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# Proactive quality management in the residential construction sector

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Abstract

Despite extensive research efforts, conventional approaches that focus primarily on defect causes and quality costs often overlook the psychological factors influencing individual behaviour in quality management. This study adopts a novel perspective by exploring how workers' perceptions, beliefs, motivations, and decision-making processes impact their engagement with quality management practices. Key findings indicate that essential resources and conditions for effective proactive quality management are often insufficiently addressed. The prevailing culture, which emphasises defect identification, contributes to a blame-oriented atmosphere that undermines workers' pride in their craftsmanship. Additionally, an overemphasis on tangible quality costs obstructs the advocacy of proactive approaches. The absence of tailored training programs for both hard and soft skills further complicates the situation. The report provides actionable insights aimed at enhancing quality management at various levels within the industry, emphasising strategies that promote knowledge sharing, leverage social norms, and improve perceived behavioural control. Ultimately, this research lays a solid foundation for understanding the relationship between individual behaviour and quality outcomes, paving the way for effective interventions that can lead to long-term improvements in the residential construction sector.

# Contents

# Executive Summary

This report details a research initiative to enhance quality management practices within the residential sector. Traditionally, quality management has focused on identifying defects and calculating the costs of poor quality. However, these methods often overlook the psychological factors that influence behaviour related to quality.

The project seeks to drive real behaviour change by understanding and addressing the barriers that prevent effective quality control. Using the Theory of Planned Behaviour, a psychological framework, the study examines how workers' beliefs, motivations, and decision-making affect quality management. Key findings reveal that essential resources and conditions for proactive quality management are often lacking. This issue is exacerbated by a prevailing culture that emphasises defect identification and accountability, creating a negative environment that undermines worker pride and engagement. Additionally, an overemphasis on the direct costs of quality management hinders the adoption of proactive practices. The research also highlights a significant gap in training programs that address both technical and interpersonal skills tailored to the diverse needs of construction professionals.

To address these issues, the report proposes a structured framework based on the Right First Time (RFT) approach. This framework operates at three levels, industry, organisation, and project, to tackle cultural, technological, and knowledge-related barriers to RFT adoption. A central finding is that cultural misalignment, particularly negative perceptions of construction quality, undermines both worker pride and stakeholder confidence. The report recommends public engagement initiatives to improve the industry's external image and cross-disciplinary team building to foster a more collaborative internal culture. It also identifies the need to reconcile the sector's cost-driven priorities with the less tangible benefits of RFT, such as enhanced reputation and worker well-being, by reframing quality as a driver of long-term resilience rather than a cost burden.

For technology to help with quality management, it must fit the real-world needs of construction companies. This requires collaboration between researchers, technology providers, and construction professionals to develop practical solutions. The report also suggests using knowledge graphs to organise and share best practices across projects. Other interventions include visual guides for standard building elements and platforms to share lessons learned, which help address fragmented knowledge and support different learning styles.

A phased, multi-level roadmap outlines three key intervention pathways: education and training, technology co-development, and organisational culture change.

- Short-term initiatives focus on raising awareness through introductory training on RFT principles, soft skills, and growth mindset development. Pilot projects using simple

digital tools like mobile kiosks and basic project management software are launched to demonstrate benefits and gather user feedback. Industry campaigns, site tours, and client workshops are conducted to reshape perceptions and foster pride in quality work.

- Medium-term efforts aim to scale successful initiatives by expanding training programs and integrating RFT principles into licensing and certification requirements. Advanced digital solutions, such as IoT and real-time monitoring systems, are developed and deployed, tailored for SMEs through collaboration with research institutions and technology providers. Additionally, organisational culture change is promoted through team-building activities, cross-trade initiatives, and shared objectives to encourage collective responsibility for quality.
- Long-term goals focus on institutionalising continuous improvement by embedding RFT and proactive quality management into industry standards, education, and professional development pathways. A comprehensive digital ecosystem will support data-driven decision-making, innovation, and industry-wide adoption for effective practices. Cultural initiatives will aim to reinforce a positive industry reputation and uphold ethical standards, ensuring sustainable cultural transformation.

In summary, this research advocates for a holistic, behaviour-focused approach to quality management in the residential sector, underpinned by cultural change, targeted training, and collaborative technological innovation.

# 1. Introduction

## Project Background

The current "quality management" emphasis in the construction sector primarily focuses on the finished project, with much less attention given to quality management during construction (Chen & Luo, 2014). The quality of New Zealand homes is determined by the ability and willingness of industry professionals to communicate, achieve requirements and manage errors (Wardle & Duncan, 2017). As a result, around 86% of new homeowners have to call back their builders to fix defects after the first occupancy (Knight & Guerrero, 2024). The occurrences of quality issues in residential buildings have dire consequences on end-users, construction professionals and the industry as a whole (Rotimi, 2013; Sampford et al., 2024; Sandanayake et al., 2022).

The key recommendations for raising the quality are education and training in the workforce, utilising technologies to contain and reduce errors and improving the construction process (Gordon & Curtis, 2018; Love, Smith, et al., 2018; Matthews et al., 2024). Recently, the focus of quality management has shifted from post-control to in-process control and pre-control, which drives "Right first time" (RFT) (Get it right initiative Ltd, 2019). If work quality meets standards or specifications in each process, there is a high probability that the final product will meet the standards. Hence, factors such as workers' motivation, awareness, attitude, emotion, and ability will determine their behaviour and affect the quality of the product (Luo et al., 2022). However, limited research investigates individual behavioural change towards proactive quality management and RFT.

While behaviour change is a difficult process, many psychology theories try to explain why and how individuals or groups change their behaviour. Various factors, including environmental context, sociological, cultural, and psychological (individual) characteristics, influence the propensity toward behavioural change. It is widely believed that humans cannot directly engage with the goals they wish to achieve. Instead, they require a clear understanding of the actions they must take, informed by the resources at their disposal and underlying principles of cause and effect (Sunding & Ekholm, 2015). This insight is crucial for managing the complexities of the present situation in quality management, focusing on rework and defects (passive quality management) and successfully progressing toward the desired future state, RFT (proactive quality management).

This research, therefore, is guided by psychology theory for behaviour change, to investigate the underlying issues in quality management at the individual level. The theory of planned behaviour (TPB) is used to guide data collection since it is based on the premise that a person's motivation to change a behaviour is shaped by the opinions of others around them and their perceptions of how easy it is to implement that behaviour

(Ajzen & Schmidt, 2020). This resonates with the consideration that quality issues are produced and handled in the social practices of construction projects (Koch & Schultz, 2019). The insight gained through individuals' behaviour intention of RFT provides the baseline to develop interventions addressing the needs in the residential sector.

## Research Aims

This project seeks to promote behavioural change and proactively tackle quality issues by deepening our understanding of the barriers and enablers in quality control within the residential sector. By identifying these factors, we aim to create more effective strategies for improving quality management practices. The research will focus on the following key questions:

**RQ1:** What are the behavioural intentions of professionals in the residential sector concerning quality management?
This question aims to uncover the attitudes, motivations, and intentions guiding professionals' quality management approach. Understanding these factors will help identify areas where behavioural change is necessary and provide insights into how professionals perceive and engage with quality control practices.

**RQ2:** How can intervention programs be designed to promote and institutionalise positive quality management behaviours?
This question explores the development of targeted intervention programs that can encourage professionals to adopt better quality management practices. It focuses on identifying strategies and methodologies that can effectively foster a culture of quality, ensuring that positive behaviours are promoted and sustained over time.

By answering these research questions, the project contributes valuable knowledge to the field of quality management, providing insights that can guide the development of more effective intervention strategies and foster long-term improvements in the residential sector's approach to quality control.

# 2. Quality management in the construction industry

## 2.1 Definitions of quality

Defining quality in the construction industry is inherently challenging due to its multifaceted and subjective nature. Quality encompasses not only the structural integrity and durability of a project but also its aesthetic appeal, functionality, and compliance with specifications and standards. Each of these elements is prioritised differently by various stakeholders, such as clients, contractors, and end-users, leading to diverse and sometimes conflicting interpretations of what constitutes quality.

Quality in construction is examined and investigated in the form of rework, error management and defects. Many definitions of quality and rework centre on the concept of conformance to established requirements or specifications. This means that a product is considered to be of good quality if it meets the predetermined criteria outlined in the project documentation (Love & Smith, 2018). However, it is argued that even if the initial work met the specified standards, it is not necessary to achieve quality. Hence, a broader perspective on quality is needed that considers the overall functionality and performance of the building, as well as the needs and expectations of the client (Curtis et al., 2021). Another main focus of quality management is to regard quality as a process that involves implementing systems and processes to ensure that work is carried out correctly and consistently (Egwunatum et al., 2022).

Definitions of quality abound in the literature. However, the absence of a uniform definition of quality presents significant challenges impacting project outcomes and stakeholder satisfaction. Quality becomes a subjective concept without a standardised definition and can vary widely across different projects and companies. This variability can lead to misalignment between client expectations and contractor deliverables, resulting in disputes and decreased project efficiency. Similarly, the lack of differentiation between the terms used to describe “lack of quality”, such as rework and defects, can lead to inaccurate and incomplete measurements. This hinders the establishment of universal benchmarks and best practices, complicating efforts to enhance industry standards and performance.

The fact that cost of quality encompasses all costs related to ensuring that a product is of good quality, including prevention, appraisal and failure costs. The main research in construction quality management focuses on measuring quality and the root causes of quality problems.

## 2.2 Measuring quality costs

Inherited from the ambiguity of the definition of quality, there is no consonant view of what quality cost means and how it can be measured (Aoieong et al., 2002). Most research focuses on the tangible costs of quality, in the notion of quality costs and rework

costs. The most widely recognised approach is the prevention-appraisal-failure (PAF) model, which includes prevention, appraisal, and failure costs (Porter & Rayner, 1992). The cost of quality (COQ) is recognised as a prominent approach for qualifying quality in financial terms and optimising resource use and cost-saving through preventive measures and evaluation activities (Sharma & Laishram, 2024). The COQ's key elements are prevention, appraisal, and failure costs. Prevention costs are the costs related to actions taken to investigate, prevent or reduce the risk of nonconformity or defect, while appraisal costs are the cost of evaluating the achievement of quality requirements. Failure costs compose the costs of nonconformity both internally (discovered before the handover) and externally (discovered after the handover). Among these costs, failure cost is the most difficult to identify and collect (Aoieong et al., 2002). Reported rework costs range from less than 1% to over 20% of a project's contract value (Love & Smith, 2018). These figures, however, are often unreliable and do not include indirect costs such as delays, disruption, claims and litigation. The cost of quality remains a "known, unknown", which is considered a challenging issue to justify any investment in quality improvement measures.

