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Digital Adoption and Organisational Competitiveness: Analysis of Subcontracting Organisations in New Zealand's Construction Industry

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Abstract

This study examines the relationship between digital technology usage and organisational competitiveness among subcontracting organisations in New Zealand's residential construction industry. A survey of 91 subcontracting organisations was conducted. Principal Component Analysis (PCA) was used to develop a composite measure of organisational competitiveness. Spearman's rank correlation was then applied to examine associations between the frequency of digital technology usage and organisational competitiveness. More frequent use of digital technologies was associated with stronger organisational competitiveness. The findings indicate that consistent use of accessible digital tools may support competitive outcomes. Cross-sectional design limits causal interpretation. This study focuses on New Zealand residential subcontracting organisations with 6–49 employees; therefore, generalisation to other construction contexts should be approached cautiously. Subcontracting organisations may strengthen competitiveness by improving the consistent and effective integration of commonly available digital technologies into everyday operations. The findings can also inform industry initiatives supporting practical digital capability development. This study provides empirical evidence on the relationship between digital technology usage and organisational competitiveness within the underexplored context of New Zealand residential subcontracting organisations.

Keywords: digital technology adoption; organisational competitiveness; subcontracting organisations; residential construction; digital transformation

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Academic Editor: Ahmed Senouci

Received: 20 October 2026
Revised: 17 November 2026
Accepted: 18 November 2026
Published: 25 November 2026

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1. Introduction

The construction industry is a major contributor to economic growth, employment, and infrastructure development worldwide. However, despite continued technological advancement and increasing investment, the sector continues to experience persistent productivity and competitiveness challenges arising from fragmented supply chains, project complexity, labour shortages, inefficient work practices, and increasing regulatory demands [1–3]. These challenges are particularly evident in New Zealand, where the residential construction sector plays a critical role in addressing housing demand while operating within a

highly fragmented, predominantly small and medium-sized enterprise (SME) environment characterised by resource constraints and variable organisational capability [3,4].

Maintaining organisational competitiveness has therefore become a strategic priority for construction organisations. Beyond traditional measures of cost and financial performance, competitiveness increasingly reflects an organisation's ability to coordinate project activities, respond to changing market conditions, improve operational efficiency, and consistently deliver high-quality outcomes [5–7]. As construction projects become increasingly complex and collaborative, digital transformation has emerged as a key strategy for enhancing organisational performance through improved communication, information management, coordination, and decision-making [8,9].

The emergence of Industry 4.0, Construction 4.0 and, more recently, Industry 5.0 has accelerated the adoption of digital technologies such as Building Information Modelling (BIM), cloud computing, mobile applications, artificial intelligence, Internet of Things (IoT), and data-driven project management systems [9,10]. These technologies have demonstrated considerable potential to improve productivity, collaboration, project coordination, quality, and organisational competitiveness. Nevertheless, the construction industry remains one of the least digitalised sectors globally due to its fragmented project structure, temporary organisational arrangements, limited investment in innovation, and resistance to organisational change [11–13]. Consequently, digital technology adoption remains uneven, particularly among SMEs, where financial, technical, organisational, and skills-related barriers continue to constrain implementation [3].

These challenges are particularly significant for subcontracting organisations. Subcontractors undertake much of the physical construction work and play a central role in determining project productivity, quality, and delivery performance [14,15]. Unlike principal contractors, however, subcontractors typically operate with limited organisational resources, smaller workforces, and lower investment capacity while relying heavily on coordination with multiple project participants [4]. In New Zealand, where residential construction is dominated by SMEs and fragmented supply chains, subcontractors are also recognised as important sources of innovation and digital transformation, yet they frequently experience greater barriers to technology adoption than larger organisations [3,16]. Despite their importance, research examining digital transformation has primarily focused on individual technologies such as BIM, implementation barriers, or productivity improvement within the broader construction industry, with comparatively little empirical attention given to residential subcontracting organisations or their organisational competitiveness [17,18].

This study addresses this gap by examining the relationship between the frequency of digital technology use and organisational competitiveness among New Zealand residential subcontracting organisations. By focusing on a highly fragmented, SME-dominated construction sector, the study extends existing research beyond technology adoption to provide empirical evidence of the relationship between digital technology utilisation and organisational competitiveness within an underexplored industry context. The findings contribute to construction management literature by providing context-specific evidence to support organisational decision-making and industry strategies aimed at enhancing competitiveness through digital transformation.

- Accordingly, this study addresses the following research questions:
- What are the current patterns of digital technology adoption among subcontracting organisations in New Zealand's residential construction industry?
- What associations exist between the frequency of use of different digital technologies and organisational competitiveness among residential subcontracting organisations in New Zealand?

2. Literature Review

Organisational competitiveness has become increasingly important in construction as firms respond to productivity pressures, labour shortages, stronger client expectations and growing market uncertainty [3,6,19]. Digital technologies are often presented as a means of addressing these pressures because they can improve communication, coordination, information access and decision-making. However, adopting a technology does not necessarily produce a competitive advantage. The outcome depends on how the technology is used, how well it is integrated into organisational processes and whether the organisation has the resources and knowledge required to convert its use into improved performance [20,21]. This distinction is particularly important for residential subcontracting organisations, which undertake much of the specialised construction work but often operate with limited financial, managerial and technical resources.

