed that industry professionals identified adequate design, communication, QM, adequate supervision and organisational training as the top five factors positively influencing productivity in the local context (Kirby et al., 2024). Notably, QM was rigorously validated as a top three productivity driver, elevating its significance beyond theoretical discussion to a pivotal practical lever for industry and government (Kirby et al., 2024). Crucially this research extends the traditional definition of a productivity factor. By reducing defects and rework, QM rigoursly validated itself as a core factor for both economic and environmental sustainability, as demonstrated by its direct impact on waste and resource efficiency (Chapter 8).

Furthermore, the research reinforces the interconnectedness of productivity factors (RO2), advocating for an integrated approach to strategically combine QM with communication, skilled labour, and governance initiatives to maximise effectiveness (Durdyev and Mbachu, 2017; Rehan et al., 2024). This finding aligns strongly with existing literature, underscoring that robust quality practices alongside investment in skills and knowledge are essential for project success (Ahmed et al., 2014; Tezel et al., 2021). The prioritisation of these factors, 60% of which are addressable at the project level, challenges traditional views by suggesting that addressing the high-ranked organisational and project level interventions could directly mitigate issues like a lack of skilled workers, which ranked much lower. By identifying the top five productivity improvement factors, this research offers clear, evidence-based findings that provide industry practitioners and policymakers a roadmap or practical guide that enables a strategic focus of efforts and investment in areas that can yield immediate impact, enhancing the sector's performance and competitiveness (Androwis et al., 2018; Ibrahim, 2024; Jimoh et al., 2018).

However, the effectiveness of this validated set of drivers is immediately complicated by the human element. A subsequent correlational analysis (Kirby et al., 2025a) investigated the influence of demographic variables on the adoption and perception of QM practices, revealing the systemic barriers that constrain practical implementation. These findings (Kirby et al., 2025a) exposed significant demographic disparities.

Firstly, a positive association highlighting a generational resistance was observed between age and the tendency to prioritise time and cost over quality, suggesting that older professionals may adhere to a short-term viewpoint that hinders effective QM adoption for long term productivity improvement. This association manifests its drag on productivity on site as “work as done” and “work as imagined” (Kirby et al., 2025b).

Secondly, a moderate positive association exists between industry experience and the use of ISO 9000 standards, asserting that experienced professionals are more likely to adopt and successfully implement formal QM practices. Aligning with empirical research from (Tang and Kam, 1999; Beck and Walgenbach, 2005; Singh et al., 2006; Erel and Ghosh, 1997; Chini and Valdez, 2003; Yeung et al., 2003) who all confirm that industry experience shapes adoption decisions and influences ISO 9000 outcomes in various environments, including construction.

Finally, negative correlations were identified between occupational groups, QM practices, and productivity as a strategic policy. Specifically, an increased focus on QM practices have an inverse effect on perceptions and/or adoption suggesting a resistance that potentially stems from differing priorities, age groups, aversion to change, or inadequate training. Highlighting implementation challenges across diverse stakeholder groups (Green, 2016; Ibrahim, 2024). Kirby et al., (2025a) confirms that cultural factors could undermine the efficacy of QM in terms of boosting productivity. Indeed many studies suggest that occupational group differences, in terms of workloads, stress and burnout, psychological factors and work environment, all play a significant role in shaping quality outcomes across work settings (Cao et al., 2024; Brighenti-Zogg et al., 2016; Lounsbury et al., 2004; Hughes and Dodge, 1997;

Noblet, 2003). Thus, tailored interventions considering occupational groups characteristics can enhance quality, productivity and well-being.

This synthesis confirms that while the industry acknowledges the strategic value of factors (RO2 fulfilled), particularly QM, the path to successful industry implementation is not homogeneous. Aligned with empirical research (Jimoh et al., 2018; Small et al., 2021), the importance of QM is established. However, the findings illuminate a significant challenge, the imperative to leverage the experience of senior personnel who value structure (ISO 9000) must be balanced against the pervasive generational and occupational resistance (Kirby et al., 2025a). This complex interplay between validated factors in human capital constraints underscores the need for tailored multifaceted QM strategy requirement that directly informs the subsequent diagnostic phase of this research (Green, 2016; Ibrahim, 2024). Therefore, it is crucial to promote an organisational culture with a well-balanced perspective of quality, time, and cost, that also incorporates specific and targeted approaches that cater for the demographic differences.

Addressing these differences will help resolve the varying perceptions of QM and could unlock significant gains in residential construction efficiency. Leading to improved housing affordability and overall socio-economic well-being. The critical role of human capital in successful QM implementation (RO2), echoes previous research emphasising workforce development (Umair et al., 2024).

9.1.3 Research objective 3: Develop and assess a QM–based strategy

Following quantitative investigations into productivity factors and demographic influences on the adoption of QM, Kirby et al. (2025b) employed a mixed-methods approach to gain deeper insights into the perceived effectiveness of specific QM strategies for productivity improvement. The findings indicate that a multifaceted approach, integrating both quantitative and qualitative insights, is necessary to address persistent industry challenges. Specifically, this study identified the potential for an industrywide productivity training programme and gradual implementation of ISO 9000 standards to drive improvements, offering actionable recommendations for policymakers, industry leaders and construction organisations to improve productivity and operational efficiency.

This section addresses the third research objective which is to **develop and assess a QM based strategy for improving productivity in New Zealand residential construction**. This critical phase of research moved beyond the empirical validation of QM factors to initiate the strategies development, by first diagnosing the root cause of the persistent implementation gap (Kirby et al., 2025b). The studies emphasis on QM as a primary driver rather than a secondary consideration challenges the traditional industry mindset that prioritises time and cost over quality (Fuller et al., 2021; Gunduz & Yahya, 2015; Jaafari, 1996). Despite empirical evidence affirming QM as a top productivity driver (Kirby et al., 2024), its effectiveness remains severely constrained by persistent resistance tied to demographic disparities (Kirby et al., 2025b). To resolve this systemic failure, and inform the strategic design, the research adopted the Theory of Constraints (TOC) a rigorous analytical lens to isolate the non-physical bottleneck hindering systemwide productivity (Goldratt, 1984).

The TOC suggests that total system throughput can only be improved when the core constraint is resolved. The application of the TOC revealed that the root cause of the productivity crisis was not a tangible issue such as inadequate tools, supervision or training, but rather an intractable cultural constraint that has "hyper-normalised substandard practices" (Kirby et al., 2025b). This finding has profound implications that transcend pure economics. The cultural constraint, the time and cost over quality ethos, is currently diagnosed as the single largest non-technical barrier to meeting New Zealand's climate change and waste reduction targets. Each incidence of rework caused by poor QM generates unnecessary material consumption and embodied carbon, directly impeding UNSDG 12 for waste minimisation (Chapter 8).

This constraint stems from a pervasive, underlying misalignment between organisational strategy and execution at the project level, defined in this research as the "QMS Paradox." The paradox is a profound disconnect between management's "Work as imagined (where QM is perceived as a strategic investment) and "Work as done" (where workers use pragmatic cost focused approaches over formal QM practises). This disconnect is due to the perception of QM as an additional task and bureaucratic process (Rostami et al., 2015; Sahoo, 2019). The paradoxical finding was exemplified by data in this study showing only 20% of survey respondents considered ISO 9000 standards as the most effective strategy, and only 25%. considered the QM systems fit for purpose. Identifying a need for education around QMS (ISO 9000) purpose and intent. Of note participants did not consider cost as a barrier to implementing a QMS (Kirby et al., 2025b).

This diagnosis confirms that simply advocating for adoption of ISO 9000 is insufficient, without a fundamental cultural shift and targeted interventions to realign industry perspectives, mindsets and practises. Crucially the persistence of the cultural constraint is directly attributable to a decades long policy vacuum created from a mid 1980s government shift towards deregulation and "free market economy" moving away from national support for quality. It left industry in a "hands off, self-regulated," model that has institutionalised a culture that prioritises "time and cost over quality", we still see today. Therefore, the strategic imperative derived from this TOC diagnosis is dual. Improving productivity and addressing the sustainability failure caused by this same deep seated cultural misalignment.

The analysis highlighted the necessity of integrating QM practises such as ISO 9000, Lean principles and the Plan, Do Check Act cycle across project, organisational and policy levels (Fuller et al., 2021; Gunduz & Yahya, 2015; Jaafari, 1996). However, for the resulting strategy to be effective it must incorporate a "strong quality culture" (RO1). The strong quality culture in this study, is the behavioural and mindset shift needed before any improvement to the system can be sustainable. The study's emphasis on QM as a primary driver challenges the traditional industry mindset that prioritises time and cost over quality aligning the New Zealand residential construction sector with global best practice for long-term sustainable growth (Fuller et al., 2021; Gunduz & Yahya, 2015; Jaafari, 1996).

The strategic imperative derived from this TOC diagnosis strongly suggests that productivity improvement must be elevated to a national priority to facilitate the necessary cultural change through improved training, incentivisation, government support, and industry collaboration. Transcending political cycles to facilitate the necessary cultural change. This definitive diagnosis of the strategic bottleneck provides the essential context for developing the effective targeted solution, the transformative framework (HEM) which is addressed in the subsequent synthesis of findings. This novel perspective challenges the conventional wisdom, indicating that a more comprehensive, culturally embedded approach to quality may be more impactful.

The practical relevance and impact of the strategies identified are further underscored by their early recognition notably, their promotion in the Property Foundations February 2025 newsletter (Property Foundation, 2025). This external validation confirms the timely and actionable nature of the findings, which provide the essential context for developing an effective, targeted solution, addressed in the subsequent synthesis of findings.

The key findings from Kirby et al. (2025b) have significant implications for the New Zealand residential construction industry within the broader field of construction management, particularly in understanding how to effectively implement QM for productivity gains. The focus on addressing the strategic bottleneck (the cultural constraint) provides the context for developing an effective, targeted solution, which is addressed in the subsequent synthesis of findings

9.1.4 Research objective 4: To validate the developed strategy- expert consultation

This section formally addresses RO4 by detailing the expert consultation phase (Kirby et al., 2025c), which was essential for establishing the perceived effectiveness, practicality and feasibility of the emerging transformative framework (HEM). The fulfilment of RO4 was achieved through the final qualitative phase (Kirby et al., 2025c) which used in depth expert interviews (N=15) to gain a conceptual corroboration of the strategic components.

The expert consultation process directly evaluated the effectiveness and applicability of key QM strategies relative to the transformative frameworks design. Expert consensus affirmed the theoretical soundness and alignment of the proposed solution within the New Zealand context. particularly the low barrier entry requirements suitable for micro-firms.