Other benefits, or indirect costs of rework, introduced by quality management, such as improved productivity (Love & Smith, 2018), reduced workers' levels and unsafe practices (Love, Teo, et al., 2018), have yet to be empirically quantified. This limitation in measuring quality costs provides an incomplete picture of the value of quality management.

## 2.3 Root causes of quality problems

Studies emphasise that understanding why quality problems, such as defects, occur is crucial for developing effective strategies to prevent them and, ultimately, enhance overall project quality (Mostofi et al., 2023). Many such studies have identified singular causal factors, including poor communication, workmanship and quality management, which have been repeatedly recognised as key defect causal factors (Ye et al., 2015). However, these factors lack clarity regarding the scope and consequences and hence oversimplify the interdependency and complex relationships that lead to the occurrence of quality issues in construction (Love & Smith, 2018).

It is arguable that the factors that influence the end outcome of a construction project stem from the first principles of best-practice procurement and effective contracting. The main issue caused by the procurement selection is that the current practices do not specify how the project will be delivered and who will be responsible. From the quality aspect, achieving so is even more challenging because of the ambiguous and subjective nature of quality. Curtis et al. (2021) claim that the focus on the lowest cost rather than the highest value during the construction procurement process was detrimental to the end quality of the building. Consequently, it has a domino effect on the contractors involved, where the cost becomes the only meaningful measurement. Cost-based

procurement system selection diminishes the opportunity to assist customer satisfaction and achieve overall build quality.

Focusing solely on identifying singular causes of quality problems has been shown to be ineffective in creating strategies to reduce and manage rework, as it neglects the underlying conditions that lead to the events causing it. As a result, studies use various mechanics, such as the Swiss cheese model (Aljassmi et al., 2013) and cognitive mapping (Jingmond & Ågren, 2015), to establish frameworks for identifying and analysing the correlations and inter-causalities of the root causes of defects in construction (Lambers et al., 2023). The frameworks (Atkinson, 2002; Mostofi et al., 2023) developed to understand defect causation acknowledge that human error is the immediate cause of many construction defects. Various factors contribute to human error, such as lack of knowledge and skills and inadequate supervision.

The research examined the social and organisational factors that foster environments prone to errors and highlighted the impact of social dynamics and power relations within construction projects (Bugdol, 2020; Love, 2020). Further investigations extend to modelling and simulating the interactions and interdependencies among various variables contributing to rework. However, the dynamic and fragmented nature of the construction industry poses significant challenges in applying these studies in practice. As a result, while these frameworks may provide valuable insights, their practical implementation is limited.

## 2.4 Right first time

Research focusing on defects and error management tends to emphasise problems rather than solutions, limiting the potential for meaningful change. The shift from a focus on rework to a commitment to achieving the “Right first time” (RFT) is crucial for fostering a culture of quality and efficiency within organisations (Get it right initiative, 2018). When research and discussions revolve around the concept of rework, it tends to highlight shortcomings and errors, which can create a culture of blame and negativity. In contrast, promoting RFT encourages a proactive approach to quality management (Ford et al., 2023). The RFT approach aligns with Total Quality Management (TQM) principles, emphasising a comprehensive commitment to quality. TQM advocates for continuous improvement, customer satisfaction, and employee involvement, which are key elements that resonate with the RFT philosophy (Ali & Johl, 2022).

Despite the critical role that individual behaviour plays in driving RFT in the construction industry, limited research focusing on the individual level remains. Much of the existing tends to concentrate on the industry level, (Ford & Gosling, 2024; Riaz et al., 2023), often overlooking how individual actions, attitudes, and social relations directly influence quality.

## 2.5 The theory of planned behaviour

This research delves into the individual level of workers in the residential sector to explore their evaluation towards RFT, identify support needed from others, and access the tools and knowledge that can aid them in managing quality proactively. In this study, TPB is employed to guide the data collection to cover the residential sector context, social expectations and individual perception. The TPB was developed Ajzen (1991) as a general predictive model explaining behavioural intention across many contexts, from physical activity to drug use, from recycling to choice of travel model (Ajzen & Schmidt, 2020). The TPB is also increasingly used as a framework for designing and evaluating the effects of behaviour change interventions (Hagger et al., 2022).

As illustrated in Figure 1, intentions are the most proximal determinant of behaviour, which are influenced by behavioural attitude, subjective norm, and perceived behavioural control, each with its own determinants (Kan & Fabrigar, 2017). In TPB, intentions are defined as the indication of an individual's willingness to perform a given behaviour (Jimmieson et al., 2008). Behavioural attitude refers to an individual's evaluation toward performing a specific behaviour, be it favourable or unfavourable (Jimmieson et al., 2008). This attitude is determined by a person's belief of whether this behaviour will lead to a particular outcome (their behavioural belief). Subjective norms refer to the general perception of the prevailing opinion held by society and significant others about them performing a behaviour. In the context of construction quality management, that is, a person's perception of whether those closest to them think they should or should not manage quality proactively. Subjective norms are a product of normative beliefs and the motivation to comply with a particular referent. Normative beliefs refer to the perception of an individual's thoughts towards performing a particular behaviour. The importance of this referent to the individual will determine the value given to this belief. The more pertinent the referent is, the more likely the behaviour will reflect what they believe the referent expects from them. Perceived behavioural control (PBC) refers to the perceived difficulty level in performing the target behaviour. PBC is the only determinant with the potential to influence behaviour both directly and indirectly via its influence on behavioural intentions, and directly.

Hence, TPB's primary elements, behavioural attitude, subjective norm, and perceived behavioural control, serve as a framework for guiding data collection. This approach yields valuable insights into the challenges and motivations of construction workers to inform the development of targeted intervention programs designed to enhance their intention to drive RFT.

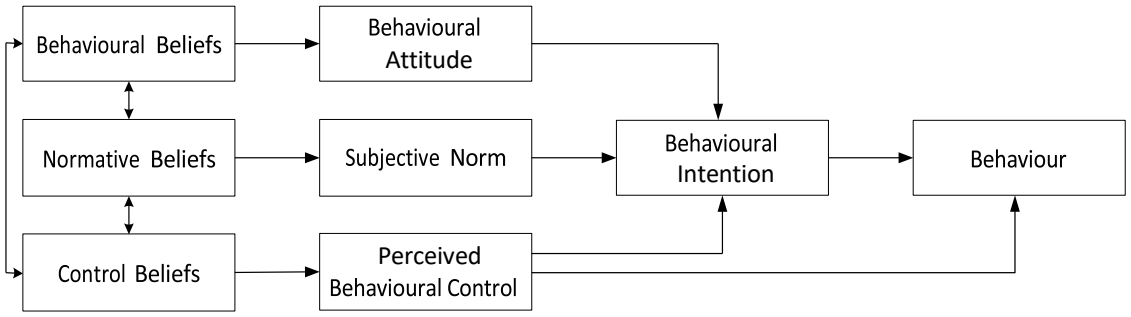


*Figure 1 Structural diagram of the theory of planned behaviour (Ajzen, 1991)*

# 3. Research methods

## 3.1 Ethics

Full ethics approval for this research project was granted from the Massey University Human Research Ethics Committee (approval number 4000027454). Consent was granted from all participants prior to data collection.

## 3.2 Study Design

In this study, a phenomenological approach was employed to explore construction professionals' perceptions of quality control and management. This approach is particularly suitable for exploring the lived experiences of professional workers, revealing the essence of their perceptions and actions (Creswell & Creswell, 2018). By focusing on their subjective experience, we aimed to understand how organisational contexts shape an individual's operational practices in quality management.

Through semi-structured interviews, participants shared their personal narratives, offering insights into the working environmental dynamics and their interaction with individual beliefs that influence their practice. The phenomenological analysis allows us to capture the richness of these experiences, highlighting the interplay between individual perceptions and broader social and environmental factors (Creswell & Creswell, 2018).

In this study, reflexive thematic analysis employed the inductive method. The inductive method allowed themes to emerge organically from the data, honouring individuals' unique perspectives and experiences without imposing preconceived categories. This approach ensured that the voices of participants were central to the analysis, capturing their insights and reflections.

In line with recommendations from Clarke and Braun (2013), questions were designed to remain broad and open-ended and were delivered in a flexible manner, encouraging participants to feel comfortable and self-directed in their responses.

**Participants**

The research method involved conducting interviews with participants selected from the operational level within the residential sector. To facilitate this, the research team visited various residential construction sites across the wider Auckland area, engaging directly with workers to ensure a representative sample. The data collection period spanned from September to December 2024, allowing for in-depth conversations that captured the experiences and perspectives of these individuals. However, a limitation of this participant selection is that it may not fully represent the diversity of roles within the sector, as only those present on-site at the time of visits were included. To address this limitation, the research team proactively contacted various professional bodies to engage interview participants from different segments of the residential market, including both high-end and affordable housing. This approach aimed to enrich the data set and provide a more comprehensive understanding of the operational challenges and experiences across the diverse landscape of the residential construction industry. Participant profiles are summarised in Tables 1 and 2.

| ROLES | NO. | % |
|---|---|---|
| **Builder** | 15 | **24** |
| **Carpenter** | 3 | **5** |
| **Consultant** | 4 | **6** |
| **Developer** | 2 | **3** |
| **Electrician** | 3 | **5** |
| **General worker** | 2 | **3** |
| **Painter** | 3 | **5** |
| **Plumber** | 4 | **6** |
| **Project manager** | 22 | **35** |
| **Site engineer** | **4** | **6** |

*Table 1 Roles of interview participants*

| Characteristics | Categories | No. | % |
|---|---|---|---|
| Years of experience | Less than 5 years | 31 | 50 |
| | 5 to 10 years | 14 | 23 |
| | 10 to 20 years | 10 | 16 |
| | More than 20 years | 7 | 11 |
| Employment status | Self-employed | 18 | 29 |
| | Employee | 44 | 71 |
| Company size | Small (<20) | 31 | 50 |
| | Medium (20-49) | 11 | 18 |
| | Large (>50) | 20 | 32 |

*Table 2 Characteristic of participants*

## Procedure

62 semi-structured individual interviews were conducted with construction workers who have working experience in the residential sector to investigate their understanding, behavioural attitude, subjective norm and perceived behavioural control of proactive quality management. The interviews were conducted in person to ensure confidentiality and privacy, and only the researcher and participant were present. There were five sections of interview questions (see Appendix). The data for this study relates to sections three to five. Section one is about general information for the participant profile. In section two, participants were asked about their understanding of RFT and related activities. In section three, the focus was on the role of subjective norms in proactive quality management. Section four explored the behavioural attitude and outcomes of RFT. The last section probed the actual and perceived behavioural control. All interviews were transcribed verbatim.