This review examines organisational competitiveness as a multidimensional concept and considers how digital technologies may contribute to it. It first establishes the theoretical meaning of competitiveness in construction subcontracting, then critically examines the relationship between digital technology use and organisational performance, before explaining the indicators adopted in this study. Previous studies provide substantial evidence of the potential benefits of digitalisation, but limited direct evidence of whether the frequency of using different technologies is associated with organisational competitiveness among New Zealand residential subcontractors [4,22–24].

2.1. Conceptual Perspectives on Competitiveness in Construction Subcontracting

Competitiveness generally refers to an organisation's ability to perform successfully against its competitors while maintaining its position over time. In construction, this concept extends beyond profit or market share because firms operate within temporary project teams, fragmented supply chains and changing project conditions [25,26]. A competitive construction organisation must therefore combine financial performance with reliable project delivery, operational efficiency, client satisfaction, managerial capability, workforce development, innovation and the ability to respond to market change [5,27]. This implies that financial performance alone provides an incomplete assessment, as a profitable firm may still experience weaknesses in project delivery, employee capability, client relationships or long-term adaptability.

The Resource-Based View (RBV) provides an appropriate theoretical basis for explaining these differences in organisational competitiveness. RBV proposes that competitive advantage develops through resources and capabilities that are valuable to the organisation and difficult for competitors to reproduce [21]. In construction, these resources include managerial knowledge, skilled employees, relationships, organisational routines, operational processes and technological resources. However, possessing a resource is not sufficient. Its value is determined by the organisation's ability to combine and deploy it in ways that improve project delivery, efficiency and client outcomes [20,26].

This distinction is central to understanding digital competitiveness. Most commonly available technologies can be acquired by competing firms and are therefore unlikely to create a sustained advantage through ownership alone [20,21]. Their strategic value emerges when their use becomes embedded in organisational routines and supports faster communication, more reliable information, stronger coordination and better decisions [4,24]. Consequently, the competitive resource is not simply the digital technology but the organisational capability developed around its use. This interpretation challenges the treatment of adoption as the final outcome and supports examining how technologies are used in everyday operations [21,24].

The resource-based explanation is particularly relevant to subcontracting organisations. Residential subcontractors contribute directly to project quality, productivity and delivery performance, yet they frequently operate with smaller workforces, variable workloads and restricted investment capacity [14,15]. These constraints are evident in New Zealand, where the residential sector is characterised by SMEs and fragmented supply chains [3,4]. Larger organisations are generally better positioned to invest in advanced systems, training and specialist support, whereas smaller firms experience stronger financial, technical and skills-related barriers [12,13,28]. Conversely, smaller subcontractors may depend more heavily on affordable mobile, cloud and office-based technologies, which can improve communication, information access and workflow without the investment required for more complex systems [4,29]. This does not necessarily place them at a competitive disadvantage, as accessible tools may create substantial value when they are consistently integrated into daily work. Competitiveness may therefore depend less on adopting the most advanced technology and more on using available resources effectively [20,21].

Nevertheless, RBV has limitations when applied to project-based construction. Subcontractors do not use their resources independently; their performance is influenced by main contractors, consultants, clients and the compatibility of systems used across the project network [4,23]. A capable subcontractor may gain limited value from a digital tool if other participants do not share information, follow common standards or use compatible systems [22,30,31]. Thus, organisational resources remain important, but their value is partly shaped by the wider project environment. This supports a context-specific examination of subcontractors rather than assuming that findings from large contractors, manufacturers or infrastructure projects apply equally to residential SMEs [18,28].

2.2. The Role of Digital Technologies in Shaping Competitiveness in Subcontracting Organisations

Digital technologies offer several routes through which construction organisations may improve their competitive performance. BIM, cloud computing, mobile applications, social media, project management software, artificial intelligence and the Internet of Things can support information sharing, visualisation, coordination, monitoring and decision-making [8–10]. When applied effectively, these functions can reduce delays and rework, improve resource use and strengthen communication with clients and project partners. They may consequently contribute to project delivery, operational efficiency, reputation and client satisfaction, which are important dimensions of organisational competitiveness [20,32].

Among these technologies, BIM has received substantial attention in construction research for its applications in visualisation, coordination and information management, although adoption varies across organisations and project stages [30,31]. AutoCAD/Revit support digital drawing and modelling, while AI and IoT offer more advanced applications in data-driven decision-making, automated monitoring and construction management [4,23]. Mobile applications and cloud computing facilitate site communication, document sharing and access to project information [4,29]. Alongside these technologies, Microsoft Office or similar tools support administration, estimating and record management; project management software supports planning and scheduling; and social media enables marketing and client engagement. These nine technology categories represent prominent digital tools and systems discussed in the construction literature.

Previous research generally supports the performance potential of digitalisation but provides less certainty about the conditions under which benefits are achieved. Chowdhury et al. [4] identified BIM, cloud computing, mobile computing, RFID, GIS and GPS as technologies capable of supporting productivity and profit improvement. Harrison and Thurnell [30] associated 5D BIM with stronger cost planning and information manage-

ment, while also identifying incomplete information and manual checking as continuing constraints. Likita et al. [22] found that Lean–BIM integration can improve workflow, coordination and productivity, but its value is restricted by training costs, limited knowledge and organisational resistance. Sivakumaran et al. [31] similarly linked BIM with collaboration and real-time information sharing in New Zealand procurement, although its use remained concentrated in particular project stages. At a broader level, Naji et al. [23] and Souza et al. [33] associated digital transformation with improved collaboration, lifecycle information, productivity and sustainability. Taken together, these studies establish plausible connections between digital technology and performance. However, they examine different technologies, sectors and performance outcomes and frequently rely on conceptual analysis, project applications or limited organisational samples. They therefore demonstrate what digital technologies can potentially achieve more clearly than whether their use improves multidimensional competitiveness across construction organisations.