Aligned with empirical research, the key conceptual collaborations included the studies **cultural focus** (Jaafari, 1996; Lapidus et al., 2024). The novel emphasis on prioritising a "strong quality culture" was conceptually affirmed by experts as the necessary behaviour and mindset shift required for sustainable improvement. It directly addresses the intractable reactive "time and cost over quality" cultural constraint within the industry as identified via the TOC analysis (Kirby et al., 2024b).

The choice of ISO 9000 as the structural core QMS framework was validated by expert consensus aligning with the contingency theory argument regarding its feasibility for micro-firms (Taylor and Taylor, 2013; Raymond and Bergeron, 2008; Macca et al., 2024). Experts endorsed ISO 9000 for its cost effectiveness, structured certifiable framework and alignment with national standards, which contrasts favourably with TQM's higher demands for cultural commitment (Kirby et al., 2025c).

Experts confirm the lean principles emerged as top-rated strategy for improving productivity due to its focus on waste minimisation and efficiency in resource constrained micro-organisations (Cairampoma-Caro et al., 2022). This expert endorsement of Lean principles strongly corroborates the findings of Chapter 8, which affirmed that QM's focus on defect and waste reduction makes it a direct enabler of sustainable building performance. By reducing nonvalue adding activities, Lean principles help resource constrained micro-organisations optimise their limited resources (Likita et al., 2023; Kulakov et al., 2023).

Similarly, the PDCA cycle was affirmed as a highly effective mechanism for continuous improvement, supporting its role as the dynamic engine of the transformative framework (Lundkvist et al., 2014). Aligned with empirical research, PDCA has demonstrated measurable improvements in quality and efficiency, such as reduced errors and defects, supporting its general suitability for resource constrained settings like micro-organisation firms (Isniah et al., 2020; Kholif et al., 2018; Chen et al., 2020).

Experts also offered vital critical assessment, expressing concerns about systems like "Conqa" suggesting it lacks the ability to analyse a defects root cause, thus, cannot reduce defects (Kirby et al., 2025c). Aligning with various studies suggesting that software alone cannot resolve to ensure quality is successfully managed (Liberatore et al., 2001; Özkan and Mishra, 2019). Much debate between experts around the applicability of Inspection Test Plans (ITP) for improving productivity. The experts deemed the use of (ITPs) as not applicable to the residential sector, thereby providing nuanced feedback on specific tools and software for quality control (Kirby et al., 2025c). This aligns with a recent study on best practises and challenges of project management software, suggesting project leadership and processes can limit software performance (Menon, 2024).

These findings provide the necessary evidence to fulfil RO4 by assessing the perceived effectiveness and practicality of the developed strategy.

9.1.5 Research objective 5: Propose evidence-based QM strategies for improving productivity

This section fulfils R05 to propose an evidence-based QM strategy for enhancing New Zealand residential construction productivity. The emergent transformative framework termed the Holistic Enhancement Model (HEM), is the strategic recommendation synthesised from four preceding research objectives, designed as a comprehensive, evidence based and expert corroborated solution to the QMS paradox. The HEM is not a single system, but a multidimensional strategy designed to achieve pervasive cultural change and permanently realign “Work as imagined with Work has done.” Offering a complete mechanism to sustainably improve New Zealand residential construction productivity.

The HEM comprises four interconnected and evidence-based components with the argument for each being grounded in the preceding research findings.

The first element is the TOC diagnostic lens (RO3) which is the frameworks primary mechanism. The initial application of the TOC lens provides the strategic function of identifying the constraints within the broader system (Kirby et al., 2025b). This diagnostic step is mandatory for ensuring the framework remains adaptive and permanently focuses resources on the critical bottleneck (Goldratt ,1984; Vasudevan, 2021). Its primary purpose is to ensure the identification of the most limiting factor (Goldratt, 1984) enabling maximum system throughput (e.g. building more affordable quality housing on time and to budget).

Element 2 is the “strong quality culture” (RO2). Identified in this research as the required cultural change, this forms the foundation of the framework, representing the necessary behavioural and mindset shift required before any improvement can be sustainable and effective (Kirby et al., 2024b). This element directly addresses the intractable cultural constraint identified through the TOC analysis, which is highlighted as the key imperative for change in this research (Kirby et al., 2025c). Therefore, developing a quality culture that includes worker engagement and specific training is vital for effective QM and improvement in construction projects (Jaafari, 1996; Lapidus et al., 2024).

The third Element is the ISO 9000 QMS framework combined with Lean principles (RO1). This provides the structural integrity and processes required to guide daily site works. The ISO 9000 standards provide the scaffolding for documentation and process control (Bajjou et al., 2019). While the integration of Lean principles translates these controls into efficient daily site practises, (e.g. waste reduction and improved flow). This dual integration makes the "strong quality culture" tangible and operational, moving it from an abstract goal to an embedded routine (Sá et al., 2020). Furthermore, the structural integration provides verifiable pathway for industry to move toward sustainable reporting, translating efficient quality control into documented reductions in waste and resource uses that align with national climate goals. Several studies suggest that the combination of ISO 9000 and Lean principles forms an effective structural and procedural foundation that can guide and improve daily operations improving quality and efficiency (Chiarini, 2011; Sá et al., 2020). Aligned with empirical research this study affirms the crucial role of QM and supporting standardised systems like ISO 9000 (Small et al, 2021). The strong endorsement of standardised QM systems by industry experts (in this study) such as ISO 9000 (Kirby et al., 2025c), further strengthens the broader argument and highlights the effectiveness of QM as a key strategy for enhancing New Zealand residential construction productivity.

Experts in this study agree (element 4), the Plan-Do-Check-Act (PDCA) cycle as a highly effective approach for enhancing New Zealand's residential construction productivity, consistent with empirical research (Lundkvist et al., 2014; Nguyen et al., 2023; Rajagopalan, 2020). This element serves as the dynamic engine for the continuous improvement critical for operationalising change. It ensures that any constraint identified and removed from the system remains external, providing the necessary system stability and adaptive capacity to manage the high variability inherit in the residential construction environment (Chen et al., 2019).

Empirical research highlights the link between ISO 9000 and PDCA and determines the PDCA cycle as a key construct that leads to better business performance, confirming PDCAs role as a driver of sustained quality enhancements (Chen et al., 2019; Isniah et al., 2020).

9.1.6 Comparative advantage and theoretical extension

The HEM represents a significant theoretical and practical extension of conventional QM frameworks, specifically addressing their limitations within the context of fragmented micro-organisations dominated sectors.

This framework resolves the ISO 9000 versus TQM dilemma by leveraging the strengths of both. While ISO 9000 alone enforces compliance and TQM promotes general improvement, neither successfully anchors cultural change in resilient daily practise without deliberate efforts to manage cultural dynamics in organisations (Gotzamani et al., 2006: Kuo et al., 2009; Magd and Curry, 2003; Sun, 2000). The ISO 9000 provides the structural scaffolding and TQM's philosophy is embedded through the "strong quality culture."

Crucially, the HEM explicitly shifts the industry from reactive QM (fixing defects after they occur) to proactive QM (anticipating and preventing issues), moving QM from compliance or vague philosophy to a resilient operational industry wide system. The inclusion of the TOC ensures cultural attention is directed towards systemic bottlenecks, not just compliance (Goldratt, 1984). This creates a mindset where workers are trained to see constraints as external to the system, a critical shift that reduces the "blame culture" and fosters the collective problem solving necessary for sustained productivity gains (Parker and Davies, 2020).

Thus, the HEM offers strategic evidence based, expert corroborated solution, positioning QM as the unified strategy for achieving both high productivity and environmental sustainability, thereby providing the necessary mechanism to fundamentally improve New Zealand's residential construction productivity and fulfilling RO5.

9.2 Chapter summary

Chapter 9 synthesised the empirical data and applied TOC to diagnose the root cause of the productivity crisis is the cultural constraint concluding with the development of the corroboration of the Holistic Enhancement Framework, this discussion chapter consolidates this research journey, formally summarising the achievements, itemising the contributions to knowledge, outlining the limitations and defining a clear trajectory.

Through an in-depth discussion across 6 research papers, this research thoroughly addresses the research objectives, questions and overarching research aim. It offers innovative, context-specific insights that advance academic understanding, providing a solid background for further academic inquiry. Additionally, this research lays a foundation for industry and policy initiatives that can enhance New Zealand's residential construction sector.

Regardless, interpreting these findings requires careful consideration of the research's inherent limitations.

9.3 Limitations

This section critically appraises the inherent limitations associated with each methodological stage of this research. It acknowledges the potential factors that may influence the interpretation and generalisability of the findings

The literature review Kirby et al. (2022) presented in this study has several limitations that should be considered when interpreting the findings and implications. Firstly, the review is narrative, synthesising existing research rather than presenting new empirical data. While this provides a solid foundation for understanding the potential role of quality management in improving construction productivity, it does not offer a definitive assessment of the current practices and effectiveness of different quality management systems within the New Zealand residential construction sector. More in-depth, context-specific investigations would be needed to expand upon the insights generated here. Additionally, the review acknowledges that the research on how quality management affects New Zealand residential productivity at the organisational level is relatively limited, with Hwang et al. (2020) noting that 'few have quantified how quality affects productivity.' This highlights a key gap in the existing literature that the current study cannot address conclusively from a global perspective. Further empirical research would be required to establish the impact of strategic quality management initiatives on construction productivity outcomes.

Another limitation is the scope of the review, which is focused solely on the New Zealand residential construction subsector. While this provides valuable insights for that specific context, the findings may have limited generalisability to other construction sectors or international settings. Expanding the research to examine quality management and productivity across a broader range of construction activities and geographies could provide beneficial insights. The narrative review offers a summarised overview of the current knowledge but does not generate new data. To address this limitation, incorporating additional data sources, research methods, and analytical techniques like the systematic literature review method (SLR) could deepen the understanding of the topic and provide a more comprehensive evaluation.

In summary, this literature review establishes a crucial foundation for further research into the strategic role of quality management in enhancing construction productivity, particularly within the New Zealand residential sector. However, the limitations outlined above suggest that continued, more in-depth investigations will be crucial to fully unlock the potential benefits and validate the practical implications of this management approach.

While the earlier narrative literature review (Kirby et al., 2022) offered a valuable synthesis of existing knowledge. In contrast, the later study by Kirby et al. (2024) sought to address research gaps through primary data collection, also acknowledging its inherent limitations.