## Analysis

All interviews conducted were thoroughly listened to, and each recording was transcribed using Microsoft Word to ensure accuracy and detail. The research team thoroughly read each transcript to verify the content and confirm its fidelity to the original recordings. Each transcript was assigned a unique numerical code to maintain participant anonymity, ensuring that personal identifiers were removed from the analysis. ATLAS.ti software was employed to establish an initial codebook for the initial coding process. These codes focused on the semantic meaning of the data but gradually developed during codebook refinement to incorporate latent (deeper level) interpretations. This refinement involved conversations between the research team members regarding data interpretation and reflecting on biases that might be influencing the data interpretation. Following this, individual codes were articulated to broader themes by grouping related codes into potential themes. This involved examining how various codes interrelate and may collectively contribute to an overarching theme. As themes were finalised, sub-themes were refined and renamed, providing a structured hierarchy of meaning within the data (Braun & Clarke, 2006). Finally, the thematic presentation was reviewed with further input by the whole authorship team.

## Subjectivity and Reflexivity Statement

Researcher reflexivity is essential in recognising subjectivity when coding qualitative data and forming themes, particularly in a construction context (Braun & Clarke, 2022). Throughout the analysis process for this project, the researchers consistently reflected on their assumptions and practices to critically assess how these factors impacted their approach to data analysis (Braun & Clarke, 2022). For the purposes of this project, the research team engaged in both epistemological and personal reflexivity to transparently

address how their background and perspectives as researchers influenced the findings. Epistemologically, the research team critically examined the theoretical frameworks and methodologies chosen for the project, reflecting on how ecological systems theory and thematic analysis shaped the interpretation of the data. Personally, the team reflected on how their professional background and beliefs could potentially influence the research. They acknowledge that their experiences may lead to an empathetic bias towards participants' challenges, potentially affecting their interpretation of participants' narratives. By documenting their reflections, the research team aimed to provide a transparent account of how both methodological choices and personal experiences influenced the research findings, thereby enhancing the study's credibility and depth.

# 4. Research Findings

The findings were presented into three main categories following the theory of planned behaviour. Each of these addressed the individual perceptions of RFT and the motivation and resources required for its implementation, respectively. These would pave the foundation for the development of intervention strategies.

## 4.1 Behavioural attitude

Behavioural attitude pertains to the individual's positive or negative evaluation of performing a specific behaviour, shaped by beliefs about its outcomes and the value assigned to those outcomes. During the interviews, participants were asked to discuss any positive and negative impact that RFT can have, including on them as individuals and their businesses.

The majority of participants (n=50) perceived RFT as having a positive impact. Nine participants considered the impact inclining to be positive, and three thought it was negative since RFT costs more to implement than the benefits received. Further discussion on the impacts of RFT, including financial and non-financial impacts, reveals the themes of participants' behavioural attitudes.

### 4.1.1 Positive evaluation

**Cost saving and efficiency**

Generally speaking, the participants showed a good understanding of how RFT principles directly translate to optimised resource allocation and enhanced productivity for their firms. For example, as stated in one remark, "*Getting things done right the first time will prevent us from spending more money and time on double work or re-work*". This quote encapsulates the core financial rationale behind RFT. Participants clearly recognised that rework caused by initial errors can incur significant costs, not just in terms of additional

labour but also wasted materials and lost time. RFT can minimise the risk of costly mistakes, safeguarding both budget and schedule.

The participants also recognised the powerful impact of RFT on project timelines and overall productivity. As one quote mentioned, "Positive impact is saving time, so we can spend time on other projects". Teams can maintain project schedules and deliver projects on time, avoiding delays caused by rework. This efficiency frees up valuable resources, time, labour, and budget, which can be redirected towards new projects, boosting the company's capacity and output. The ability to take on more projects due to the certainty of streamlined workflows directly translates to increased revenue and business growth.

**Reputation and trust**

Beyond the tangible benefits of cost savings and streamlined workflows, participants consistently emphasised RFT's critical role in building a sterling reputation and establishing a competitive edge within the landscape of residential construction.

As one participant noted, "*Other companies are more likely to choose you for quality work*". This quote reveals the core of RFT's influence on a company's reputation. In the competitive residential sector, a company's past performance serves as a powerful indicator of future success. The participants realised that a reputation for delivering high-quality work is not desirable but essential. Most participants indicated an understanding that doing RFT can cultivate a sense of trust with clients. They believed doing RFT could demonstrate their commitment to professionalism and client satisfaction. This positive client experience can be a powerful marketing tool, generating word-of-mouth referrals and repeat business.

Some participants further explained that the reputation of doing RFT can elevate their companies' standing within the market. The reputation of quality "*can open doors to new opportunities and partnerships*", as one participant recognised. Construction companies' priority on quality can demonstrate to the clients that their time and investment are valued highly. The participants believed that this could attract new clients seeking high-quality workmanship and willing to pay higher prices for their service. Companies' reputation for quality also helps attract like-minded firms to create a network of mutually beneficial partnerships.

### 4.1.2 Mixed Impact

Nevertheless, some participants considered that high quality sometimes requires sacrifice or trade-off other project priorities. The interplay between individual company benefits and collective project success emerged as a recurring theme, reflecting the complexities of implementing RFT in multi-stakeholder environments.

**Balancing the competing priorities**

Several comments suggested that while RFT may extend timelines although it may ultimately lead to higher-quality outputs. A participant stated "*The construction process will be longer because RFT might influence their effectiveness, but in the long term, the product we present will have a higher quality.*" This statement touches on the trade-off between short-term speed and long-term quality inherent in RFT principles. In residential construction, the longevity of materials and workmanship is critical. Quality issues that go unnoticed during construction can manifest years later, leading to costly repairs, warranty claims, and client dissatisfaction.

Time investment in RFT may not always be perceived as affordable or achievable. "*I will need to spend more time checking the quality and making a plan. You know, managing various teams and accommodating all of their needs.*" This quote highlights the tension between the time required for effective quality management and the demands of project schedules. While this investment in time has a clear payoff in terms of enhanced reputation and reduced future rework, it also creates scheduling challenges, particularly in an industry where tight deadlines and delays can have significant financial and reputational consequences. This tension is especially pronounced in projects where teams are pressured to deliver results quickly, often at the expense of quality. Participants described these situations as highly stressful, with team members feeling overwhelmed by the expectation to perform under unrealistic timelines. This pressure worsens when contractors or subcontractors do not share the same commitment to quality, creating friction and further complicating the implementation of RFT.

Furthermore, there are the financial implications of RFT due to different contract types. "*RFT benefits projects with cost-reimbursement contracts but not with lump sum contracts due to the significant investment in time and money without tangible returns in some case*s." Participants noted that cost-reimbursement contracts, which provide flexibility in managing project costs, are more conducive to RFT because they allow for the additional time and resources needed for quality assurance. In contrast, lump-sum contracts, which fix the project price regardless of actual costs, often discourage RFT because they incentivise cutting corners to save time and reduce expenses. This dynamic creates challenges for companies striving to uphold RFT principles, as the financial risks of investing in quality are heightened under lump-sum contracts. For example, participants described how tight budgets and low-profit margins in lump-sum projects often force companies to prioritise cost savings over quality, resulting in substandard work and frequent call backs. These experiences are especially common in affordable housing projects, where clients prioritise the lowest cost over long-term value.

**Challenges of benefits realisation**

The participants also expressed doubt and uncertainty about whether these benefits would be fully realised. As one participant pointed out "*Only if all teams of the projects stick with the RFT, then the benefits would be realised.*" The construction ecosystem is

inherently complex, involving numerous stakeholders with varying priorities, timelines, and processes. For RFT to achieve its full potential, all teams must adhere to the agreed-upon schedule and maintain a commitment to quality.

Participants expressed concern that the schedule certainty created by their adherence to RFT might benefit other teams more than their own company. For instance, if one team completes their work on time and to a high standard, but subsequent teams do not follow suit, the overall project may still face delays and quality issues. Participants also noted that many clients, particularly in the affordable housing sector, lack an understanding of how cost-driven procurement practices can negatively impact project outcomes. Participants expressed frustration with the prevailing practice of prioritising the lowest cost over quality, which left little room for companies that take pride in their work. Some participants called for greater industry-wide awareness of the trade-offs in construction projects, as one participant suggested "*It calls for an industry-wide understanding of trade-off projects, also the education of clients*".

### 4.1.3 Impact on individuals

The interviews reveal that the impact of RFT extends beyond operational and financial benefits to touch on the personal and professional lives of employees. While RFT contributes to the success of construction projects, it fosters an environment where workers feel valued, motivated, and empowered to grow in their roles. In addition, a small number of participants have also mentioned personal benefits, such as better job security, career advancement, and higher pay (n=7). However, participants also noted that the realisation of these benefits is contingent upon the company's culture and leadership commitment to quality. Without a supportive environment prioritising quality, these positive outcomes risk being diminished or lost altogether.

Some hourly-paid workers stated "It "(RFT) has nothing to do with me". This statement highlights a significant gap in the perceived relevance of RFT among certain workforce members. RFT may appear to have little personal significance for workers who are paid by the hour or are less directly impacted by project outcomes. Without a clear connection between RFT principles and their own roles, these workers may feel disengaged or indifferent toward the initiative. This lack of alignment can hinder the successful implementation of RFT, as the commitment of every individual involved is essential to its success. This disconnect underscores the need for companies to actively demonstrate how RFT benefits all levels of the workforce—not just management or clients.

One individual shared their personal experience, stating, "*Once I kept getting things done correctly as the experience grew, I was promoted to the team lead*". This quote highlights the direct relationship between RFT and individual career development. Participants emphasised how a culture of quality, fostered through RFT, can create opportunities for employees to advance professionally. As employees gain experience and demonstrate

their ability to deliver high-quality work consistently, they not only build their technical skills but also position themselves for promotions, increased pay, and greater job security. This underscores how RFT can serve as a stepping stone for personal growth and career progression within an organisation.

The interviews also reveal how RFT positively influences employee morale. Individuals are more likely to feel valued and motivated in an environment that prioritises quality and recognises employees' contributions. Knowing that their efforts are aligned with a company's commitment to excellence fosters a sense of pride and purpose in their work. This motivational boost can lead to higher levels of engagement, reduced turnover, and a stronger overall workforce.