BIM illustrates the difference between technological potential and realised organisational value. Its shared information environment can improve visualisation, coordination, cost planning and communication across project participants. New Zealand research also indicates that BIM can support real-time information sharing and more informed procurement decisions [31]. However, its application remains uneven and is often concentrated in design rather than integrated across procurement and construction. Incomplete information, inconsistent standards and continued manual checking can also reduce its practical value [30]. This suggests that BIM adoption alone does not confirm improved performance; the benefit depends on information quality, stakeholder participation and integration across project activities.

The integration of Lean practices and BIM presents a similar pattern. Combined use can strengthen workflow planning, collaboration and waste reduction, implying improvements in productivity and project performance. Nevertheless, implementation is restricted by training costs, limited knowledge, incompatible processes, weak management support and resistance to organisational change [22]. These barriers are not separate from competitiveness. They determine whether a technological investment develops into a reliable capability or remains an underused organisational resource. The evidence therefore supports the RBV position that technology generates value through complementary organisational resources rather than through installation alone.

Knowledge and employee capability are especially important in this process. Digital tools cannot improve organisational performance if employees lack the confidence, motivation or opportunity to apply them. New Zealand evidence indicates that self-efficacy and motivation influence the transfer of digital knowledge into workplace use [24]. This reinforces the importance of human capability but does not directly establish an improvement in organisational competitiveness. Knowledge transfer, technology use and competitive performance are connected stages, yet they are not interchangeable outcomes. Research that measures readiness, knowledge or adoption should therefore not be treated as direct proof of competitive advantage [4,22].

Despite the reported benefits, digital technology adoption remains uneven because of implementation costs, technical complexity, fragmented project structures, skills shortages and resistance to change [12,13,34]. These challenges are more pronounced among SMEs, which generally have fewer financial and technical resources and may depend on external parties for digital information and support [18,28]. Conversely, the growing availability of cloud platforms, mobile applications and common office technologies may reduce some entry barriers. Their lower cost and familiarity can make them more suitable for subcontractors than complex systems requiring specialist staff. Accordingly, the relationship

between digitalisation and competitiveness should not be assessed only through advanced technologies [4].

Previous studies have concentrated mainly on BIM, Lean–BIM integration, automation and other specialised technologies [22,23,30,31]. However, routine digital tools may be more relevant to the daily activities of residential subcontractors. Mobile applications can support site communication and immediate access to information, while cloud computing can enable documents to be shared across organisations and locations [4,29]. Office software can assist estimating, scheduling and record management, whereas social media may strengthen visibility, client communication and market reach [4,8]. Project management software provides more specialised planning and control functions, but its value depends on project scale, user competence and integration with existing processes [12,34]. Combining these technologies into a general category of digital adoption may therefore conceal differences in their accessibility, purpose and contribution to organisational performance.

Within New Zealand, previous research has mapped available technologies, examined individual applications and identified barriers to digital transformation [4,35,36]. This work provides an important understanding of the national digital environment, but it offers limited evidence at the level of residential subcontracting organisations. Research based on reviews, document analysis, expert interviews or small case studies can identify technologies and explain implementation conditions, yet it cannot establish the strength of the relationship between technology use and competitiveness across firms. Furthermore, studies centred on infrastructure projects, consultants or large organisations may not represent the resource conditions of residential subcontractors.

Consequently, three related limitations remain in the literature. First, digitalisation is more commonly linked with individual project outcomes, implementation readiness, knowledge transfer or expected productivity benefits than with multidimensional organisational competitiveness. Second, previous research gives limited attention to whether different frequencies of using specific technologies are associated with different competitive outcomes. Third, there is limited empirical evidence concerning New Zealand residential subcontractors, despite their central role in project delivery and their distinctive resource constraints. This study addresses these limitations by examining the association between the frequency of using specific digital technologies and organisational competitiveness among residential subcontracting organisations.

The theoretical contribution is to extend the application of RBV from the possession of digital resources to their routine organisational deployment [20,21]. The study does not assume that technology is inherently valuable or that association demonstrates causation. Instead, it examines whether greater use of accessible digital resources corresponds with stronger organisational competitiveness. This approach provides a more cautious explanation of digital value and recognises that technologies, organisational capabilities and competitive outcomes are related but conceptually distinct.

2.3. Indicators of Organisational Competitiveness

Organisational competitiveness is a multidimensional construct that cannot be represented adequately by a single financial or operational measure [25,37,38]. In residential construction, firms must maintain financial performance while delivering projects reliably, satisfying clients, managing risks, developing employees and adapting to market and regulatory conditions [6,7,39]. These outcomes are connected, but they are not identical. For example, stronger project delivery may improve client satisfaction and reputation, whereas leadership and employee development may support longer-term innovation and adaptability. A broad assessment is therefore required to avoid presenting one area of performance as the organisation's overall competitiveness.