Kirby et al. (2024) acknowledges several limitations that may impact the study’s results: The focus on the New Zealand residential construction sector and the relatively small sample size

(N=106) could restrict the generalisability of the findings to other regions or areas within the construction domain. The distinct characteristics of the residential sector in New Zealand may differ from those in other countries, potentially impacting the importance assigned to ranked productivity improvement factors. The study's reliance on self-reported data can lead to inaccuracies. Participants' perceptions and experiences may not fully align with objective measures of productivity, and various personal or organisational factors could influence their responses.

However, some factors, such as economic conditions, regulatory frameworks, or broader industry trends, fall outside the scope of this study. Nonetheless, it is acknowledged that these external elements might impact the assigned importance of productivity enhancement factors.

The Garrett ranking technique successfully prioritised productivity improvement factors, however, limitations exist. Limitations like the potential masking of the underlying complexities of relationships and interdependencies with other variables as well as the study's reliance on closed-ended questions, both of which might omit vital insights that could add nuanced perspectives to the research findings.

Despite these limitations, the study offers a valuable springboard for future research. Exploring these limitations through larger-scale, multi-country studies that incorporate objective productivity measures and include open-ended questions could significantly enhance and broaden the understanding of the factors that improve construction productivity within the New Zealand residential sector and in other contexts.

The subsequent study that investigates the influence of demographic variables on quality management and productivity (Kirby et al., 2025a) also recognised limitations in its methodological approach. Limitations are twofold, firstly the reliance on self-reported data might introduce bias in participant responses and the smaller sample size limits generalisability.

Future research should offset these limitations through a larger sample size and increased diversity of the sample profile. The study's focus on quantitative analysis, while effective, is narrow. Therefore, incorporating qualitative methods that explore human behaviour could yield more profound insights. Another potential limitation is the cross-sectional nature of the data, which captures a snapshot in time. Conversely, longitudinal studies will offer greater insights in tracking changes in perceptions and adoption of quality management systems, and productivity outcomes.

Aligned with empirical literature, the study provides valuable evidence-based insights for industry and organisations. The findings highlight specific strategies related to the critical element of human capital and its subjective aspects. Specifically, clear demographic evidence that can be leveraged in tailoring the implementation of quality management strategies in the New Zealand residential sector.

Despite these limitations, the study provides valuable insights into the complex interplay between demographic characteristics, quality management, and productivity enhancement in the New Zealand residential construction sector. The findings align with the existing body of research and offer important nuance, further underscoring the necessity of a multifaceted approach to productivity improvement, considering the diverse demographic landscape of the New Zealand residential construction workforce.

To gain a more comprehensive understanding of productivity improvement strategies, integrating both quantitative and qualitative perspectives, the research next employed a mixed-methods approach in Kirby et al. (2025b). This study built upon insights from the correlational analysis of demographic factors and their influence on quality management and productivity (Kirby et al., 2025a). The subsequent phase of this research (Kirby et al., 2025b) focuses on exploring specific strategies and interventions that could be implemented to enhance productivity within the New Zealand residential construction sector. The mixed-methods approach employed by Kirby et al. (2025b), provides a richer and more comprehensive understanding of productivity improvement strategies. However, as in most research, limitations exist.

For instance, a reliance on self-reported data from a relatively small sample of 106 participants raises the potential for non-response bias. Additionally, limitations such as response rates, specifically the difficulty to track them effectively in online surveys may affect the results validity and generalisability. The interpretive process used in thematic analysis of data, potentially provides a subjective interpretation of researchers' perspectives and experiences, limiting its application. The study’s focus is on the unique characteristics of the New Zealand residential sector. It provides a localised focus on characteristics thought to improve productivity. However, the researchers caution that findings may be limited in other contexts. The researchers have implemented measures to reduce potential biases by ensuring the sample accurately reflects the industry's diversity and validating the self-reported data with additional sources where possible.

Conversely, the study's mixed-methods approach helps enhance the findings’ overall validity and reliability. Ultimately, the study's limitations do not undermine the significance of its contributions. The insights and recommendations provided continue to serve as a valuable reference for policymakers, industry leaders, and construction organisations in New Zealand, and may inform future research in other construction sectors and regions.

Building upon the identification of potential productivity improvement strategies Kirby et al. (2025b), the research sought deeper perspectives and validation from industry experts through a qualitative investigation (Kirby et al., 2025c). Qualitative results provided enriched insights into the effectiveness of quality management strategies. However, it also revealed specific limitations inherent in qualitative research methodologies. The study has several limitations that should be considered when interpreting the findings.

While findings provide invaluable insights at a local level, the effectiveness of quality management strategies may vary in different geographic regions or construction domains. Local characteristics, like the regulatory environment, industry structure, and cultural factors, may not be applicable to other contexts when applying the study's findings. Local characteristics, like the regulatory environment, industry structure, and cultural factors, may not be applicable to other contexts when applying the study's findings. The research focuses on quality management as a means to improve productivity. However, this perspective may overlook other important factors, such as the impact on project quality, safety and environmental sustainability. Future studies could benefit from a more comprehensive evaluation of how quality management impacts various performance metrics within the construction industry.

Despite its limitations, the study presents an analysis that offers a deeper and more comprehensive understanding of quality management and its role in enhancing productivity within the New Zealand residential construction sector. The findings lay a solid foundation for future research and industry development, potentially guiding the strategies and practices of organisations, policymakers, and industry stakeholders in similar contexts.

9.4 Chapter synopsis

This chapter has provided an enlightened discussion of the research findings across five interconnected studies (Kirby et al., 2022, 2024, 2025a, 2025b, 2025c), systematically evaluating the effectiveness of QM as a strategy to enhance productivity within the New Zealand residential construction.

The work progressed from providing a foundational basis via a narrative review (Kirby et al., 2022) to empirically confirm key factors positively influencing productivity (Kirby et al., 2024). The research then examined the impact of demographic variables and perceptual barriers on QM adoption (Kirby et al., 2025a, 2025b) positioning QM as a key driver.

Crucially, the research applied the Theory of Constraints (TOC) to diagnose the root cause of the productivity crisis as the cultural constraint (Kirby et al., 2025b).

Finally expert consultation corroborated the significance of QM and emphasised the emerging importance of a “strong quality culture” , validating the effectiveness of strategies like the ISO 9000, Lean Construction, and the PDCA cycle (Kirby et al., 2025c). This entire synthesis culminated in the proposal of the HEM as the evidence based solution.

Additionally, the research examines a qualitative investigation involving expert interviews (Kirby et al., 2025c) corroborated the significance of QM and emphasised the emerging importance of a robust quality culture. Validating the effectiveness of strategies like the ISO 9001, Lean Construction and PDCA cycle, offering data-driven insights into their potential applicability in New Zealand’s construction landscape.

9.5 Contributions to knowledge

This research presents several novel and interconnected contributions, significantly advancing the theoretical and practical understanding within the fields of construction productivity and QM, particularly within the fragmented New Zealand residential sector.

9.5.1 Empirical and Methodological Contributions

The study provides empirical validation of crucial productivity factors specific to the New Zealand residential construction industry. Furthermore, the research conducts a comprehensive assessment of diverse QM methodologies, such as ISO 9001, Lean Construction, and the PDCA framework, offering evidence-based perspectives on their potential effectiveness within the New Zealand context. The study also investigates the impact of demographic variables on the implementation and perceived efficacy of QM practices within this sector, yielding valuable information for developing customised implementation approaches.

Foremost the study introduces the Holistic Enhancement Model (HEM) an evidence based, expert validated transformative model, designed for immediate impact and industry application (RO5). This model resolves a significant conceptual divergence in the literature. The general QM literature links quality to holistic improved performance, however, the construction productivity literature often treats poor quality as merely one factor among many, rarely positioning QM as a primary strategic driver for productivity enhancement. The HEM rectifies this by strategically combining proven QM components to target productivity improvement, structuring QMs strategic role.

The HEM framework is anchored by the Theory of Constraints, which provides the critical insight that the root cause diagnosis of poor productivity in the New Zealand residential construction sector, is a cultural constraint - the “time and cost over quality” mindset. This pervasive issue is linked to a “hyper normalisation of sub-standard practices,” potentially exacerbated by the mid 1980s governmental shift toward a deregulation, leaving industry in a “hands off-self-regulated” model. The HEMs specific inclusion of quality culture is the mechanism to address this deep seated constraint, prioritising over solely training-centric approaches.

This study provides a crucial extension by demonstrating that the cultural constraint is not only an economic and productivity bottleneck but also the primary impediment to achieving national sustainable targets (Chapter 8) The Hem is thus validated as a unified solution to the triple challenge of improving productivity, reducing waste/embodied carbon, and fostering institutional resilience.

The overarching aim of this research, to determine the effectiveness of QM as an organisational strategy for improving New Zealand residential construction productivity, is fully realised through a systematic investigation across these six papers that culminates in the delivery of the HEM strategic conceptual framework.

9.6 Final considerations

The findings of this research suggest that QM is an effective strategy for enhancing productivity within the New Zealand residential construction sector. Empirical evidence strongly indicates the potential of QM. However, research emphasises the importance of considering contextual factors such as the workforce demographics and the specific needs of micro-companies that dominate the sector. The strategic shift towards a culture that prioritises quality offers a promising opportunity for long-term and sustainable improvements in productivity, aligning with governmental aspirations

However, addressing the perceptual gaps and implementation challenges, particularly the disconnect between management and worker perspectives, will be crucial for fully realising the benefits of QM. Ultimately, this research provides a robust, context-specific understanding that yields targeted interventions tailored to the unique characteristics of the local residential sector, aiming to foster a more productive and sustainable New Zealand residential construction industry

Figure 8.1: The productivity bottleneck (Author's work)