While participants recognised the potential for RFT to impact individuals positively, they also pointed out that this impact is highly dependent on the company's culture and leadership. As one participant noted, some employers or supervisors prioritised speed and progress over quality, which can undermine the benefits of RFT for employees: "*On certain occasions, I was asked to get things done, instead of doing it right*". This statement reflects a critical challenge in implementing RFT: the misalignment between an organisation's stated values and actual practices. When companies fail to prioritise quality or pressure employees to prioritise deadlines over doing things correctly, the positive impact of RFT on morale and career development is diminished. Employees may feel undervalued or frustrated if their efforts to uphold quality are overlooked or dismissed in favour of expediency. Over time, this disconnect can erode motivation and lead to disengagement, ultimately harming both the individual and the company.

## 4.2 Subjective norm

Subjective norms refer to the perceived social pressure to perform or not perform the behaviour. This is influenced by the beliefs about whether people who are important to the individual think they should engage in the behaviour. To implement RFT, subjective norms are crucial in influencing whether individuals and teams adhere to this principle.

For this study, participants were asked to identify the subjective norm referents. These referents are the stakeholders or individuals who significantly influence and motivate them to engage in RFT. Additionally, participants were asked to specify the types of support that effectively encourage their practice in RFT. This included exploring various forms of motivational support, such as financial incentives, professional development opportunities, peer recognition, and organisational resources.

Participants identified five groups of referents, most frequently mentioned as clients, team members, supervisors, family members and employers, and self, as illustrated in Figure 2. Many participants referenced multiple groups, highlighting the interconnected nature of these roles in successfully executing tasks and projects. For instance, one remarked, "*Clients, supervisors, teammates, and consultants all play a vital role in doing RFT*", emphasising the collaborative effort required.

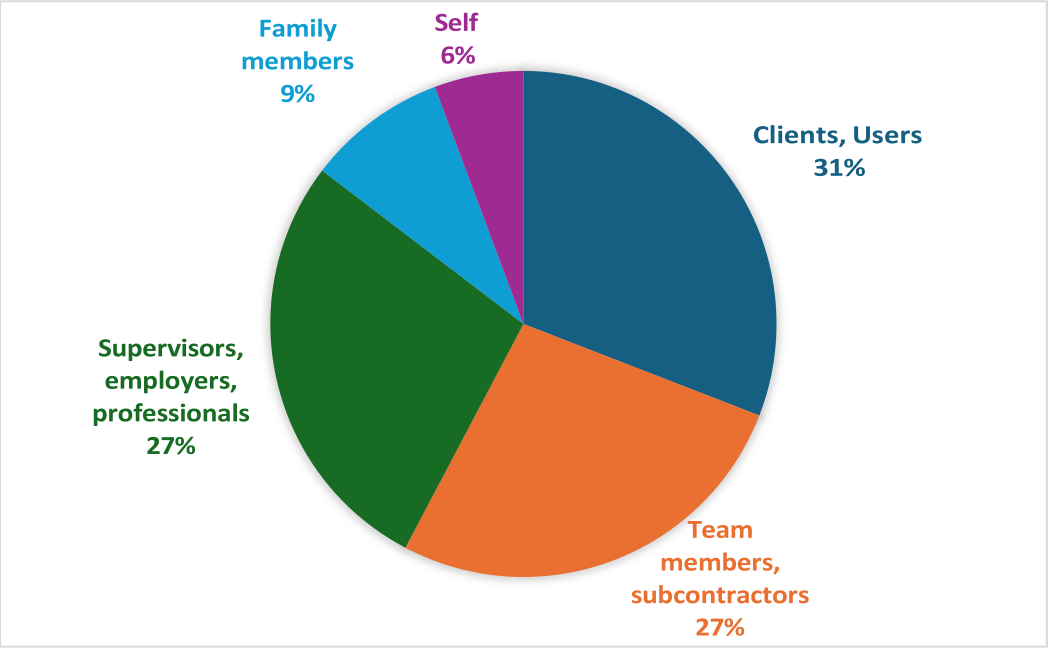


*Figure 2 Frequencies of referents mentioned*

### 4.2.1 Clients as subjective norm

Clients and users emerge as the primary referents. Participants strongly associated client satisfaction with their professional duty and the company's reputation, suggesting a high motivation to comply with perceived client expectations regarding quality and functionality. This emphasis on client satisfaction as crucial for company success underscores a perceived power dynamic where clients hold significant sway over operational decisions.

Some participants claimed they are motivated to meet client expectations, but their ability to consistently achieve RFT heavily depends on client understanding and support. They considered adequate project timeframes approved by clients as essential for reducing errors and rework. Unrealistic deadlines, often driven by client demands, can undermine RFT by forcing workers to sacrifice quality over speed.

Furthermore, a need for greater clarity and alignment between client expectations and the realities of project delivery has surfaced. The support clients can provide is being "*reasonable*" and acknowledging that "*quality comes with costs*". This indicates the importance of transparent communication regarding quality standards, the impact of project changes, and the financial investment required to deliver RFT consistently.

Other client support specified by the participants included well-defined project requirements and prompt access to information. Well-defined project requirements significantly reduce the likelihood of revisions and reworks, directly supporting RFT. Prompt access to necessary information, such as material specifications and missing design details, prevents costly delays.

### 4.2.2 Team members

Achieving RFT is a collective effort requiring teamwork among colleagues and subcontractors. The importance of shared objectives and collective ownership is highlighted as a social support element. As one participant stated: "*The whole project team needs to have this mindset and put effort into it to achieve RFT*". This shared responsibility fosters a supportive environment where team members feel empowered to contribute their expertise and work together to address quality issues.

Clearly defined roles and responsibilities within the team structure ensure accountability and streamline workflows. The statement that "*every trade shall be responsible for their own work is the way to encourage subcontractors to get things done right the first time*" reveals the need for clear accountability. This approach not only encourages individual trades to prioritise quality but also streamlines the overall workflow, reducing the potential for errors and rework.

Furthermore, the presence of experienced colleagues and senior staff emerged as a valuable asset in supporting RFT implementation. Their knowledge and experience provide a safety net, mitigating potential costs and delays associated with rectification work. Beyond practical support, these experienced individuals also contribute to a culture of learning and improvement, where knowledge is shared and best practices are passed on.

### 4.2.3 Supervisors and managers

Besides overseeing daily work, supervisors and managers act as intermediaries between clients and frontline workers, providing essential feedback and emotional support. Participants considered feedback and emotional support provided by supervisors and managers influential. This direct engagement, characterised by open communication and a willingness to address worker concerns, is essential for maintaining morale and encouraging a proactive approach to quality. One participant noted, "*Having an open discussion with my supervisor, I should be able to openly talk about my doubts and questions if I have any*." This claim implies the importance of approachable leadership that values worker input and creates a safe space for open dialogue.

Beyond direct interaction, supervisors and managers also contribute to a culture of continuous improvement, a crucial element of sustained RFT implementation. The participant stated, "*My boss creates a culture that allows me to provide feedback and*

*improvement of processes exemplifies this commitment to ongoing learning and refinement.*"

Furthermore, managerial support helps to mitigate the pressures that can hinder RFT. One participant bitterly stated, "*I wish when a delay happens, my manager does not rush to me and think it is my fault.* " They explained that they face different issues on sites, and sometimes it is beyond their ability to solve quality issues. When their managers listened to their reasoning and stepped in to solve the problems, they felt "*I've got your back*". This experience highlights the need for leadership that prioritises quality and supports its workforce in consistently achieving RFT, even when faced with external pressures.

### 4.2.4 Family members

Family members serve as a powerful and perhaps unexpected source of motivation. While not directly tied to the workplace, the desire to provide financial security and earn family pride drives commitment to quality. Some participants expressed that supporting their loved ones fosters a strong work ethic, while others found motivation in the respect and admiration their craftsmanship brings. A participant stated, "*My sense of responsibility towards my family makes me want to earn more for my family for a better substance*."

This intrinsic motivation, rooted in family approval and admiration, went beyond financial reward and tapped into a deeper sense of purpose and identity. One participant shared, "*Encouraging words from family members keep high spirits and motivation, taking pride in my job*." Interestingly, a potential cultural influence on the significance of family as a motivating factor for RFT is noted. Participants of Asian ethnicity more frequently cited family encouragement and values as key drivers behind their commitment to quality. This finding suggests that cultural norms, particularly those emphasising family honour and the importance of hard work, can significantly shape work ethic and professional pride.

### 4.2.5 Self

Several participants (n-7) identified themselves as the driving force behind their commitment to quality, using phrases like "*endogenetic force*" to describe their internal motivation. This perspective emphasises the importance of personal character, work ethic, and a sense of professional pride in delivering high-quality work. As one participant articulated, "*This isn't an external question; it depends on someone's character. In this industry, we can sometimes be guilty of doing the bare minimum to meet obligations*." This statement illustrates the belief that going above and beyond minimum standards is a matter of personal integrity and a commitment to excellence.

This emphasis on internal drive was echoed by a manager who described RFT as "*a personal thing*," implying that it cannot be forced but rather emerges organically from within individuals who are intrinsically motivated to perform at their best. This

perspective suggests that companies seeking to cultivate a culture of RFT should focus on attracting and retaining individuals whose personal values align with this principle.

Participants who emphasise personal accountability consider that it can lead to a form of natural selection within the workforce. They witnessed workers not intrinsically motivated to achieve RFT were less likely to thrive in an environment where these standards are highly valued. Some of these workers left the company as a result. As described by participants, this natural filtering process ensures that the remaining workforce is composed of individuals who are inherently driven to deliver exceptional quality.

## 4.3 Perceived behaviour control (PBC)

PBC is a key component of the TPB, which refers to an individual's belief about their capability to perform a given behaviour. In this project, the interview participants were asked to name the requirements for applying RFT. According to TPB, when people feel they have access to the necessary requirements, they are likely to believe they can perform the behaviour.

Thematic analysis of the interview data reveals four key facilitators of PBC, including effective tools, scheduling and planning, project information communication, and training and knowledge transfer.