The framework adopted in this study was derived from the systematic review by Al-Kayed et al. [40], which examined 27 empirical studies of competitiveness in the construction industry. Eleven studies addressed competitiveness at the organisational level and collectively identified 13 indicators covering project, financial, operational, managerial, market, social and strategic performance. The framework is suitable for subcontracting organisations because it captures both immediate project outcomes and the organisational capabilities required to sustain performance. However, using a multidimensional framework also requires evidence that the indicators represent a coherent construct rather than a collection of unrelated outcomes.

Table 1 presents the 13 organisational competitiveness indicators adopted for this study. Together, they reflect the view that competitiveness involves an organisation's capacity to deliver present projects successfully while developing the resources, relationships and adaptability needed for continued performance.

Table 1. Indicators of Organisational Competitiveness in the Construction Organisations.

Indicator	Authors
Project Delivery	[6,25,41–43]
Financial Performance	[37,38,41,43]
Client Satisfaction	[7,42–44]
Competitive Strategy	[38,39,41,43]
Operational Efficiency & Risk Management	[25,37,38]
Health & Safety Standards	[6,25,42]
Employee Development & Culture	[6,7,42,44]
Leadership & Management	[7,37,41,44,45]
Innovation Capability	[6,37,41,43,45]
Market Adaptability	[38,44]
Regulatory Compliance	[6,38]
Reputation & Stakeholder Relationships	[25,43]
Sustainability & CSR	[6,25,43]

3. Methodology

This research was conducted in New Zealand, where the construction sector plays an important role in economic activity. The industry depends heavily on subcontracting organisations, many of which are small and medium-sized firms undertaking a large share of residential construction work [4]. Small and medium-sized enterprises account for the vast majority of firms in the sector, with businesses employing fewer than 50 people representing over 95% of construction enterprises in New Zealand [46]. These conditions provide a relevant setting for examining how subcontracting organisations adopt digital technologies and how such practices relate to organisational competitiveness.

3.1. Study Design and Survey Administration

This study adopts a quantitative, cross-sectional design to examine how organisational competitiveness varies by the levels of digital technology usage among residential construction subcontractors in New Zealand. A quantitative approach is appropriate for identifying patterns and relationships across a large number of organisations and is widely used in construction research [47,48].

The target population for this study comprised subcontracting organisations operating within the New Zealand construction industry. As official statistics do not distinguish subcontractors by project type or contractual role, an industry-based definition was adopted. Business demography data published in Figure.NZ indicate that 7233 construction businesses employing between 6 and 49 employees were active in New Zealand [46], and this group was therefore considered the population relevant to this study. Due to reliance on publicly available professional listings and industry directories, organisations with valid contact information were identified and used as the effective sampling frame.

An ethics application was submitted and received approval from the AUT ethics committee under reference number Autec 24/188 for this study. A total of 1020 organisations were identified as subcontracting organisations through publicly available professional listings, company websites and industry directories, forming the effective sampling frame. Recruitment targeted these organisations, with one survey invitation issued per organisation. A total of 172 responses were received, representing an overall response rate of 16.9%. Following screening for completeness and the study's organisational eligibility criteria, 91 responses were retained, representing 8.9% of the organisations invited. Not all retained participants answered every question: 85 provided responses to the digital technology usage section, and 81 completed all 13 competitiveness indicators. The latter cases formed the sample for the PCA and parallel analysis.

$$n_0 = \frac{Z^2\, p(1-p)}{e^2} = \frac{1.96^2 \times 0.5 \times 0.5}{0.1^2} = 96.04$$

To account for the finite population size, the finite population correction was applied:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} = \frac{96.04}{1 + \frac{95.04}{7233}} \approx 95$$

The calculated target was approximately 95 completed responses. Although 91 eligible responses were retained, 85 participants responded to the digital technology usage section and 81 completed all 13 competitiveness indicators. The achieved sample sizes were therefore below the calculated target.

Although the study focuses on subcontracting organisations involved in residential construction, firms were included if they had direct experience delivering residential projects, regardless of whether they also operated in commercial or other sectors. This approach reflects the structure of the New Zealand construction industry, where subcontracting organisations commonly operate across multiple project types, and was necessary to maintain an adequate sample size. Digital technology usage was measured on a seven-point frequency scale, ranging from 1 (do not use) to 7 (always). The competitiveness indicators were measured on a seven-point agreement scale, ranging from 1 (strongly disagree) to 7 (strongly agree), with reference to organisational performance over the previous three years. This period was chosen to capture recent changes while minimising recall bias. It also provides sufficient time for digital technologies to become integrated into routine operations, while ensuring a consistent timeframe across organisations that adopted these technologies at different stages.

Participation was voluntary, and the participant information sheet assured respondents that responses were anonymous and that no identifying information would be collected. Digital technology usage and competitiveness were presented in separate questionnaire blocks. The two measures also used different response anchors: frequency of use for digital technologies and agreement with statements concerning competitiveness.

3.2. Measures

Organisational competitiveness was the dependent construct and was measured using thirteen indicators reflecting operational, financial, strategic, risk, innovation, client, and sustainability dimensions. These indicators were derived from the systematic review conducted by Al-Kayed et al. [40], which examined factors influencing competitiveness within the construction sector. The review analysed 27 empirical studies, of which 11 specifically assessed competitiveness at the organisational level. Respondents provided subjective assessments of their organisations' performance and improvements over the previous three years. The resulting composite therefore represented perceived organisational competitiveness rather than independently verified competitive performance. Internal consistency was evaluated prior to inferential analysis.