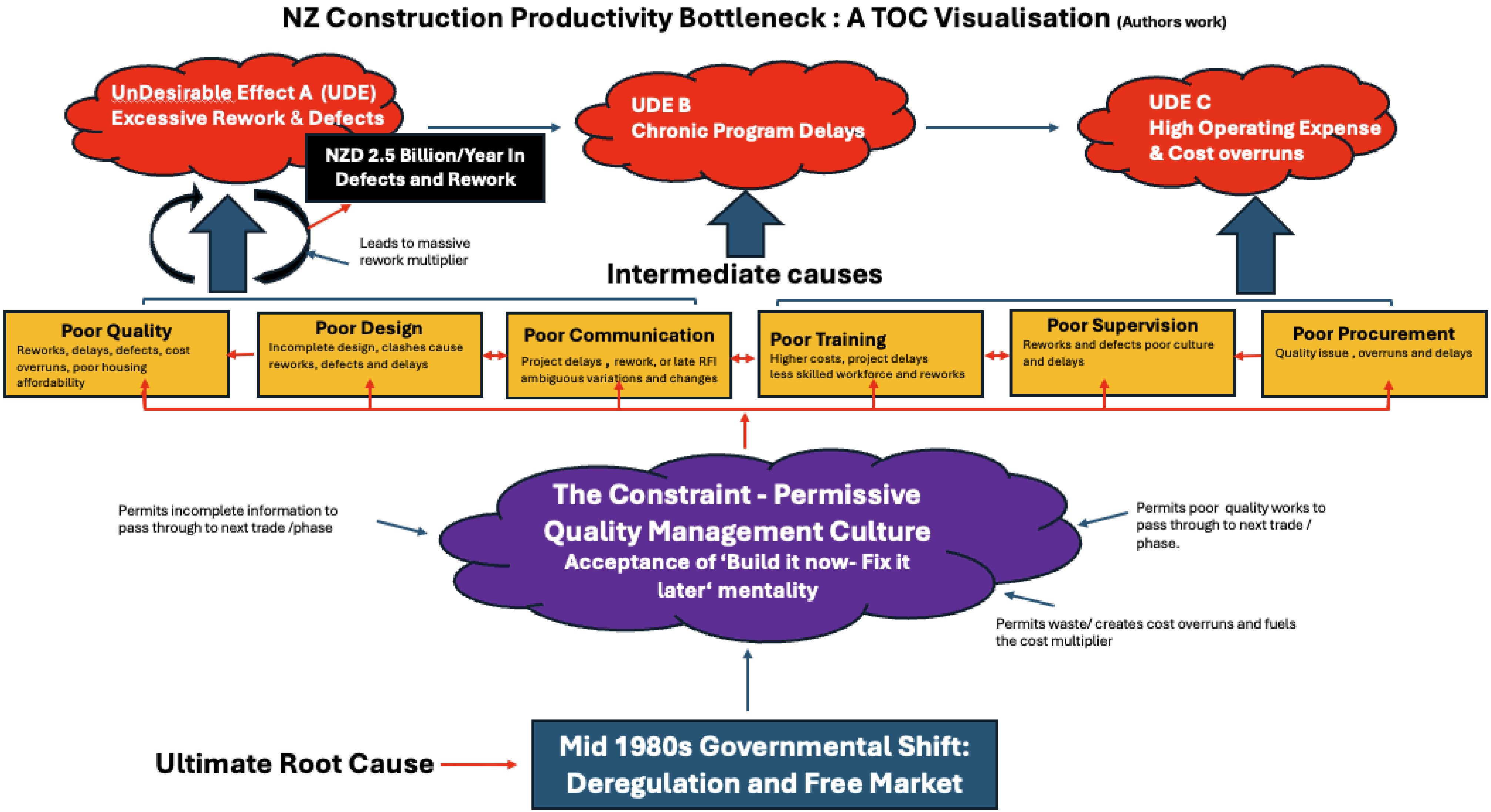
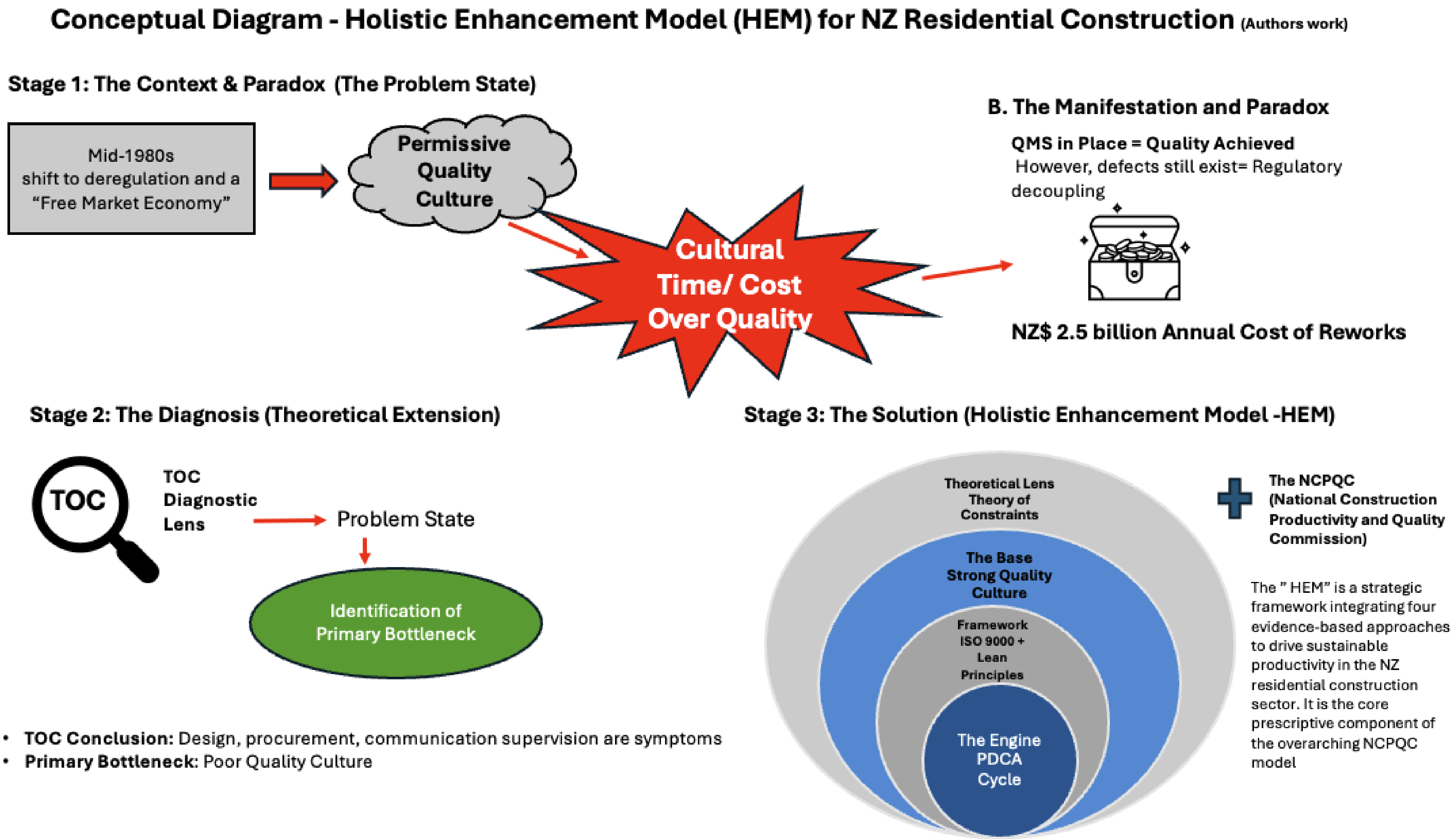


Figure 8.2: Conceptual diagram - Holistic Enhancement Model (Author's work)



Chapter 10
Conclusion

Overview

The New Zealand residential construction sector is characterised by a persistent productivity gap, the challenge rooted not merely in technical inefficiency, but in a deep-seated institutionalised culture that prioritises short-term cost and time over quality. The primary aim of the thesis was to address this systemic value by developing an evidence based, context specific strategic QM framework suitable for the sector's unique micro firm environment.

The research pursued a rigorous mixed-methods approach, systematically fulfilling 5 key research objectives (RO1-RO5). The journey commenced with the strategic selection of low barrier QM systems, ISO 9000 and TQM, which were deemed contextually suitable under contingency theory (Kirby at all. 2022). Empirical validation confirmed QM as a top three productivity driver but simultaneously exposed significant implementation barriers related to generational and occupational resistance (Kirby et al., 2024; Kirby et al., 2025a). The study then applied the theory of constraints to formally diagnose the root cause as the intangible cultural constraint, leading to the conceptualisation of the QMS paradox, "Work as done" and "Work as imagined" as the core mechanism of the systemic failure. This thesis culminated in development of the Holistic Enhancement Model (HEM), the evidence-based solution whose components were conceptually corroborated by industry experts.

In conclusion, the research confirms that the longstanding productivity crisis is not a deficiency of tools, but a failure of culture and system alignment. The HEM provides the practical and philosophical mechanism to overcome the cultural constraints, offering a definitive strategic solution to align the New Zealand residential construction sector with global best practise.

10.1 Fulfilment of research objectives (RO1-RO5)

This section formally consolidated the achievement of each research objective, drawing together the key insights from discussion chapters.

Research objective 1 (RO1) asks **"what quality management systems do residential construction organisations use to improve construction productivity?"** This objective was fulfilled by establishing the theoretical boundary conditions of QM adoption in New Zealand context. Consequently, the review confirmed the unsuitability of the resource intensive LSS and identified ISO 9000, (structural feasibility) and TQM (philosophical focus on culture) as the most appropriate foundational frameworks in this study. Emphasising the need for QM to be proactively integrated across all organisational levels.

Importantly, the findings confirm the empirical link between quality and productivity and suggest that a cohesive, strategic approach to QM can effectively enhance productivity in this setting. Conversely, the review acknowledges further empirical research is needed to quantify the specific impact of different QM initiatives on productivity outcomes in the New Zealand residential construction sector. The study uses a comprehensive narrative review spanning 40 years of research, providing new insights into key strategies for improving New Zealand residential construction productivity. The current understanding, while positive, remains limited in its ability to provide definitive context specific guidance for practitioners or policy. This understanding forms the central theoretical foundation upon which the subsequent empirical investigations of this thesis will build.

Research Objective 2 (RO2) is to identify and analyse the significant factors that positively influence productivity in the New Zealand residential construction subsector and was successfully achieved. Empirical validation through the Garrett ranking technique confirmed the top 5 productivity improvement factors as adequate design, communication, QM, adequate supervision and training, identifying QM as a top 3 productivity driver. However, correlational analysis revealed that the effectiveness of these drivers is severely complicated by demographic disparities, including generational resistance that prioritises short-term cost over quality, highlighting the crucial human capital element of the enduring problem. Beyond productivity, this research concurrently demonstrated that QM's central role as a top factor is inherently tied to its function as a strategic enabler (Chapter 8) driving waste reduction and resource efficiency. This hierarchy offers a clear and actionable roadmap for practitioners and policymakers seeking to optimise performance within this vital sector.