### 4.3.1 Effective tools

Some participants, especially the tradespeople doing physical work on sites, strongly associated having the right and effective tools with their ability to achieve RFT. More than ten participants highlighted the critical role of adequate material resources in influencing their confidence and capability to do RFT. Quotes like, "*As a carpenter, more effective tools can help me to work better*" and "*You must have the right tools, mainly various types of saws*," demonstrate a direct link between tool quality and perceived work quality. Participants explicitly stated that better tools lead to better work. The examples provided are not generic. Workers specified the tools needed, such as gears for precise plywood cutting and machines for installing windows, indicating a clear understanding of the tool-task relationship for RFT. The quotes emphasise how appropriate tools enhance efficiency, including "*shorten the time you spend on the task*" and precision "*control the precision of the work*". This connection is crucial for RFT, as time wasted on corrections and rework due to inadequate tools directly contradicts the principle. The desire for "*advanced tools*" such as automatic wall spraying machines and electric sanders suggests an awareness of how technology can contribute to RFT. This is also related to social exchange theory, where workers experience satisfactory and comfortable working conditions, and they repay companies with improved service quality (Yee et al., 2008).

### 4.3.2 Scheduling and planning

The interview data reveal a strong link between effective planning and the ability to achieve RFT. This finding highlights how intangible processes, not just physical tools, are crucial for creating an environment where RFT is achievable. Participants explicitly acknowledged the tangible benefits of scheduling and planning. The quote, "*If you plan things ahead you will be saving more time and money*," demonstrates a clear understanding that efficient scheduling directly impacts both project costs (rework reduction) and overall quality (RFT). Some participants used tools like MS Project, Excel, and project management apps for scheduling and communication. This emphasises the need for accessible, user-friendly technology to support RFT at the project level. The use of CCTVs for "real-time progress" and remote inspection by two participants highlights a proactive approach to quality control. This suggests a move towards utilising technology for scheduling and ongoing monitoring to ensure adherence to RFT principles. Furthermore, some participants touched on the distinction between single-family and multi-unit projects, regarding software use, which is important. It suggests complexity influences perceived control, with larger projects demanding more sophisticated planning tools and collaboration for successful RFT.

### 4.3.3 Information communication

Effective project information communication is essential for RFT, ensuring shared understanding, reducing errors, and fostering collaboration. The interview data suggest that bridging the gap between traditional practices, varied technological adoption, and diverse workforce skills is essential for maximising RFT success. While weekly meetings and pre-construction briefings are key, reliance on printed drawings and verbal instructions can lead to misinterpretation, especially for inexperienced workers or those facing language barriers. Participants expressed a strong preference for intuitive visual tools like 3D models to improve comprehension and reduce errors. However, uneven technology adoption, particularly among subcontractors, limits technology's full potential. A worker stated, "*All we require is for the boss to sketch out a rough plan for* us", highlighting a reliance on potentially error-prone communication methods. The data also reveals a strong desire for intuitive visualisation tools, particularly among workers struggling with traditional 2D drawings. One worker confessed, "*I'm still struggling with understanding the plan... I believe a more straightforward visualisation can provide me [with] a better understanding*".

Thus, achieving consistent RFT may require a multi-level communication strategy. Regular meetings with clients, site teams, and consultants are crucial for maintaining alignment and addressing emerging challenges. However, these traditional methods must complement visual aids like 3D models, physical process samples ("*We would consider doing a sample room if the project size is large*"), and on-site technology like tablets displaying 3D drawings. Providing workers with diverse, accessible information

Channels give them a clearer understanding and minimise reliance on error-prone interpretations.

### 4.3.4 Training and knowledge transfer

Over half of the interview participants (n=37) named robust training and knowledge transfer as requirements to support RFT implementation. The analysis highlights key themes of the desired training approaches.

1. Practical skills and standardised procedures
   Participants wanted to move beyond the theoretical explanations and engage in practical exercises, simulations, and on-site demonstrations directly related to their daily tasks. One builder considered "*Training for improving workmanship standards*", emphasising the need for training that directly translates to improved on-the-job performance. The training should cater to varying levels of experience, providing foundation knowledge for apprentices, such as "*teach the boys how to read the drawings, how to use the tools properly*", while offering opportunities for seasoned workers to refine their skills and learn new techniques "*proper training for the team on the latest construction practices*".
2. RFT principles and best practices
   Participants considered it essential to clearly articulate the consequences of not achieving RFT, both in terms of project outcomes, such as delays and rework costs and potential impact on individual performance reviews or company reputation. The quote, "*Training is also a good option to change people's perception about RFTs*", highlights the need to address potential resistance or misconceptions about RFT. Several participants at the management level believed that it is crucial that RFT training is not positioned as just another task for workers. They considered that supervisors and project managers should actively participate in training, demonstrating their commitment to RFT and fostering a culture of quality from the top down.
3. Technology integration and digital literacy
   Some participants claimed that introducing new software or APPs to the workers is insufficient. Workers must understand how these tools can enhance quality and reduce errors when using new digital tools to improve quality. Only when workers agree that these tools are beneficial for their jobs will they have the desire to use them for RFT purposes. Also, training for using digital technology needs to be accessible to workers with varying levels of comfort with technology. This might involve offering multiple learning formats, such as online modules, in-person workshops, and on-site demonstrations) and providing ongoing support to build confidence.
   Participants raised concerns about how technology can help in RFT when discussing the training requirements of technology integration. The main concern

is how technology can be seamlessly integrated into existing work processes to enhance, rather than disrupt, productivity and quality. Some participants tried different APPs and digital tools only to discover they were ineffective in daily practice. The other concern is about digital collaboration. As one quote, "*Training on using [a project management app], but contractors don't normally adhere to our requirement*", highlights the importance of consistent data input and collaboration. To realise the benefits of using digital tools for RFT, all companies involved in a project must adopt such measures.

4. Mentorship and on-the-job knowledge transfer
   Creating opportunities for workers to share best practices, troubleshoot challenges, and learn from each other's experiences can be highly effective. Some participants agreed that experience is a cornerstone in achieving RFT in the construction industry. Seasoned workers bring a wealth of knowledge, practical skills, and insights that are invaluable in pre-empting common pitfalls and enhancing project outcomes. Experienced professionals are adept at identifying potential issues early, allowing for timely interventions that prevent defects and rework. Hence, a structured mentorship program can facilitate knowledge transfer and provide ongoing support. The knowledge to be diffused includes both the specified trade/areas and the construction process covering upstream and downstream activities. There is a growing expectation for management-related positions, such as site manager, to understand tasks outside their own assigned tasks, including the design process and knowledge. Access to expert advice and support from engineers, architects, and other professionals is equally important. One participant noted the significance of engineer involvement, stating, "*Engineer involvement is important for us to do RFT because it provides an opportunity for critical thinking*." This highlights the necessity of having professionals who can offer technical insights and innovative solutions.

# 5. Intervention programmes for RFT

Based on the present findings, we propose an intervention plan to enhance quality management practices by leveraging behavioural attitudes, subjective norms and perceived behavioural control to promote the consistent implementation of RFT principles across organisations.

## 5.1 Strengthening behavioural attitude

The research data suggest that the RFT outcome is generally recognised as positive. Implementing RFT can bring tangible and intangible benefits to both individuals and construction firms. However, the concerns of balancing time and costs against quality and the realisation of benefits must be addressed. Hence, interventions should focus on awareness campaigns and cultural integration to strengthen behavioural attitudes.

### 5.1.1 Awareness campaigns

The awareness campaigns aim to enhance understanding and appreciation of the RFT principles. Such campaigns can play a pivotal role in addressing the concerns regarding the trade-offs associated with RFT, particularly in terms of cost, time, and quality. This discussion outlines the development of case studies, the conduction of workshops, and the sharing of employee success stories as integral components of this campaign.

To begin with, the creation of case studies serves as a powerful tool for illustrating the tangible benefits of RFT. These case studies should focus on real-world examples where the application of RFT principles has led to significant cost savings, enhanced productivity, and improved client trust. By documenting specific projects that exemplify successful RFT implementation, stakeholders can gain insights into how avoiding rework not only reduces immediate expenditures but also fosters long-term financial health for construction firms. For instance, a case study could highlight a project that initially faced challenges due to errors and subsequent rework. By shifting to an RFT approach, the project team could demonstrate how they streamlined processes, reduced waste, and delivered a high-quality product ahead of schedule. Such narratives not only convey the financial rationale behind RFT but also serve to inspire other firms to adopt similar practices.

In parallel with the case studies, conducting workshops is essential for engaging stakeholders in meaningful discussions about the financial and reputational implications of avoiding rework. These workshops should be designed to be interactive and informative, encouraging participants to share their experiences and challenges related to RFT. Facilitators can guide discussions on the consequences of rework, emphasising how it can erode profits and damage client relationships. Moreover, workshops can incorporate financial modelling exercises, where participants can calculate potential savings associated with RFT versus the costs incurred from rework. By actively involving individuals in these discussions, the workshops can foster a collective understanding of the importance of RFT, thereby strengthening the commitment to quality practices across the industry.

Another critical aspect of the awareness campaign involves sharing employee success stories illustrating the personal and professional benefits of adherence to RFT. Highlighting individual achievements can humanise the concept of RFT and demonstrate its impact on career growth and job satisfaction. For example, an employee who played a key role in implementing RFT on a significant project could share their journey, detailing how their commitment to quality not only contributed to the project's success but also led to recognition from management and advancement opportunities. These narratives can be disseminated through various channels, including social media and industry publications, thus inspiring others to embrace RFT principles in their own work.

### 5.1.2 Cultural integration

Cultural integration within organisations is essential for embedding the principles of RFT into the operational fabric of the residential construction sector. A critical aspect of this integration involves recognising and rewarding individuals or teams that consistently meet RFT standards, as well as developing internal communication campaigns that articulate RFT's significance in achieving organisational goals and enhancing market competitiveness.

The recognition and reward of employees who follow RFT principles serve multiple purposes. Firstly, it reinforces a culture of excellence and accountability, where quality is not merely an expectation but a celebrated achievement. By implementing a structured recognition program, companies can motivate workers to prioritise quality in their work, thereby fostering an environment where RFT becomes a shared value. This recognition can take various forms, such as awards, public compliments, or informal acknowledgments during team meetings. Such recognition is particularly important in an industry where many firms consist of small to medium-sized businesses (SMEs). In these contexts, where resources are often limited and the pressure to deliver is high, acknowledging the efforts of individuals can significantly enhance employee morale and encourage a collective commitment to RFT.

Moreover, the implementation of recognition programs should be aligned with the broader goal of extending the benefits of RFT from the short term to the long term. While the industry widely acknowledges that RFT can reduce costs and enhance reputation, a prevailing challenge remains, understanding the investment required to implement RFT effectively and its corresponding benefits. Emphasising the intangible benefits of quality management at both the company and individual levels is crucial. For construction firms, this means fostering a culture conducive to business growth, while for employees, it translates into opportunities for career advancement and professional development. Acknowledging these dual pathways can help bridge the gap between immediate project outcomes and long-term organisational success.