The independent variables in this study comprised the frequency of use of nine digital technologies identified in the literature review: Microsoft Office or similar tools, mobile applications, cloud computing, social media, project management software, AutoCAD/Revit, BIM, IoT and AI. These technologies were included in the questionnaire to assess their usage among subcontracting organisations in New Zealand's residential construction industry.

3.3. Analytical Procedures

Data were analysed using descriptive and inferential statistical techniques. Descriptive statistics, including frequencies and percentages, were used to summarise the demographic characteristics of participating organisations and the frequency of digital technology usage. The internal consistency of the thirteen competitiveness indicators was assessed using Cronbach's alpha (α). Principal Component Analysis (PCA) was then conducted to derive a composite measure of organisational competitiveness after confirming data suitability using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's Test of Sphericity. Components were extracted using the eigenvalue-greater-than-one criterion, and the first principal component (PC1) was retained as the overall competitiveness score. Finally, Spearman's rank correlation was used to examine the relationship between the frequency of digital technology usage and the PCA-derived organisational competitiveness score.

Harman's single-factor test was conducted as a basic assessment of potential common method bias. The five digital technology usage items included in the correlation analysis and the 13 competitiveness indicators were entered together into an unrotated principal component analysis. Cases with missing responses on any of these items were excluded listwise.

Partial Spearman correlations were additionally calculated between each technology usage variable and the PC1 competitiveness score, controlling simultaneously for firm size and sector involvement. Complete cases were selected separately for each analysis before ranking the variables, with mean ranks assigned to ties. Unadjusted and adjusted correlations were compared using the same cases.

A robustness check was conducted by recomputing PC1 after excluding the indicator "improved adoption of digital technologies and innovation". The PCA used the same 81 participants as the original analysis, with one component extracted from the remaining 12 indicators. Spearman correlations between the revised PC1 score and the five technology usage variables were compared with the original results.

4. Results

4.1. Demographic Information

The survey sample comprised 91 participants representing subcontracting organisations operating in New Zealand's residential construction industry. Of these, 77 organisations

worked across both residential and commercial projects, while 14 operated exclusively in residential construction.

Table 2 summarises the organisational characteristics of the participating firms, including organisation size and office location. Among organisations working in both sectors, firms employing 20–49 employees represented the majority (62.3%), followed by those with 6–19 employees (37.7%). In contrast, residential-only organisations were generally smaller, with 64.3% employing 6–19 employees and 35.7% employing 20–49 employees, indicating that firms operating solely in the residential sector tend to be smaller.

Table 2. Profile of survey participants (Authors' own work).

	Organisation Type	**Both Residential and Commercial (N = 77)**		**Residential (N = 14)**	
Profile of Participants		**Frequency**	**Percent**	**Frequency**	**Percent**
Organisation size	6 to 19 employees	29	37.7%	9	64.3%
	20 to 49 employees	48	62.3%	5	35.7
Office Location	Auckland Region	49	63.6%	11	78.6%
	Waikato Region	6	7.8%	0	0%
	Wellington Region	9	11.7%	1	7.1%
	Canterbury Region	9	11.7%	2	14.3%
	Otago Region	4	5.2%	0	0%

Most respondents held senior management or technical positions, such as general managers, directors, engineers, and estimators, representing 72.2% of the sample. These roles suggest that respondents were positioned to provide informed assessments of organisational practices. However, their responses represented individual informants' perceptions and were not independently verified by other employees or organisational records.

Regarding office location, most organisations were based in the Auckland Region, accounting for 63.6% of mixed-sector firms and 78.6% of residential-only firms. Other organisations were located in Waikato, Wellington, Canterbury, and Otago. Among mixed-sector firms, Waikato represented 7.8%, Wellington 11.7%, Canterbury 11.7%, and Otago 5.2%. Residential-only firms were represented in Wellington (7.1%) and Canterbury (14.3%), with none reported in Waikato or Otago. Overall, the distribution reflects the strong concentration of construction activity in Auckland, while still capturing participation from several other regions across New Zealand.

4.2. Digital Technology Adoption

Frequency of Use

This section presents participants' use of nine digital technologies identified through literature review. The technologies were grouped into basic digital technologies (Microsoft Office, mobile technology, cloud computing, project management software, and social media) and advanced digital technologies (IoT, AutoCAD/Revit, BIM, and AI). Respondents evaluated each technology using a seven-point Likert scale (1 = Do not use, 7 = Always use). For ease of interpretation, responses were grouped into low usage (Do not use, Rarely, Occasionally), moderate usage (Moderately), and high usage (Frequently, Very Frequently, Always).

A total of 85 participants provided responses to the digital technology usage section. As shown in Figure 1, basic digital technologies were more widely used than advanced digital technologies. Microsoft Office recorded the highest level of high usage (92.7%),

followed by mobile technology (81.1%) and cloud computing (72.9%), reflecting their widespread use in everyday business activities. Project management software (47.1%) and social media (44.7%) showed more variable adoption across organisations. In contrast, advanced digital technologies exhibited consistently low adoption, with more than 70% of respondents reporting low usage of IoT (71.8%), AutoCAD/Revit (72.2%), BIM (74.1%), and AI (83.5%). Overall, the findings indicate that while basic digital technologies are well established among New Zealand residential subcontracting organisations, the adoption of advanced digital technologies remains limited.