Having identified the key factors influencing construction productivity in the New Zealand residential sector (Kirby et al., 2024), the subsequent study (Kirby et al., 2025a) provided a more granular understanding of how demographic variations might influence the effectiveness of quality centred improvement strategies. The research highlights the complex relationships between productivity variables, emphasising the need for a nuanced and multifaceted approach to improve productivity, and provides a foundation for fostering meaningful and sustainable change within the industry.

Research objective 3 is to develop and assess a QM-based strategy for improving productivity in residential construction. This objective was achieved through an integrated mixed methods process that spanned phase 2 of this research. The strategy was developed by applying the TOC to diagnose the systemic failure as the cultural constraint. The significance of this cultural constraint transcends economics, as the pervasive "time and cost over quality" mindset was simultaneously diagnosed as the primary non-technical bottleneck preventing the industry from achieving national sustainability and climate change targets (Chapter 8).

This cultural diagnosis informed the creation of the Holistic Enhancement Model (HEM). The framework was subsequently assessed by experts, confirming its theoretical soundness and feasibility, setting the stage for the formal validation of its components. The underpinning research (Kirby et al., 2025b) comprehensively analysed QM strategies, including ISO 9000, Plan Do Check Act (PDCA), Lean principles and Total Quality Management and their potential and impact on the New Zealand residential construction sector. The findings confirm the strategic importance of QM, particularly the potential benefits of implementing ISO 9000 standards, with Lean principles and the PDCA cycle in driving productivity improvements. The investigation was grounded in the robust theoretical framework of the TOC, which provides in-depth insights into the complex interplay between quality, constraints, and productivity.

Ultimately, this research contributes to RO3 and the overall research aim of determining the effectiveness of QM as a key strategy for enhancing productivity within this vital New Zealand industry. It opens new avenues for future research on identifying and mitigating key constraints within the industry using these QM frameworks.

Research objective 4 is to validate the developed strategy through expert consultation and assessment. The study confirms that QM is a pivotal strategy for enhancing productivity within New Zealand's residential construction sector. It suggests a shift towards a quality-focused culture over traditional training methods, challenging industry norms and perspectives on productivity improvement. The findings highlight the effectiveness of QM systems like the ISO 9000, in providing a structured framework for quality enhancement and productivity gains. This finding highlights the foundational role of pervasive cultural foundations in explaining the effectiveness of QM, while acknowledging the crucial role of strategic QM systems, such as ISO 9001, and methods like Plan-Do-Check-Act (PDCA) or Lean construction. Moreover, this study offers valuable, context-specific, empirical evidence on the operational aspects of QM within the distinctive residential construction sector of New Zealand.

The study advocates for an integrated approach to productivity improvement that highlights the interconnectedness of various productivity factors combined with QM. Factors like effective communication, adequate design and advanced training programs which QM systems like the ISO 9000 already have protocols embedded within the QMS. This objective was fully met through the final qualitative research phase. Expert interviews provided conceptual corroboration the frameworks, integrated components, the TOC lens, combined with a “strong quality culture,” the ISO 9000 and Lean principles as the structured framework with the final element, the PDCA engine. Expert corroboration further extended to the model's strategic mandate, confirming that the integrations of QM components Lean principles provide a low barrier pathway for organisations to meet both productivity goals and UNSDG aligned sustainable outcomes. Confirming the frameworks perceived effectiveness and practicality as a low barrier solution for the target sector.

Research Objective 5 is to propose evidence-based recommendations for enhancing residential construction productivity through QM practises. This study emphasises a critical shift towards prioritising a "strong quality culture" as a key driver of productivity in the local residential sector, challenging traditional thought on conventional improvement methods such as training and design. The study brings to attention the often-overlooked significance of QM in improving New Zealand's residential construction productivity, necessitating a re-evaluation of industry culture, shifting from a time and cost focused approach to a quality-centric one. To achieve this, the study recommends the strategic integration of the "strong quality culture," QM systems, such as ISO 9000, Lean principles, and the PDCA cycle, alongside specific organisational initiatives and formal adoption of a QM system, quality-focused training, and enhanced communication. Collectively, these findings and recommendations compel a necessary paradigm shift that strategically positions QM as the unified solution for the New Zealand's dual challenge. A challenge of improving productivity and achieving its environmental stewardship goals, requiring changes at both organisation and policy levels to drive quality centric sustainable productivity improvements.

For policymakers in industry associations, the implications include promoting quality awareness, providing resources to incentivise QM adoption in micro-organisations, and developing sector-specific quality standards. Collectively, these findings point towards the necessary paradigm shift in the industry, requiring changes at both organisational and policy levels to drive quality-centric productivity improvements.

10.2 Research contributions

This study makes significant and unique contributions to the body of knowledge across theoretical, methodological and practical domains. Providing a comprehensive solution to the persistent productivity, quality and sustainability challenges in the New Zealand residential construction sector.

10.2.1 Theoretical contributions.

The thesis extends established management theories by developing novel constructs tailored specifically for fragmented micro-firm dominated industries.

The first contribution is the conceptual divergence resolution. The research provides a significant theoretical contribution by successfully reconciling the conceptual divergence between QM and construction productivity literature. QM literature traditionally views QM holistically, tying it to improved performance whereas construction productivity literature often treats poor quality merely as one many factors contributing to poor productivity, rarely viewing it as the primary strategic approach for improvement.

This thesis definitively resolves this divergence by empirically validating QM as a top three productivity driver (RO2) and critically utilising the TOC to diagnose the cultural constraint as the strategic bottleneck that precludes all other avenues of productivity improvement.

The second contribution is the extension of the TOC. This research successfully applied TOC from its traditional manufacturing settings into the complex project based human centric realm of construction management. Crucially, this application utilised TOC to diagnose the root cause of systemic failure as the intangible cultural constraint. Thereby broadening the utility of TOC for strategic problem identification in the service and project-based economies.

As the third contribution. The study formalises the “QMS paradox,” a novel concept describing the systemic disconnect between management's strategic expectations “Work as imagined” and on-site reality “Work as done.” This construct provides a new powerful lens for analysing the causes of implementation failure in fragmented sectors where centralised control is inherently weak and cultural resistance is high.

The fourth key theoretical contribution is the strategic QM framework extension, the Holistic Enhancement Model. The HEM refines existing QM systems by strategically integrating a “strong quality culture” with TOC, ISO 9000 and Lean principles, with the PDCA cycle. This synthesis creates a system where cultural change is anchored in resilient system logic, making the framework uniquely effective and less fragile than isolated ISO 9000 or TQM models.

The final theoretical contribution is the QM as a strategic enabler. The research provides a definitive theoretical extension by confirming that QM is not merely a tool for economic productivity or compliance, but a strategic enabler for environmental stewardship. This is achieved by demonstrating that the resolution of the cultural constraint (the time and cost over quality mindset) is the prerequisite for reducing waste, materials consumption and embodied carbon, thereby aligning the industry with UNSDGs (12, 13) and a national climate objectives. This reframes QM as a direct policy instrument for sustainability.

10.2.2 Practical and policy contributions

The research provides 2 distinct, high impact solutions addressing both practice level inefficiencies and the critical historical policy root cause.

The practice-level solution (HEM) delivers an immediate, low barrier, evidence based strategic framework tailored to the New Zealand micro-organisations. The HEM provides a clear mechanism to overcome demographic resistance by explicitly linking quality activities (through Lean / PDCA) to empirically validate productivity gains. The research advocates that productivity must be enshrined as a national priority at the policy level, regardless of political cycles.

The second contribution is a high-level policy mechanism termed in this research as the “National Construction Productivity and Quality Commission (NCPQC).” This model directly addresses the historical government shift (mid 1980s deregulation) that institutionalised the culture (the hyper-normalisation of substandard practices) of prioritising time and cost over quality. The NCPQC model is the necessary high level policy instrument, conceptualised as a political firewall comprising industry and academic experts, designed to leverage New Zealand’s unitary state structure. Its core function is to enshrine construction productivity and quality as a non-partisan national priority that transcends political cycles, providing long term governance and funding necessary to implement and sustain the HEM gradually across government-funded residential projects, ultimately leading sector wide reform.

Additionally, the research empirically provides prioritisations data, being the first empirically validated ranking of productivity drivers specific to the New Zealand residential sector, allowing the industry to allocate resources and guide future policy and training with unprecedented accuracy.

10.2.3 Methodological contributions

The final contribution lies in the methodological domain. The study showcases a robust integrated mixed-methods design grounded in the pragmatic worldview. It successfully demonstrates a replicable approach for addressing complex, systemic problems in fragmented industries. This research commenced without an a-priori hypothesis, instead using the defined research objectives to guide a data driven inductive process. This allowed the theoretical constructs such as the TOC diagnosis and the resulting (HEM) to organically emerge and evolve directly form the empirical evidence across both quantitative and qualitative phases. This sequential approach comprising narrative review (RO1), quantitative ranking (RO2), TOC diagnosis (RO3), and qualitative corroboration (RO4), providing a proven template for future research addressing similar challenges globally.

10.3 Overall thesis conclusion

This research clearly highlights the essential role of QM in addressing the persistent and complex productivity challenges within New Zealand’s residential construction sector. Through a systematic and multi-faceted investigation spanning five distinct yet interconnected studies, this thesis has not only rigorously identified critical enablers and inherent barriers to productivity improvement but has also delivered empirically grounded insights and expert-validated strategies that culminate in a transformative framework for enhancing industry performance.

This emergent framework fundamentally reconceptualises QM as a strategic, systemic driver of efficiency, moving beyond its traditional reactive or siloed application.

It advocates for the integrated application of the Theory of Constraints (TOC) diagnosis with a "strong quality culture", formalised by established systems like ISO 9000 and Lean principles and driven by the Plan-Do-Check-Act (PDCA) cycle. Providing a comprehensive approach to identifying and addressing diverse, interconnected constraints within the construction process, changing how we think about productivity improvements. Establishing a quality-centric organisational culture (strong quality culture) is a fundamental component of this framework. It helps facilitate the strategic implementation of tailored QM systems and fosters an unwavering commitment to continuous improvement. This framework is a key strategy for enhancing productivity and requires strategic and context-specific adaptations for optimal impact in the New Zealand residential construction industry. This scholarly contribution enriches construction management theory by reconceptualising QMs role from a reactive measure to a proactive, systemic driver of efficiency.

Crucially, this research aligns directly with the New Zealand government's strategic focus on fostering an efficient, high-performing, and sustainable construction sector. By demonstrating the vital connection between QM, enhanced productivity and the resultant improvements in environmental resource efficiency (through reduced waste and rework), this thesis directly contributes to achieving national and global sustainability goals.