In conjunction with recognition programs, developing internal communication campaigns is vital for communicating RFT's role in achieving organisational goals and enhancing market competitiveness. These campaigns should focus on illustrating how RFT practices contribute to the company's overall success, particularly in the context of cost savings, improved client satisfaction, and enhanced reputation. By strategically disseminating information about the financial implications of RFT—such as reduced rework and improved project timelines—companies can cultivate a shared understanding among employees about the importance of quality in their work. This communication will also aid in creating a unified organisational philosophy where "being on the same page" becomes a norm, ensuring that all team members are aware of the benefits of RFT and are prepared to commit to its principles.

## 5.2 Leveraging subjective norm

As the interview data suggests, the influence of key references is our clients, team members, supervisors and family members. Therefore, interventions should aim to enhance the positive influences these referents exert on individuals within the construction industry. To leverage these social influences, we suggest programs targeting these referent groups.

For clients, client-centric workshops are proposed to align client expectations with RFT principles and enhance their role as influential referents. Participants frequently noted that quality is a subjective concept, and some quality issues arise from mismatches between clients' perceptions and actual defects. These workshops serve a dual purpose in promoting RFT. Firstly, they help clients understand the technical aspects of quality, reducing reliance on superficial assessments. Secondly, they educate clients about the benefits of RFT, emphasising procurement and tender evaluation's impact on quality and the long-term benefits for clients. By fostering a deeper understanding and alignment between client expectations and the realities of project delivery, these workshops ensure clients appreciate the importance of RFT and are willing to support it through reasonable project timeframes, well-defined project requirements, and prompt access to necessary information. This support is crucial for reducing the likelihood of revisions and reworks, directly supporting RFT by preventing costly delays.

Regarding team members, team collaboration enhancement sessions are recommended to foster an environment where RFT is a shared goal. These sessions can be conducted at both project and company levels, involving regular team-building activities that emphasise communication, problem-solving, and shared responsibility for quality outcomes. During these sessions, team members can express support and expectations regarding RFT. This collaborative approach leads to internalising RFT values among team members, fostering a culture of mutual accountability and encouragement. The participants' shared objectives and collective ownership underscore the importance of a supportive environment where team members feel empowered to contribute their expertise and work together to address quality issues. The presence of experienced colleagues and senior staff, as well as the celebration of high-quality work, further reinforces this culture of striving for excellence.

For supervisors and managers, leadership training is essential to empower them to champion RFT and positively influence their subordinates. Leadership is the skill to inspire, motivate and channelise activities to achieve organisational goals (Sony et al., 2023). These training programs focus on developing skills in providing constructive feedback, recognising achievements in quality, and fostering a supportive environment for quality work. Equipped with these skills, supervisors can become strong advocates

for RFT, using their influence to enhance workers' commitment to proactive quality management. The pivotal role of supervisors and managers in shaping worker perceptions and behaviours towards RFT is evident from the participants' feedback. Effective supervision, characterised by open communication and a willingness to address worker concerns, is crucial for maintaining morale and encouraging a proactive approach to quality. Supervisors who model high-quality work, set clear standards, and provide timely feedback set a powerful precedent for their teams, fostering a culture of continuous improvement and sustained RFT implementation.

While often overlooked in traditional assessments of workplace motivators, the influence of family dynamics should not be underestimated. Family involvement initiatives are proposed to create powerful social support systems reinforcing workers' commitment to excellence. Many construction workers take immense pride in their ability to build homes and infrastructure that contribute to society, providing security, comfort, and joy to others. They also value their role as providers for their families, where quality work directly translates to job security and financial stability. Initiatives such as site tours or virtual presentations of homes, schools, or other structures they hope to build aim to celebrate construction workers' contributions to society and instil a sense of pride among their families about the quality of their work. The influence of family members, particularly in terms of pride and providing for their well-being, emerged as a significant factor shaping participants' commitment to quality. The desire to provide financial security and the pride associated with skilled craftsmanship resonate deeply with workers, providing a compelling and intrinsic motivation to strive for RFT.

To address the "self" in promoting Right First Time (RFT) in residential construction, an intervention program can enhance individual workers' intrinsic motivation and commitment to quality, focusing on fostering self-efficacy in RFT. Self-efficacy training workshops build workers' confidence in their ability to perform tasks correctly the first time. This training mainly focuses on soft skills, such as effective communication, problem-solving, adaptability, and emotional intelligence. Despite the critical importance of soft skills in construction, these competencies are often overlooked in training programs and educational curricula. The lack of soft skills training can lead to poor communication among team members and a fragmented work environment where conflicts arise more frequently. This leads to decreased morale and less collaboration. The absence of emotional intelligence can make it difficult for workers to navigate high-pressure situations, impacting their mental health and safety on the job. Thus, Soft skills training can enhance self-efficacy by helping workers be confident in their interactions and decision-making process. Participants would engage in role-playing scenarios that simulate real-life construction challenges, allowing them to learn constructive communication and problem-solving with quality issues. They would also receive feedback from trainers on their performance, helping them identify improvement areas and build confidence in their capabilities. These workshops can enhance self-efficacy,

leading to a greater belief in one's ability to achieve RFT and encouraging more proactive work practices.

## 5.3 Addressing perceived behavioural control

Based on the empirical findings, several practical interventions can be proposed to enhance the implementation of "Right First Time" (RFT) in residential construction. These interventions aim to strengthen workers' belief in their capability to perform quality work consistently by addressing key factors influencing perceived behavioural control.

### 5.3.1 Encouraging investment in effective tools

Workers associate effective tools with RFT capability but face barriers in accessing them. Construction companies hesitate to invest in advanced tools because of the high upfront costs and unclear return on the investment. Hence, the intervention emphasises the economic and operational benefits of such investment. Case studies demonstrating tangible returns—such as reduced rework costs or improved worker efficiency—should be disseminated to align with workers' explicit beliefs that advanced tools enhance precision and time savings. Similarly, the benefits of safety, health, physical workload, and productivity relating to the ergonomics of advanced tools are worth demonstrating (Sexton & Barrett, 2003). Financial incentives, such as tax rebates or subsidies for adopting precision tools like automated wall sprayers or electric sanders, could mitigate upfront costs. Additionally, tool-leasing partnerships with equipment providers can lower entry barriers for smaller firms, enabling trials of technology that workers associate with improved self-efficacy. By framing tool adoption as a strategic investment rather than a cost, companies can internalise the long-term benefits of RFT, including heightened job satisfaction and reduced project delays.

### 5.3.2 Innovation development for planning

The scheduling and planning intervention is designed to address the gaps in real-time feedback and program forecasts. Currently, in most residential projects, the project program is not updated to reflect the site progress. The lack of project programs leads to poor planning for materials, machinery and human resources. To realise the benefits of scheduling and planning for quality, the intervention leverages IoT-enabled real-time monitoring and tiered technological solutions to cater to projects of varying scales, directly aligning with participants' expressed need for tools that enhance both planning precision and proactive schedule adjustments. Various systems using sensor technologies and methods were developed for real-time mapping and tracing of construction activities, but it still proves challenging to map an ever-changing dynamic construction site (Rao et al., 2022). Although simulation modelling is proven to be an efficient tool for managing site operations, the skill, effort and time required to build such simulation models are still a significant barrier, especially for SMEs in the residential

sector (Abdelmegid et al., 2020). To mitigate these barriers, the intervention is to develop a tiered technology framework accommodating the varying needs of single-family, multi-unit, and medium-density residential projects. The critical activities, frequency of updates and accuracy level for forecasting are to be surveyed. For smaller, single-family projects, low-cost mobile apps (e.g., Procore) are deployed to enable photo-based progress documentation, daily log updates, and simplified Gantt charts. These apps reduce the administrative burden on supervisors, who previously relied on manual Excel updates. For larger, multi-unit projects, a rough digital twin is to be developed for general and standard design, with predictive analytics initially applied to critical activities.

### 5.3.3 Innovation development for information communication

The information communication intervention addresses the fragmented, error-prone methods reported by participants, such as reliance on verbal instructions, non-standardised sketches, and 2D drawings, which often lead to misinterpretations and rework. This intervention integrates visualisation technologies, standardised digital workflows, and multilingual support to bridge gaps between traditional practices and technological adoption, directly aligning with participants' expressed need for "straightforward visualisation" and accessible information channels. A pilot program can test augmented reality (AR) and virtual reality (VR) tools on stereotypical residential components (e.g., kitchens, bathrooms, roofing systems). Contractors are provided with affordable AR headsets or tablets loaded with 3D BIM models of these components. Workers can overlay digital models onto physical spaces to visualise finishes, plumbing routes, or electrical layouts, reducing reliance on supervisor sketches. For example, a carpenter installing cabinetry can use AR to see precise dimensions and alignment directly on-site, minimising measurement errors. Mobile digital kiosks (such as tablets mounted on-site) display 3D models, construction sequences, and QA checklists. These kiosks can integrate speech-to-text and translation tools to assist workers with language barriers. For example, a worker who is unsure about a detail can use the kiosk to replay a 3D animation of the installation process in their native language. The kiosks also allow workers to flag ambiguities in real-time, triggering alerts for supervisors to clarify specifications.

### 5.3.4 Training support and culture shift

The training and knowledge transfer intervention addresses the siloed, inconsistent upskilling methods reported by participants, where apprentices lacked foundational skills, such as reading plans, while experienced workers sought updates on the latest construction practices. This intervention combines role-specific practical training and a knowledge graph platform to standardise learning and dismantle trade-specific silos. A tiered training framework is to be developed, categorising workers into skill levels, using simulation or serious gaming to address the learning needs of hands-on construction workers. This can be installing HVAC systems in a controlled environment and using IoT-

enabled tools to receive real-time feedback on alignment or pressure levels. The trainings are ensured to be directly related to daily tasks, bridging the gap between theory and practice.

A digital knowledge graph maps interdependencies between trades, standards, and RFT checklists. For example, selecting a task like "install bathroom tiles" triggers nodes linking to prerequisite skills, relevant codes and common errors. Apprentices access microlearning videos (5–7 minutes) via mobile apps, demonstrating tasks like "reading elevation markers on drawings," while seasoned workers receive AI-curated updates on new techniques (e.g., laser-guided levelling tools). The graph lets workers click on a 3D wall assembly to view installation standards or troubleshooting guides. This addresses the lack of systematic processes by creating a unified knowledge base and reducing reliance on fragmented, trade-specific mentoring.