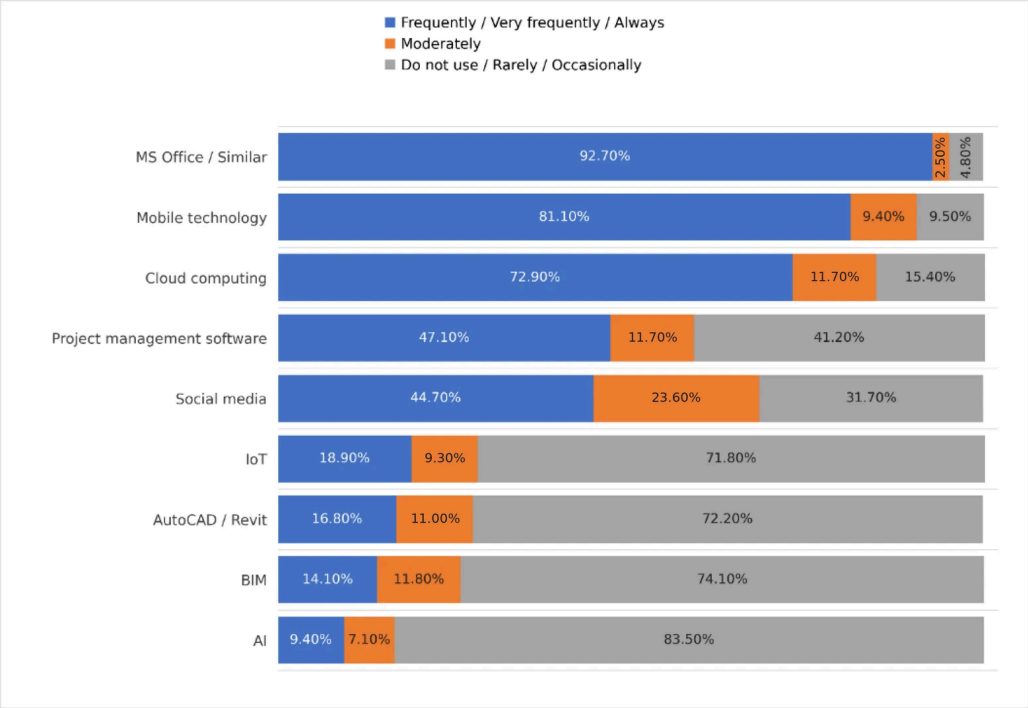


Figure 1. Distribution of Digital Technology Usage Frequency.

4.3. Common Method Bias Assessment

An unrotated principal component analysis of the 18 items identified five components with eigenvalues greater than one. The first component explained 35.24% of the total variance (Table 3), below the commonly used 50% threshold. This finding did not indicate a dominant single component; however, common method bias cannot be ruled out on this basis alone.

Table 3. Harman's single-factor test.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.343	35.239	35.239	6.343	35.239	35.239
2	2.322	12.898	48.137	2.322	12.898	48.137
3	1.406	7.814	55.95	1.406	7.814	55.95
4	1.151	6.394	62.344	1.151	6.394	62.344
5	1.007	5.594	67.938	1.007	5.594	67.938
6	0.94	5.22	73.158			

Table 3. *Cont.*

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
7	0.746	4.145	77.303			
8	0.66	3.666	80.969			
9	0.579	3.219	84.188			
10	0.515	2.863	87.052			
11	0.444	2.469	89.521			
12	0.416	2.313	91.833			
13	0.339	1.882	93.715			
14	0.308	1.71	95.426			
15	0.265	1.474	96.9			
16	0.222	1.233	98.133			
17	0.201	1.115	99.248			
18	0.135	0.752	100			

4.4. Competitiveness in NZ Construction Organisations

4.4.1. Reliability and Normality Assessment

Complete responses to all 13 competitiveness indicators were available for 81 participants. Prior to examining competitiveness levels, the dataset was screened for reliability and distributional suitability as shown in Table 4 below. The 13-item competitiveness scale demonstrated strong internal consistency (Cronbach's $\alpha = 0.882$), exceeding the recommended threshold. The results confirmed that the indicators reliably measured the underlying construct and were suitable for subsequent analysis using Principal Component Analysis.

Table 4. Reliability Statistics for the Competitiveness Scale.

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
0.882	0.885	13

4.4.2. PCA Results

Principal Component Analysis (PCA) was conducted to reduce the thirteen competitiveness indicators into a smaller set of components while retaining maximum variance in the dataset. PCA is a widely used multivariate technique for summarising organisational constructs and is suitable for analysing multidimensional concepts such as organisational competitiveness [49].

Prior to component extraction, dataset suitability for PCA was assessed. As shown in Table 5, the Kaiser–Meyer–Olkin measure indicated adequate sampling suitability, and Bartlett's Test of Sphericity was statistically significant, confirming sufficient correlations among the indicators to justify PCA.

The initial PCA results are presented in Table 6. Based on the Kaiser eigenvalue-greater-than-one criterion, three components were identified, with eigenvalues of 5.524, 1.478, and 1.174. These components explained 42.5%, 11.4%, and 9.0% of the total variance, respectively, accounting for 62.9% cumulatively. However, the Kaiser criterion was not used as the sole basis for determining the number of components to retain. Inspection of the scree plot in

Figure 2 showed a pronounced decline between the first and second components, followed by a substantially flatter pattern across the subsequent components, indicating a dominant first component.