The knowledge generated is set to serve as a catalyst for industry practitioners, policymakers, and future researchers. It is considered that this research could leave a legacy of quality-driven excellence. Ultimately transforming New Zealand's residential construction sector into a global benchmark for efficiency, resilience and sustainability.

The comprehensive understanding cultivated through this research lays a robust foundation for tangible progress in the sector. Building upon these significant contributions, the following recommendations outline strategic imperatives for industry practitioners, policymakers, and future researchers.

10.4 Thesis recommendations

Drawing upon empirical findings, expert validations, and the overarching transformative framework established in this thesis, the following principal recommendations are proposed to enhance productivity and promote sustainable practices within the New Zealand residential construction sector:

10.4.1 For industry practitioners and construction companies

The research strongly recommends that industry practitioners adopt QM as a strategic imperative, shifting the perception of QM from mere compliance to a fundamental, proactive strategy for identifying and systematically addressing productivity constraints. Companies should implement QM systems such as ISO 9000, Lean principles, and the PDCA cycle not as standalone tools, but as an integral component of core business strategy (i.e. HEM).

Concurrent with this systemic shift, organisations must actively cultivate a quality-centric culture. Fostering a “strong quality culture” throughout the organisation by ensuring leadership commitment, empowering employees in the quality process, promoting continuous learning and formally acknowledging quality achievements.

Furthermore, companies are urged to embrace constraint-focused QM, applying principles akin to the TOC to identify critical bottlenecks (such as rework defects or inefficient processes) and leveraging QM strategies specifically to alleviate these. Ensuring efforts are targeted for maximum impact on productivity. To sustain this, the industry must invest in tailored training and development. Providing specific context-dependent organisational training for all personnel from site workers to senior management. Ensuring practical competence and a shared understanding of quality’s role in productivity.

Finally, companies should foster interorganisational collaboration on quality, actively seeking collaboration with supply chain partners, subcontractors and clients to align quality expectations and processes, thereby reducing interface issues, minimising rework, improving overall project flow and efficiency.

10.4.2 Recommendations for policy makers and government bodies

The successful systemic implementation of the transformative framework requires direct intervention and policy support at the national level. Therefore, it is strongly recommended that government bodies and policy makers establish a National Construction Productivity and Quality Commission (NCPQC) as the high-level policy mechanism necessary to institutionalise cultural change and sustain sector-wide reform.

In addition, policy makers should incentivise strategic QM adoption. This involves developing and implementing policies or funding mechanisms that incentivise construction companies to adopt comprehensive, strategic QM systems and cultivate quality-centric cultures that reach beyond basic regulatory compliance. Furthermore, to embed these principles into the operational landscape, policy makers should integrate QM into the industry standards and building codes, progressively incorporating QM principles with a deliberate emphasis on process quality and continuous improvement. To facilitate industry wide growth, the government must actively support industry wide knowledge transfer and benchmarking, establishing or funding platforms for knowledge sharing, best practice dissemination. Finally, policymakers must formally recognise QMs role in sustainability mandates. This requires explicitly acknowledging and quantifying how strategic QM adoption directly contributes to national sustainability goals (reducing construction waste, and rework) within all relevant policy frameworks.

10.4.3 Recommendations. For future research

The successful validation of the transformative framework provides a clear agenda for subsequent academic work.

Large scale validation which should initially focus on conducting larger studies to validate the HEM findings across a more extensive and diverse sample of New Zealand construction companies, thereby enhancing the generalisability of the proposed framework. Complementary to this, future research should undertake longitudinal assessment of framework implementation to track the long-term impact of adopting the transformative framework on productivity, quality, sustainability performance and organisational culture overtime within specific companies. To test the robustness of the transformative frameworks' (HEM) theoretical underpinnings, comparative studies across sectors regions should be explored to examine the applicability and necessary adaptations of this framework in other construction sub sectors (e.g. commercial or infrastructure) or different geographical and regulatory contexts.

Furthermore, a deep dive into cultural change mechanisms is warranted where researchers should investigate the specific mechanisms and interventions that are considered most effective in fostering and sustaining a quality centric culture within the construction industry, with a particular focus on the crucial role of leadership.

Future research should investigate how industry 4.0 technologies and digital integration and could be utilised to automate the data collection and feedback mechanisms of the PDCA engine (BIM, IoT, sensors AI).

Finally, to build a stronger business case for its adoption, researchers should conduct quantification of QMs financial environmental returns, quantitatively assessing the financial returns on investment and the environmental benefits of implementing strategic QM practises in the construction sector.

10.5 Chapter conclusion and final statement

Through its comprehensive series of empirical studies, this thesis has addressed the persistent productivity challenges within the New Zealand residential construction sector by rigorously investigating the effectiveness of QM as a pivotal strategic lever for improving New Zealand's residential construction productivity. Drawing on theoretical insights and robust empirical evidence, the research provides a comprehensive understanding of how QM can enhance industry performance and sustainability.

By providing a hierarchical list of productivity improvement factors, analysing crucial demographic factors, proposing diverse strategies, and incorporating expert qualitative insights, this research delivers a comprehensive and context-specific perspective on productivity improvement. This body of work not only contributes significantly to the academic discourse on construction productivity and QM but also provides an evidence-based roadmap for industry practitioners and policymakers, laying essential groundwork for a more efficient, higher-quality, and ultimately more sustainable housing sector in New Zealand.

Ultimately, this thesis delivers the critical insights and a forward-looking perspective necessary to catalyse fundamental re-evaluation of productivity in the New Zealand residential construction sector, demonstrating that through effective Quality Management, productivity enhancement becomes an inherent outcome of "business-as-usual operations".

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Appendices

Appendix A - Phase 1 online Qualtrics questionnaire survey

Appendix 1 provides a full sample of the online survey instrument utilised in phase 1 of this research. The questionnaire is designed to systematically collect data from 106 industry professionals (project managers, construction managers, site managers, general managers and subcontractors) regarding productivity improvement factors and share their opinions on quality management systems and practices as well as productivity improvement strategies. The various sections of the survey are designed to specifically answer RO2-R04.

Q1.0.

You agree to participate in this questionnaire by clicking the link and completing the questionnaire.
Your participation in this research is voluntary.

Qualtrics survey - Participant InformationSheet.pdf

- (•) Yes I agree to participate in this research
- ( ) No I do not agree to participate in this research

INSTRUCTIONS.

- Please answer all questions before moving to the next page.
- You can change your answer to any question whilst on a page.
- Click the **"next page"** button located at the bottom of each page to move to the next set of questions.
- You cannot revisit a page once the **"next page"** button is clicked.
- Click the **"Submit"** button once you have finished the questionnaire.

Q1.1. Please select the category that best represents your age.

- ( ) 25- 29
- (•) 30-39
- ( ) 40-49
- ( ) 50-59
- ( ) 60+

Q1.2. What is the highest level of education you have completed?

- ( ) Senior School Certificate
- ( ) Diploma
- (•) Degree
- ( ) Postgraduate
- ( ) Other- please specify

Q1.3. Please indicate your gender

- (•) Male
- ( ) Female
- ( ) Another gender

Q1.4. Please indicate your occupation:

- ○ General Manager
- ◉ Construction Manager
- ○ Site Manager
- ○ Project Manager
- ○ Subcontractor

Q1.5. Please indicate your office location

- ○ Christchurch
- ○ Wellington
- ◉ Auckland
- ○ Hamilton
- ○ Other- please specify

Q1.6. Please indicate if you hold any industry body certifications

- ☐ Construction Management
- ☐ Project Management
- ☑ Other- please specify None

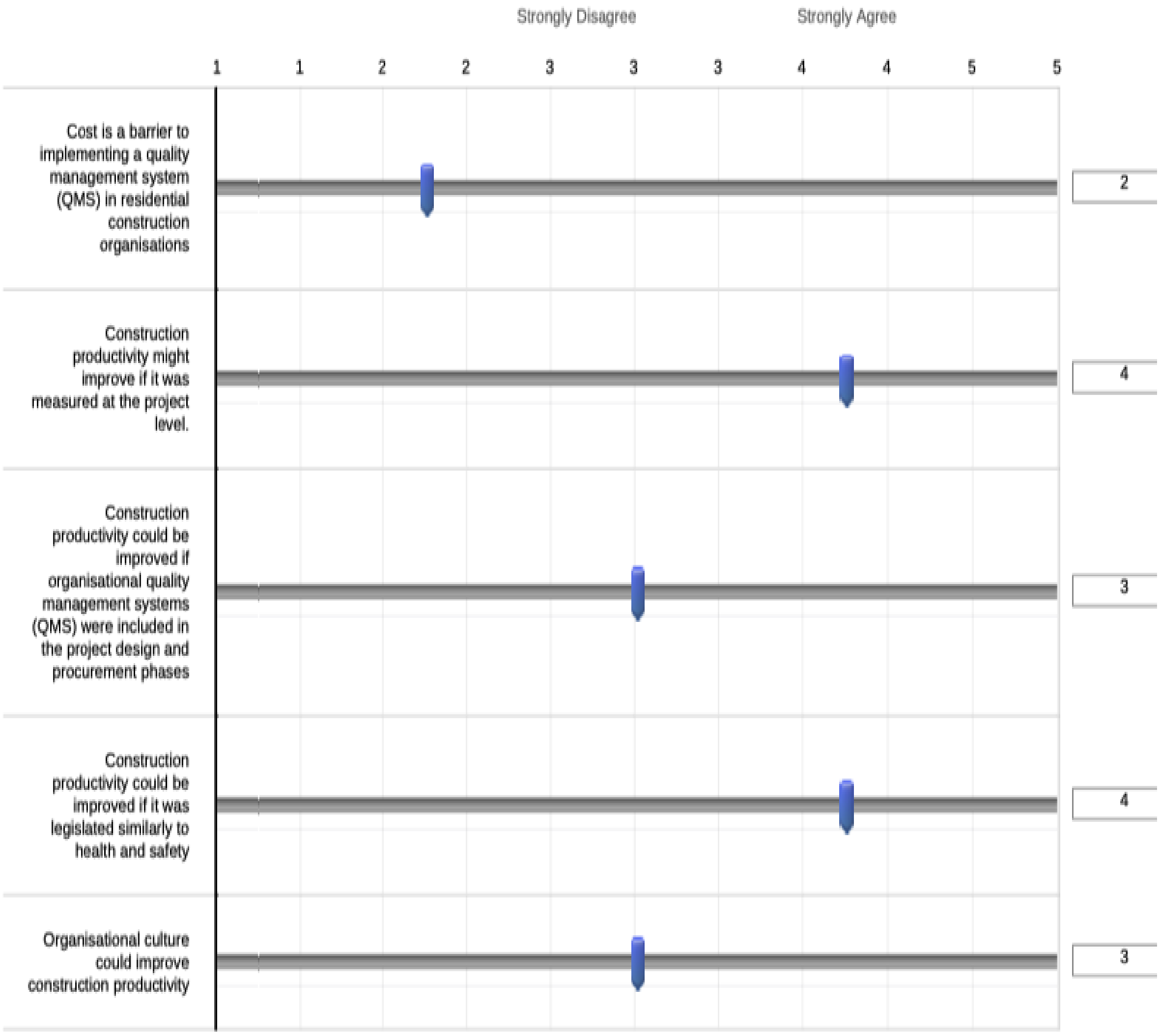
Q1.7. Please indicate the number of years of experience you have working in residential construction