# 6. Discussions

The research adopts TPB to guide interview data collection. We probe the attitudes, social beliefs and perceived behaviour control at the personal level to determine the baseline understanding and status of proactive quality management. The development of intervention programs unveils three main streams, culture, technology, and knowledge, that intertwine with the behavioural attitude, subjective norm and perceived behaviour control. Figure 3 displays the framework of interventions mapping with the industry, organisation and project levels.

## 6.1 Definition of RFT

We use the concept of Right First Time to communicate the idea of proactive quality management with the interview participants. The main reason for doing this is the ambiguity of quality management and “proactive”. It is commonly agreed that quality is subjective in the construction industry. Hence, mainstream quality management research uses defects-free or error-free to represent high quality. However, the concept of zero vision and error prevention has long been challenged (Love & Smith, 2016), since not all errors can be prevented due to the inherently error-prone nature of human cognitive processing (Frese & Keith, 2015). The interview participant echoed it: “*Achieving perfection is relatively challenging. Human errors are inevitable*”. Thus, proactive quality management aims to avoid or reduce the negative consequences of errors.

Hence, it is necessary to clarify what RFT is in the context of proactive quality management. RFT refers to each individual involved in the construction project possessing skills, knowledge and mental abilities to perform their work correctly. It emphasises the ability and self-efficacy to do the jobs correctly. As confirmed by (Love

et al., 2015), workers' personal knowledge is a key attribute for team members to react and attend to quality issues. When individuals possess the self-efficacy to perform their jobs correctly, they also gain the capacity to anticipate potential consequences caused by others. Rather than aiming for a defect or rework-free situation, promoting the RFT concept encourages the industry to move beyond a fixed mindset of avoiding errors to a growth mindset of self-efficacy enhancement.

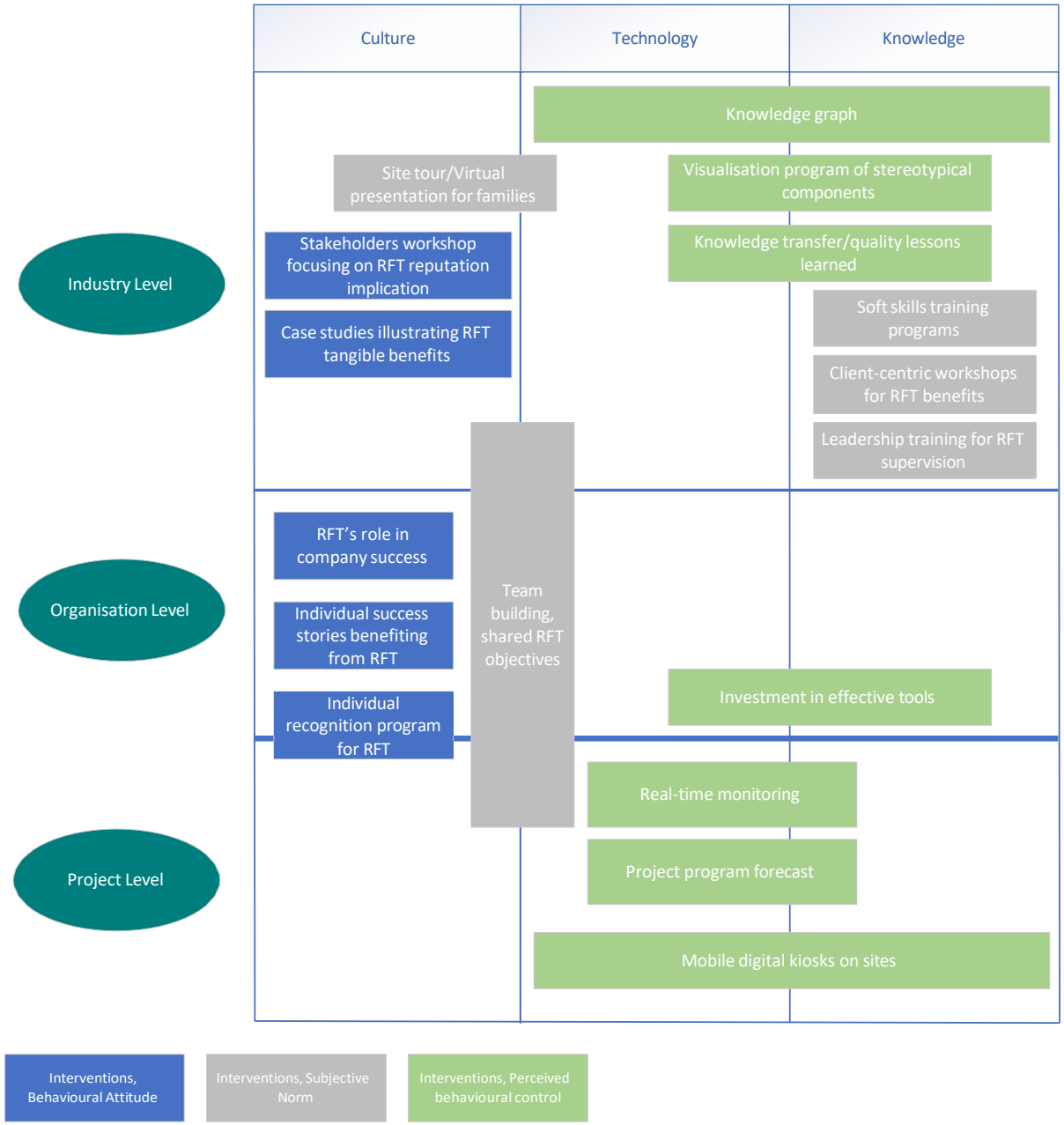


*Figure 3 Intervention mapping at the industry, company and project level*

## 6.2 Industry and organisational culture

The relationship between quality management and cultural value has been extensively explored in academic literature, emphasising their interdependencies (Palumbo & Douglas, 2024). This study identified the critical importance of industry and organisational culture. To improve the self-efficacy of RFT, the residential sector needs a positive culture at the industry level and a collaborative culture at the organisational level.

Participants consistently expressed the importance of pride in their work (in behavioural attitude and subjective norm) for RFT. However, the industry's current portrayal is characterised by poor quality and questionable ethical standards. While this depiction has some truth, it does not fully capture the reality. Many construction workers and companies are dedicated to achieving quality excellence, challenging the prevailing negative perceptions. As one identity, the sector needs to demonstrate good quality work to the stakeholders, the public, and wide communities. This, in turn, improves the sector's image, boosts workers' confidence, and attracts skilled force to the industry. Interventions, such as site tours/virtual presentations for families and client-centric workshops for RFT benefits, are the initial steps towards building a positive industry culture.

In the residential sector, the intense competitiveness and low-profit margins necessitate a strong focus on cost management and savings. The prevailing trend within the construction industry emphasises cost-benefit analysis, which poses a challenge for RFT. This is primarily because the advantages associated with RFT, such as enhanced reputation and improved workers' mental well-being, are intangible and not easily translated into immediate financial gains. Therefore, it is crucial to advocate for and demonstrate the intangible benefits of RFT. Although these benefits may not readily convert into monetary terms, the residential sector must recognise and embrace their potential to enhance long-term resilience for both the industry and its participants. By doing so, there is hope to shift the industry's culture from evaluating project management measures solely on tangible costs and benefits. Emphasising intangible benefits could facilitate the adoption of product and process innovations, paving the way for future advancements. Interventions focusing on the positive RFT impact on companies and individuals serve the role of developing such a culture.

The necessity for the residential sector to cultivate a collaborative culture is clearly demonstrated when many participants indicated that the tangible and intangible benefits of proactive quality management cannot be fully realised without it. However, current systems of training, education, and licensing focus primarily on individual expertise in knowledge and processes, which can inadvertently foster a silo mentality, hindering collaborative efforts. Several participants noted that they encourage their workers to develop "curiosity" to understand the processes of other trades and professions. This approach broadens individual perspectives and enhances the potential for collaboration

and innovation across different areas of expertise. Team building focusing on shared RFT objectives at the organisation and project levels can help strengthen such culture.

## 6.3 Technology

The integration of digital technologies within the construction industry has significantly advanced, leading to the belief that digitisation is key to enhancing construction productivity (Tam, 2024). However, the application of digital technology in quality management has not received equivalent attention in research (Luo et al., 2022). Key digital technologies employed in this domain include Building Information Modelling (BIM), Augmented Reality (AR), the Internet of Things (IoT), computer vision, and blockchain. These technologies serve to dismantle information barriers between companies (Čuš-Babič et al., 2014), expedite onsite training and safety (Schiavi et al., 2022), enable real-time monitoring of construction processes (Fang et al., 2019), automate post-construction quality assessments (Liu et al., 2017), and manage quality information effectively (Wu et al., 2021).

During this research, it was observed that the use of technology for quality management in the residential sector remains limited. Among the companies interviewed, only a few used off-the-shelf software for project management purposes. Fewer participants utilised BIM and IoT to exchange design information and monitor construction sites. The low adoption rates can be attributed to the investment costs and the skills required to implement these technologies (Adawan & Ying, 2024).

In the residential construction sector, the predominance of small to medium-sized enterprises presents significant challenges in acquiring and developing technologies tailored to their specific needs. The interventions identified, such as real-time monitoring systems, project program forecasting, and mobile digital kiosks for onsite use, necessitate careful design and development. This process should involve collaboration with research institutions and technology service providers to ensure that the solutions are practical and effective. A thorough needs assessment is thus crucial to the success of these technological interventions. It is essential to determine the required accuracy levels for forecasting and evaluate the intended users' skill levels. Such evaluations will ensure the technologies are accessible and usable for the companies involved. By addressing these factors, the interventions can be better aligned with the operational realities and capacities of small to medium-sized construction firms, ultimately enhancing their ability to adopt and benefit from technological advancements.

## 6.4 Knowledge

Hard skills, being the technical competencies essential for performing specific trade job duties, form the core of current training programs. These programs typically emphasise specialised trade skills and incorporate a blend of classroom instruction with practical site experiences. However, there is a growing need for diverse teaching methodologies to accommodate various learning preferences, such as those of visual learners or individuals facing language barriers. The trade-centric focus of these programs often overlooks a comprehensive understanding of the construction process. This broader perspective is particularly crucial in residential construction, where tight schedules and limited working space demand a more integrated approach. Furthermore, interviews have highlighted the industry's pressing need for training that addresses legislative updates and the introduction of new tools and materials. To address these challenges in knowledge management of the construction process and skills, knowledge graph can be a powerful tool for knowledge management in the residential sector (Deng et al., 2022). To address the challenges in managing knowledge related to construction processes and skills, the utilisation of a knowledge graph can serve as an effective tool, particularly within the residential sector. Interventions such as visualisation programs for stereotypical components of residential projects, alongside the transfer of knowledge and lessons learned in quality management, provide a valuable testing ground for knowledge representation and modelling. This approach forms a central aspect of the knowledge graph, enabling a more structured and efficient information management. However, developing knowledge graphs within the construction industry necessitates a substantial initial investment, rendering it nearly infeasible for individual companies to undertake this endeavour independently. Instead, a collaborative effort is imperative to effectively gather, digitise, and validate construction process knowledge across various residential building typologies, such as standalone and terrace houses. This collective investment by the industry is crucial for the proper dissemination of knowledge, ultimately benefiting the sector as a whole. Thus, further discussions with stakeholders in the residential sector are needed to prioritise the specific domains of knowledge that require immediate attention to enhance hard skills for proactive quality management.