Table 5. Kaiser–Meyer–Olkin (KMO) and Bartlett's Test of Sphericity for Competitiveness Indicators.

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.803
Bartlett's Test of Sphericity	Approx. Chi-Square	464.554
	df	78
	Sig.	<0.001

Table 6. Total Variance Explained by Principal Component Analysis.

Total Variance Explained						
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	5.524	42.495	42.495	5.524	42.495	42.495
2	1.478	11.365	53.861	1.478	11.365	53.861
3	1.174	9.028	62.888	1.174	9.028	62.888
4	0.984	7.571	70.46			
5	0.667	5.128	75.588			
6	0.596	4.582	80.17			
7	0.565	4.346	84.515			
8	0.537	4.134	88.65			
9	0.425	3.269	91.919			
10	0.363	2.794	94.713			
11	0.274	2.106	96.819			
12	0.236	1.813	98.633			
13	0.178	1.367	100			

To provide a stronger statistical basis for determining the number of components to retain, Horn's parallel analysis was conducted. The analysis used 1000 randomly generated datasets with the same dimensions as the observed dataset (N = 81; 13 variables), applying the 95th-percentile criterion. Under parallel analysis, a component is retained when its observed eigenvalue exceeds the corresponding 95th-percentile eigenvalue generated from random data.

As shown in Table 7, the observed eigenvalue for PC1 (5.524) substantially exceeded the corresponding 95th-percentile random eigenvalue (1.910). In contrast, the observed eigenvalues for PC2 (1.478) and PC3 (1.174) were below their respective random-data thresholds of 1.661 and 1.490. PC4 also fell below its corresponding threshold. Thus, although the Kaiser criterion initially identified three components with eigenvalues greater than one, parallel analysis supported the retention of only the first principal component. This result was also consistent with the pronounced break after PC1 observed in the scree plot.

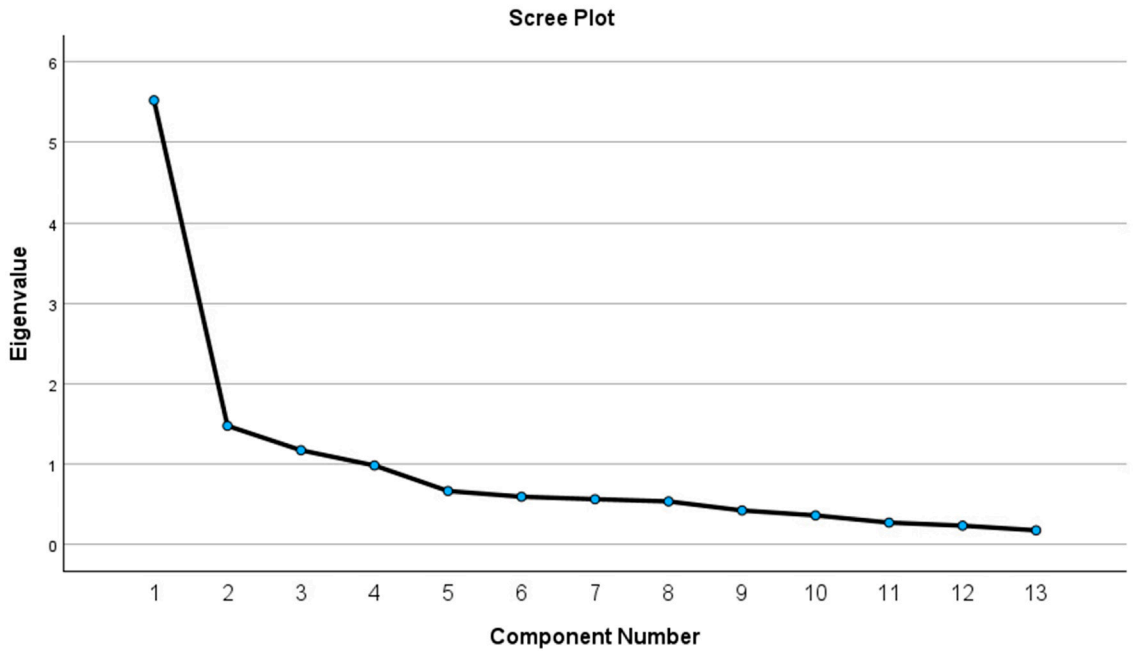


Figure 2. Scree Plot of Competitiveness Indicators.

Table 7. Parallel Analysis for Component Retention.

Component	Observed Eigenvalue	Mean Random Eigenvalue	95th Percentile Random Eigenvalue
PC1	5.524	1.729	1.910
PC2	1.478	1.535	1.661
PC3	1.174	1.387	1.490
PC4	0.984	1.260	1.348

The retained PC1 accounted for 42.5% of the total variance and represented the dominant common pattern across the thirteen competitiveness indicators. As shown in Table 8, all thirteen indicators loaded positively on PC1, with loadings ranging from 0.517 to 0.765. The consistently positive loadings indicate that higher PC1 scores correspond to higher values across the different aspects of organisational competitiveness. Accordingly, PC1 was interpreted as a composite measure of overall organisational competitiveness.

Table 8. Component Loadings for the First Principal Component (PC1).