- ○ 2-5 years
- ○ 6-9 years
- ◉ 10+years

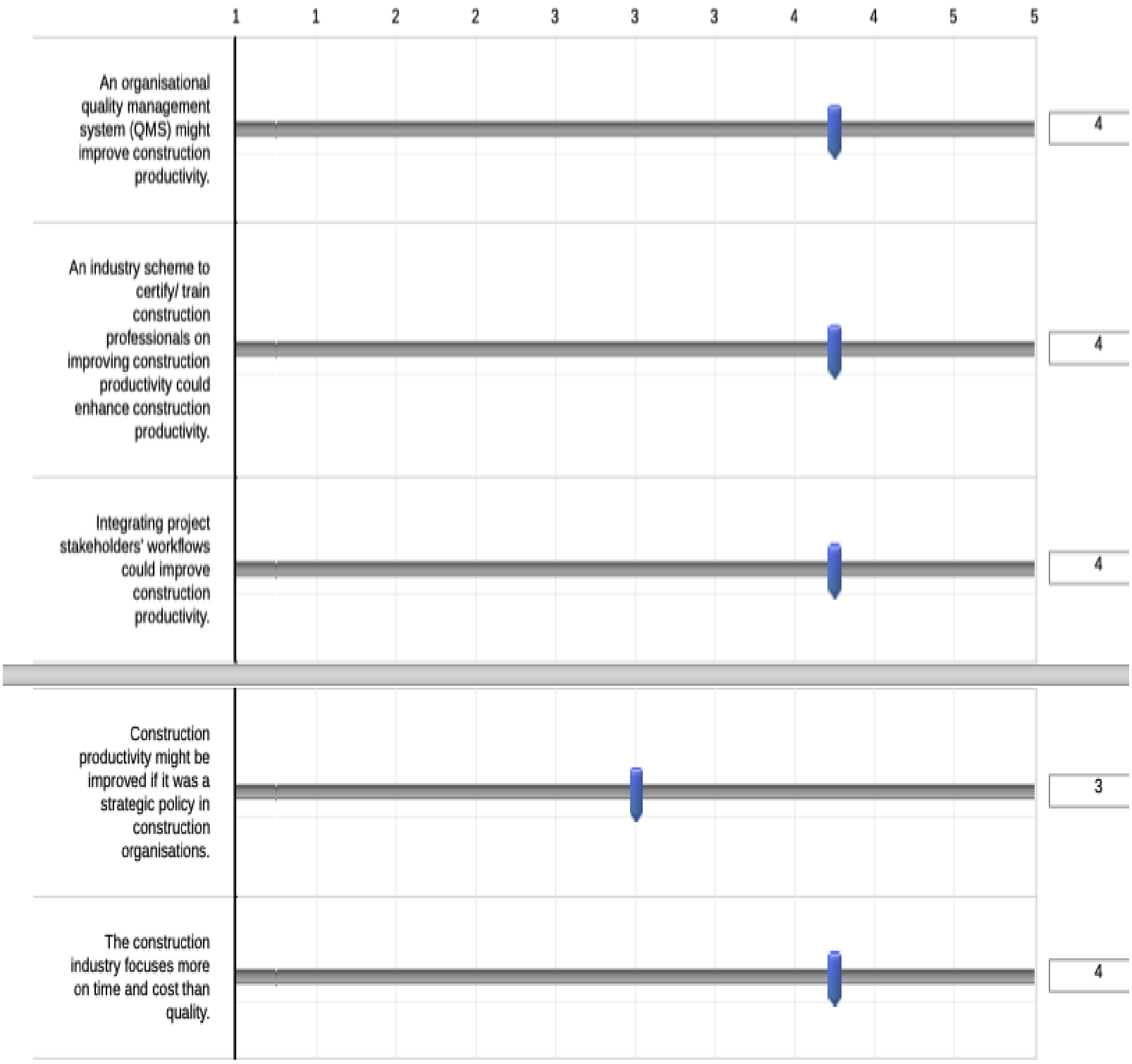
Q2.1. The following are the factors that positively affect construction productivity.
Please rank them in terms of significance to you (where 1 is the most significant and 10 is the least significant).
Factors can be dragged and dropped to change positions.

Design and specifications	1
Quality management	2
Communication	3
Construction reworks	4
Adequate Supervision	5
Client variations	6
Unskilled workers	7
Lack of skilled workers	8
Employee motivation	9
Organisational Training	10

Q2.2. On a scale from 1-5, please indicate the extent to which you agree or disagree with the following statements (where 1 is Strongly Disagree, 3 is Neutral and 5 is Strongly Agree).



Q3.1. On a scale from 1-5, please indicate the extent to which you agree or disagree with the following statements (where 1 is Strongly Disagree, 3 is Neutral and 5 is Strongly Agree).



Q4.1 . Please indicate the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
International standards for quality management (ISO 9001) could be used to enhance productivity in residential projects?	○	○	○	◉	○
Using a quality management system (QMS) might improve time and cost outputs on construction projects	○	○	○	◉	○
Managing quality in residential construction projects is generally a reactive process.	○	○	○	○	◉
Your organisational Quality Management System (QMS) effectively achieves its quality objectives.	○	○	◉	○	○

Q4.2. In your opinion, who is most responsible for managing construction productivity in residential construction companies

Project Managers

Q4.3 . Which of the following Quality Management Systems does your organisation use

- [ ] Total Quality Management (TQM)
- [ ] ISO 9001 Standard for Quality Management
- [ ] PDCA (Plan-Do-Check-Act)
- [x] Other- please specify: Generic policy

Q5.1. What strategies are you aware of that could be used at the project level to improve construction productivity? Please specify

Preplanning and coordinate works, better QM focus, incentivise trades, job should be ready for trades to do

Q5.2. What Quality management strategies can you suggest for improving construction productivity? Please specify

PDCA might work

Q5.3. What strategies does your organisation use to improve construction productivity? Please specify

Pre Planning, minimise defective work and subcontractor team meetings

Appendix B - Phase 2 Semi-structured Interview Questions

Appendix 2 presents the semi-structured interview protocol employed during the qualitative phase of this research. This guide facilitated in-depth discussions with 15, industry experts, (project managers, site managers, construction managers, general managers, subcontractors) to explore their nuanced perspectives on the effectiveness of Quality Management strategies and their interplay with other productivity factors in New Zealand's residential construction sector.

Phase one learnings	**Research objectives**
	RO#2 - What are the common factors that positively affect construction productivity in the NZ residential construction sector **RO#3 -** How effective is the developed strategy for quality management in the residential construction sector? **RO#4 -** What quality management strategies can be suggested for improving productivity within construction residential sector? **Manuscripts** 1.An investigation into quality management systems and factors affecting construction productivity: The New Zealand residential construction industry. (Accepted) 2. Factors for improving productivity in the New Zealand residential construction sector (Accepted) 3. A Multidimensional Analysis of Stra6tegies for Improving New Zealand Residential construction productivity. (Under review) 4.NZBERS Symposium 2025- Abstract submitted (Under review)

Introduction

In the pursuit of a deeper understanding of quality management and its impact on construction productivity in the New Zealand residential sector, we conducted an initial phase of research utilising an online survey questionnaire. The survey aimed to gather insights from industry professionals regarding the relationship between quality management practices and productivity. To further validate and enrich those findings, we are now engaging in expert interviews. These interviews will provide an opportunity to explore the nuances of the survey results, allowing us to confirm our conclusions and gain further insights from experienced practitioners.

Your perspectives will be invaluable in shaping a comprehensive understanding of the factors and strategies that can influence productivity in this vital sector.

Section 1. refers to RO#2- What are the common factors that positively affect construction productivity in the New Zealand residential construction sector?

Q1. What are your thoughts regarding the findings of this study that suggest QM is the only factor from the top ten factors that can be applied holistically across all levels of the construction ecosystem, including the organisational and legislative levels, towards improving New Zealand residential construction productivity?

Top Ten Improvement Factors	**Top Ten Factor Ranking**
Design and specification	1
Communication	2
Quality management	3
Adequate supervision	4
Organizational training	5
Employee motivation	6
Lack of skilled workers	7
Unskilled workers	8
Client variations	9
Construction reworks	10

Q2. Findings highlight that effective communication strategies can improve quality, supervision and training, when structured according to organisational and project requirements. What are your thoughts regarding this statement

Top 5 Factors	**Top 5 factor Ranking**
Design and specification	1
Communication	2
Quality management	3
Adequate supervision	4
Organizational training	5

Q3. QM is noted within the top 5 factors as a factor to improve NZ residential construction productivity. This highlights the particularly important role that quality management plays in improving NZ residential construction productivity.

What are your opinions on the following statement.

In terms of the top 5 factors, can using a QMS, like the ISO 9000 standards for QM , can ensure a quality culture, quality communication, quality design and specification, quality training and quality supervision, which may have far-reaching effects on organisational performance.

Improvement Factors	**Final factor Ranking**
Design and specification	1

Communication	2
Quality management	3
Adequate supervision	4
Organisational training	5

Q4. This study highlights 7 key factors for improving NZ residential productivity, particularly the important role that QM plays in future improvements.

What are your views on the following statement.

The 7 factors noted below can be used individually or in unison to create effective organisational responses towards productivity improvement.

7 key Improvement Factors	**7 key Improvement Factors Final Ranking**
Design and specification	1
Communication	2
Quality management	3
Adequate supervision	4
Organizational training	5
Employee motivation	6
Skilled workers	7

Q5. Interestingly, Employee motivation is shown among the bottom 5 factors (less important) in this study for improving NZ residential construction productivity.