Soft skills, including work ethics, communication, leadership, and self-management, are essential for fostering the adaptability necessary to navigate and remain current amid changing circumstances in the construction industry (van Heerden et al., 2023). These competencies enhance workers' relationships and drive initiative, which is particularly vital in a sector characterised by diverse stakeholders and collaborative efforts. Despite their importance, soft skills are often inadequately defined and conceptualised within the prevailing culture of the construction industry. This lack of clarity may hinder the development and recognition of these skills, ultimately affecting the industry's capacity to adapt to evolving challenges and opportunities. Interview data indicate that effective communication with clients, the provision of timely and

constructive feedback, and a strong work ethic are all critical components for achieving RFT. These elements are intrinsically linked to being persuasive without provoking conflict or fostering stakeholder mistrust. Despite their significance, there is a notable scarcity of training and educational programs incorporating these essential skills within vocational and tertiary education curricula. To implement RFT, training programs targeting different skill and responsibility levels need to be developed. For project managers and client-facing roles, the initial focus should be on soft skills training that emphasises communication regarding quality expectations, as this serves as a foundational element for successful client interactions. At the supervisor level, it is crucial to train individuals on how to provide timely feedback and clearly communicate expectations to their teams, thereby fostering an environment of accountability and continuous improvement. For workers, a strong understanding of work ethics, workplace professionalism, self-management, and time management skills is imperative to ensure that tasks are completed efficiently and to a high standard. Furthermore, engaging in discussions with various training providers and professional bodies is necessary to develop tailored soft skills training programs that address the specific needs of the residential sector, ensuring that the workforce is adequately equipped to meet the demands of RFT initiatives.

## 6.5 Roadmap for intervention development

The proposed roadmap, as shown in Figure 4, is structured around a phased, multi-level approach that strategically integrates interventions across cultural, technological, and educational domains to foster proactive quality management and the adoption of the RFT philosophy within the residential construction sector. In the short-term phase, immediate actions focus on raising awareness and establishing foundational capabilities. These include developing introductory training modules that emphasise the principles of RFT, soft skills, and the growth mindset necessary for quality improvement. Concurrently, initial pilot projects involving simple digital tools, such as mobile kiosks and basic project management software, are to be launched to demonstrate tangible benefits and gather user feedback. At the industry level, awareness campaigns and stakeholder engagement activities—such as site tours and client workshops—are vital for reshaping perceptions and fostering pride in quality work, serving as early steps towards cultivating a positive industry culture.

Moving into the medium-term phase, the focus shifts towards scaling up successful interventions and embedding them within organisational practices. This involves expanding training programs to incorporate diverse teaching methodologies that cater to various learning styles, as well as integrating RFT and proactive quality management principles into licensing and certification requirements. On the technological front, efforts are directed at co-developing and deploying more sophisticated digital solutions, including Internet of Things (IoT) and real-time monitoring systems. These solutions must be tailored to the operational contexts of small to medium-sized enterprises (SMEs)

through comprehensive needs assessments and close collaboration with research institutions and technology providers, ensuring that the tools are accessible, cost-effective, and capable of generating measurable improvements. Additionally, fostering a collaborative organizational culture remains paramount; initiatives such as team-building activities, cross-trade curiosity development, and shared objectives are promoted to break down silo mentalities and encourage collective responsibility for quality outcomes.

In the long-term phase, the roadmap aims to institutionalise continuous improvement, industry-wide recognition, and a sustainable cultural transformation. This involves embedding RFT and proactive quality management into industry standards, educational curricula, and professional development pathways, thereby ensuring that these principles become ingrained in the sector's operational ethos. Technologically, the goal is to establish a comprehensive digital ecosystem that supports data-driven decision-making, innovation, and resilience. This includes scaling successful pilot solutions into industry-wide standards, fostering ongoing research and development, and maintaining an environment conducive to technological evolution. At the cultural level, sustained efforts are made to reinforce a positive industry image, uphold ethical standards, and cultivate pride in quality work, which in turn attracts skilled professionals and enhances the sector's reputation. Throughout this phased approach, continuous feedback and adaptive management are crucial to refining interventions and ensuring their alignment with evolving industry needs and capacities.

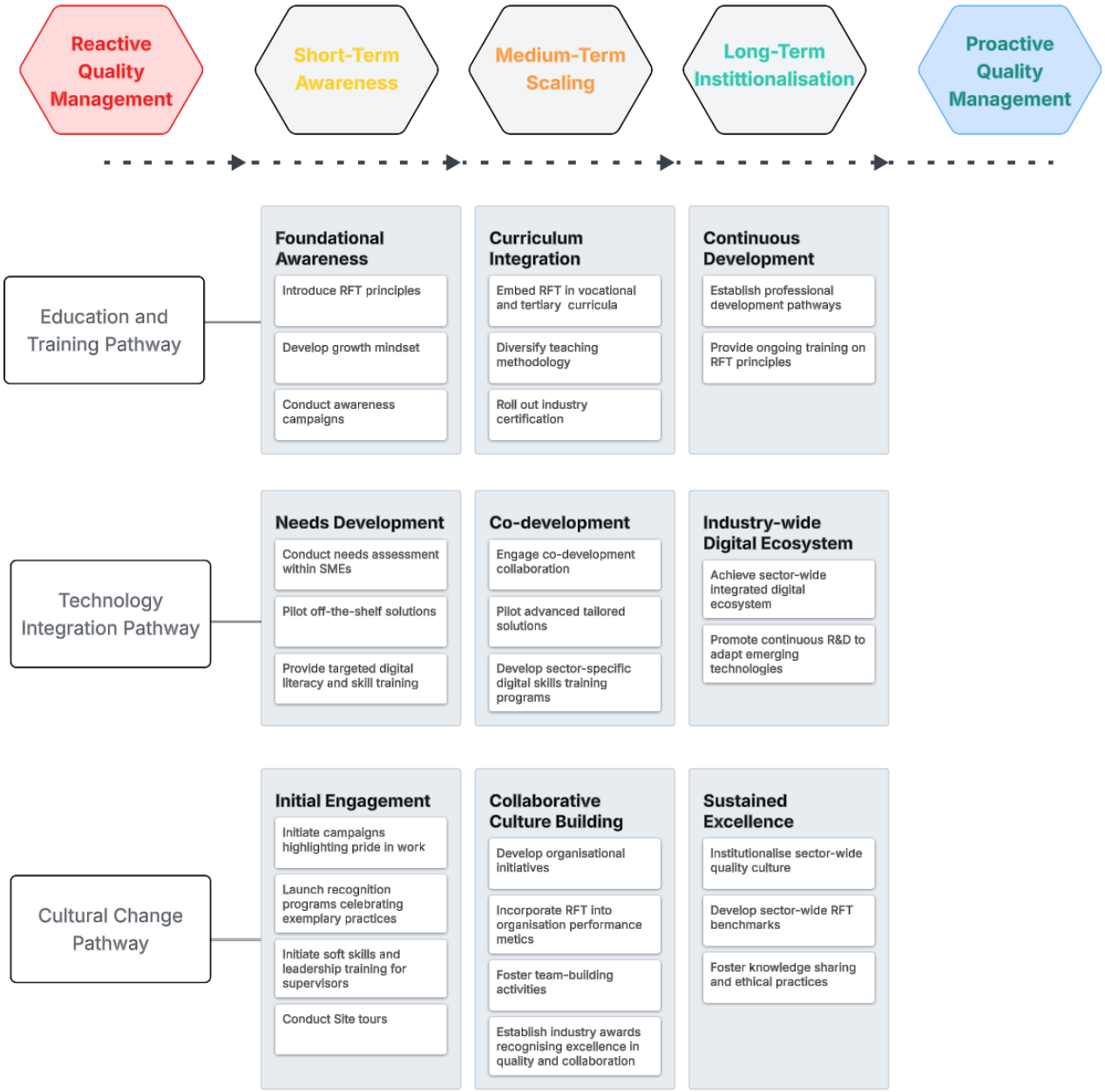


Figure 4: Roadmap for intervention development

# 7. Conclusion

Contexts are endogenous factors or attributes that exist within organisations or individuals. This study investigates the context of the residential sector to uncover individual behavioural intentions related to proactive quality management. The findings highlight that quality issues are deeply rooted in individual perceptions, attitudes, and social norms, which shape the behaviours of construction professionals. Understanding these factors is essential for fostering a culture of quality management that prioritises proactive measures over reactive solutions. Adopting the theory of planned behaviour (TPB) as a framework for this research has provided valuable insights into the motivations

and intentions that drive professionals in the sector.

Intervention programs designed to strengthen behavioural attitudes, leverage subjective norms, and enhance perceived behavioural control can facilitate significant improvements in quality management. By focusing on awareness campaigns, cultural integration, and effective training, stakeholders can empower professionals to embrace quality as a shared responsibility, ultimately achieving proactive quality management. The framework of interventions takes into account the specific characteristics of the residential sector and the current economic challenges, integrating findings from the latest academic research to map interventions across various streams and levels. Some of these interventions represent low-hanging fruit that can be implemented relatively easily at both the project and organisational levels. Conversely, other interventions, such as soft skills training programs and the development of knowledge graphs, require significant time, talent, resources, and a commitment from all stakeholders to be successfully realised.

The actionable recommendations derived from this research serve as a roadmap for policymakers, construction firms, and industry stakeholders. By institutionalising positive quality management behaviours and implementing targeted interventions, we can create a resilient and sustainable framework that not only addresses current quality challenges but also fosters a long-term commitment to excellence in the residential construction sector.

In conclusion, the journey towards improved quality management in construction is complex and multifaceted. This research aspires to serve as a foundational step in uniting the residential sector, fostering a collective voice that can drive essential changes, particularly in mindset, to enhance resilience, improve profit margins, and elevate the overall image of the industry.

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