What is your opinion on the importance of employee motivation as a factor for improving NZ residential construction productivity. Should Employee motivation be considered more important.

Improvement Factors	**Final factor Ranking**
Employee motivation	6
Lack of skilled workers	7
Unskilled workers	8
Client variations	9
Construction reworks	10

Section 2 refers to RO#3- How effective is the developed strategy for quality management in the residential construction sector?

Q. Participants in this study were asked several questions on quality management strategies for improving residential construction productivity.
Q1. In this study the top three strategies for improving NZ residential construction productivity are:

ID#	Top Three Improvement Strategies
1	Implementing a productivity certification and training scheme for construction professionals
2	Addressing the industry's culture of prioritizing time and cost over quality
3	Enhancing QM practices.

a) Do you think the strategies offered are most likely to improve NZ residential construction productivity.

b) This study finds that addressing the industry's culture of prioritizing time and cost over quality is less effective as a strategy capable of improving NZ residential construction productivity than implementing a productivity certification and training scheme for construction professionals. What is your view.

c) Of the strategies provided the study finds that enhancing QM practises is a less effective strategy for productivity improvement than Implementing a productivity certification and training scheme. What is your opinion.

Q. Participants in this study were asked several questions on quality management strategies for improving residential construction productivity.

RO#3- How effective is the developed strategy for quality management in the residential construction sector?

Q2. The findings of this study identify six key themes centred around strategies capable of Improving NZ residential construction productivity:

ID#	Key Themes
1	Training
2	Productivity measurement
3	QM
4	Organisational culture
5	Communication
6	Stakeholder collaboration

a) Do you think the themes/strategies suggested can improve NZ residential construction productivity.

b) The findings of this research indicate that construction organisations can enhance productivity through strategic QM. What is your opinion.

c) Of the themes suggested, do you believe the majority of themes would already be catered for as part of an effective QMS.

d) What is your opinion on the following statement. Of the themes provided, QM would be the most effective theme/strategy for improving NZ residential construction productivity.

e) Organisational culture is noted among the top 6 themes capable of improving NZ residential construction productivity. What are your thoughts on improving organisational performance through a culture guided by quality.

Q3. In this study, the following Minor themes are considered necessary, although less critical

ID#	Minor Themes
1	Design
2	Technology
3	Procurement methods
4	Incentivisation schemes
5	Human capital.

f) What is your opinion of the minor themes/strategies offered relevant to being less likely to improve NZ residential construction productivity.

g) What is your opinion of Human Capital being a minor theme in improving NZ residential construction productivity.

Q4. Findings highlight "QM is high in propinquity across many stakeholder groups. Notably, QM spans all levels of the construction network; hence, systems like ISO9000 standards serve as legislative benchmarks globally to elevate industry expectations and standards. Adopting ISO9000 in the NZ residential sector fosters a quality culture enhancing communication, collaboration, and training standards, thereby boosting productivity. Other QM models (PDCA, LCM) can be integrated into the ISO9000 framework, highlighting its flexibility"

a) What is your opinion, is QM high in propinquity across many stake-holder groups

b) Findings show a QMS like the ISO9000s will foster a quality culture that enhances communication, collaboration, and training standards, thereby boosting productivity. What is your opinion in terms of the above statement.

c) Do you believe that the versatility of the ISO9000 framework is advantageous as a QMS because it can incorporate other QM models (Plan Do Check Act, Lean Construction Methods) to suit organisational needs

Q5. Results suggest that improving NZ residential construction productivity isn't attributed to any one party or element within the construction ecosystem.

a) What are your thoughts regarding the above statement

b) The findings show that collaborative and deliberate measures are needed to improve quality and productivity in the NZ residential construction sector. What is your opinion.

Q6. The top 5 Themes for improving productivity at the project level in this study are noted below.

a) What are your views on the top 5 themes being the most effective strategies for improving NZ residential construction productivity.

b) Do you have any other suggestions regarding effective strategies for improving NZ residential construction productivity.

Id#	**Top 5 Themes for improving productivity**
1	Lean Construction Methods
2	Productivity training and education
3	Quality management
4	Stakeholder collaboration
4	Adequate supervision
5	Incentivisation schemes
5	Skilled workers

Section 3 refers to RO#5- What quality management strategies can be suggested for improving productivity within construction residential sector?

Q1.This study highlights 8 QM strategies for improving NZ residential construction productivity. The top 5 quality management strategies are noted below

Id#	**Top 5 quality management Strategies**
1	Lean Construction Methods
2	Plan Do check Act (PDCA)
3	ISO9000 quality management System
4	CONQA (Quality assurance system)
5	Inspection Test Plans (Quality control/ assurance system)

a) What is your opinion of the top 5 strategies from this study for improving NZ residential construction productivity.

b) This study finds that the ISO9000 Quality Management System is the most effective QMS suitable for improving NZ residential construction productivity. What is your view regarding this statement?

Q2. The strategies below are noted as less effective in this study for improving NZ residential construction productivity

Id#	**Less important quality management Strategies**
1	Kaizen
2	Total Quality Management (TQM)
3	Technology -PM Software

a) What is your opinion regarding the strategies above being less important for improving NZ residential construction productivity?
b) In this study, TQM is noted as a less important strategy for improving NZ residential construction productivity. What are your thoughts regarding this statement?
c) Are there any other strategies that can be suggested for improving NZ residential construction productivity?

(Conclude with thanking the participants for their time and responses)

Appendix C- Auckland University of Technology Ethics Committee - Approval 24/77 (AUTEC)

21 June 2024

Funmilayo Rotimi
Faculty of Design and Creative Technologies

Dear Funmilayo

Re Ethics Application: **24/77 An investigation into subsector productivity: The New Zealand residential construction industry**

Thank you for your responses to AUTEC's conditions.

Your ethics application has been approved for three years until 21 June 2027.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC.
2. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
3. Any amendments to the project must be approved by AUTEC prior to being implemented.
4. A progress report is due annually on the anniversary of the approval date.
5. A final report is due at the expiration of the approval period, or, upon completion of project.
6. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
7. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online http://www.aut.ac.nz/research/researchethics

For any enquiries, please contact ethics@aut.ac.nz
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: Mark.kirby@autuni.ac.nz; nicola.naismith@aut.ac.nz

Appendix D - Auckland University of Technology Ethics Committee – Approval 23/83 (AUTEC)

30 March 2023

Funmilayo Rotimi
Faculty of Design and Creative Technologies

Dear Funmilayo

Re Ethics Application: **23/83 An investigation into subsector productivity: The New Zealand residential construction industry**

Thank you responding to AUTEC's conditions.

Your ethics application has been approved for three years until 30 March 2026.

Non-Standard Conditions of Approval

1. In the withdrawal statement in Information Sheet revise and simply state ' you can withdraw at any time by closing the browser but once survey is submitted withdrawal is not possible as the survey is anonymous.
2. Include …'Phase 2 of the research which will involve semi structed interviews'.

Note: The information sheet might benefit from being edited for repetition and some sections such as the purpose, benefits are quite wordy.

Non-standard conditions do not need to be submitted to or reviewed by AUTEC unless requested but must be completed before commencing your study.

Standard Conditions of Approval

8. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC.
9. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
10. Any amendments to the project must be approved by AUTEC prior to being implemented.
11. A progress report is due annually on the anniversary of the approval date.
12. A final report is due at the expiration of the approval period, or, upon completion of project.
13. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
14. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online http://www.aut.ac.nz/research/researchethics

For any enquiries, please contact ethics@aut.ac.nz
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: Mark.kirby@autuni.ac.nz; nicola.naismith@aut.ac.nz

Appendix E- Qualitative data audit trial and coding matrix (Chapter 7)

This appendix provides the complete audit trail for the thematic analysis conducted in Chapter 7 through the use of the coding matrix. This insertion required as a condition of acceptance for the thesis, directly addresses the need for transparency in the qualitative analysis process.

It is important to note the dual methodological approach inherent in the construction of this matrix. The themes themselves (core themes) were developed inductively and originally from participant findings adhering to the six-phase framework by Braun and Clarke, (2006) to ensure the authentic voice of the data was captured. However, the final column, which links these empirically generated themes to the existing research objectives (RO) and research questions (RQ), represents a necessary deductive step or abductive mapping {Citation}

(Tavory & Timmermans, 2014 p.22). The process is essential for ensuring methodological coherence and is a core technique in mixed methods integration, where the findings of one phase are systematically mapped to the overall research framework for ultimate fulfilment of the study's aims (Cresswell & Clarke, 2017; Guest et al., 2012)

This dual process ensures that the emergent validated findings directly addressed the predefined strategic aims of the thesis. Thereby guaranteeing methodological coherence and the direct fulfilment of the primary objectives.

Table 9.1: Chapter 7- Coding matrix for Expert Interviews (Author's work)
(Theme development and research objective alignment)

Key Codes / Quotes (Examples)	Sub themes / Code Clusters	Final Core Themes	Relevant Research Objective and Question
"…it's the only factor useable everywhere" (#14)	QM as a foundational and universal tool	QM as a Holistic Strategy for Productivity Enhancement (7.4)	RO2 (RQ2): Establish common factors
"ISO 9000 provides a structural framework…" (#3)	ISO 9000 ensures structure and integrity	ISO 9000 QM system and Productivity (7.6)	RO3 (RQ3):Validate strategy effectiveness RO5 (RQ5): Suggest QM strategies
"Having skilled workers is critical" (#7)	Importance of Human Capital	Top Productivity Factors (7.5)	RO2 (RQ2): Establish common factors
"Addressing the industry's culture will be dangerous…" (#2)	Deeply ingrained cultural resistance	Effectiveness of key strategies for enhancing productivity and QM (7.7)	RO3 (RQ3):Validate strategy effectiveness RO4 (RQ4): Validate findings through expert assessment
"…high in concept but average in actual practice"	Disconnect between espoused values and reality	QM propinquity, gaps and productivity (7.8)	RO3 (RQ3):Validate strategy effectiveness RO4 (RQ4): Validate findings through expert assessment

"…cost seemingly comes first" (#15)	Competing priorities and lack of resources	QM propinquity, gaps and productivity (7.8)	RO4 (RQ4): Validate findings through expert assessment
"Qualified supervisors …trained in QM principles (#8)	Leadership and competency development	Top Productivity Factors (7.5)	RO5 (RQ5): Suggest QM strategies
"QM might be costly…" (#3)	Perception of upfront investment risk	Top Productivity Factors (7.5)	RO4 (RQ4): Validate findings through expert assessment