Competitiveness Indicator	PC1 Loading
Improved project delivery and budget management	0.642
Improved financial performance and cost management	0.517
Improved client expectations and satisfaction	0.54
Improved competitive strategy in bidding and expansion	0.673
Improved operational efficiency and risk management	0.721
Improved health and safety standards	0.683
Improved employee development and company culture	0.755
Improved leadership and management skills	0.765

Table 8. *Cont.*

Competitiveness Indicator	PC1 Loading
Improved adoption of digital technologies and innovation	0.666
Improved adaptability to market changes	0.592
Improved regulatory compliance and collaboration	0.554
Improved reputation and stakeholder relationships	0.689
Improved environmental sustainability and CSR	0.617

Based on the combined evidence from the scree plot, parallel analysis, and the positive loading pattern across all thirteen indicators, PC1 was retained as the summary measure of organisational competitiveness. The PC1 score was subsequently used in Spearman's rank correlation and partial Spearman correlation analyses to examine its associations with the frequency of digital technology usage, with the latter controlling for firm size and sector involvement.

4.4.3. Competitiveness by Level of Digital Technology Usage

To examine the relationship between digital technology usage and organisational competitiveness, Spearman's rank correlation analysis was conducted between the frequency of digital technology usage (measured on a seven-point Likert scale) and the PCA-derived organisational competitiveness factor score. The analysis focused on the five most frequently used digital technologies identified in Section Frequency of Use: Microsoft Office or similar tools, Mobile Applications, Cloud Computing, Project Management Software, and Social Media. Spearman's rank correlation was selected because it is appropriate for examining associations between ordinal and continuous variables.

Table 9 presents the correlation results. Social Media ($\rho = 0.445$, $p < 0.001$) and Mobile Applications ($\rho = 0.418$, $p < 0.001$) demonstrated moderate positive relationships with organisational competitiveness, while Cloud Computing ($\rho = 0.345$, $p = 0.002$) and Microsoft Office or similar tools ($\rho = 0.237$, $p = 0.035$) showed weak but statistically significant positive relationships. In contrast, Project Management Software was not significantly associated with organisational competitiveness ($\rho = 0.079$, $p = 0.481$). Overall, the results indicate that organisations reporting more frequent use of Social Media, Mobile Applications, Cloud Computing, and Microsoft Office or similar tools tended to report higher levels of organisational competitiveness, whereas no significant relationship was observed for Project Management Software.

Table 9. Spearman's rank correlation between digital technology usage and organisational competitiveness.

Digital Technology	Spearman's ρ	*p*-Value	Interpretation
Social Media	0.445	<0.001	Moderate positive relationship
Mobile Applications	0.418	<0.001	Moderate positive relationship
Cloud Computing	0.345	0.002	Weak positive relationship
Microsoft Office or Similar	0.237	0.035	Weak positive relationship
Project Management Software	0.079	0.481	Very weak positive relationship (not significant)

4.4.4. Robustness Check and Multiple Comparisons

A robustness check was conducted to assess whether the observed associations depended on including "improved adoption of digital technologies and innovation" within the competitiveness measure. PC1 was recomputed using the remaining 12 indicators and the same 81 participants included in the original PCA. One component was extracted for comparison with the original competitiveness score. The revised component had an eigenvalue of 5.133 and explained 42.77% of the total variance. All 12 indicators loaded positively, with loadings ranging from 0.499 to 0.751.

As shown in Table 10, excluding the indicator produced slightly smaller correlations. Social media ($\rho = 0.399$, $p < 0.001$), mobile technology ($\rho = 0.403$, $p < 0.001$) and cloud computing ($\rho = 0.311$, $p = 0.005$) remained positively associated with perceived organisational competitiveness. Microsoft Office or similar tools became non-significant ($\rho = 0.217$, $p = 0.055$), while project management software remained non-significant ($\rho = 0.054$, $p = 0.632$).

Table 10. Spearman correlations using the original 13-item and revised 12-item PC1 competitiveness scores.

Digital Technology	N	13-Item PC1: ρ	*p*-Value	12-Item PC1: ρ	*p*-Value
Social media	81	0.445	<0.001	0.399	<0.001
Mobile technology	81	0.418	<0.001	0.403	<0.001
Cloud computing	81	0.345	0.002	0.311	0.005
Microsoft Office or similar tools	79	0.237	0.035	0.217	0.055
Project management software	81	0.079	0.481	0.054	0.632

For five correlations, a Bonferroni correction gives a significance threshold of 0.01 (0.05/5). Social media, mobile technology and cloud computing met this threshold in both versions of the analysis. The original Microsoft Office association ($p = 0.035$) did not survive this correction. These findings indicate that the associations for social media, mobile technology and cloud computing persisted without the potentially overlapping indicator, whereas the Microsoft Office finding was sensitive to item exclusion and multiple-comparison correction.

4.4.5. Associations After Controlling for Firm Size and Sector

Partial Spearman correlations were calculated between the frequency of use of each of the five digital technologies and the PC1 competitiveness score, controlling simultaneously for firm size and sector involvement. Both controls were binary: firm size distinguished organisations employing 6–19 and 20–49 employees, while sector involvement distinguished residential-only organisations from those operating in both residential and commercial construction. Each technology was examined separately, using the same complete cases for its unadjusted and adjusted correlations.

As shown in Table 11, the associations changed little after adjustment. Social media, mobile technology and cloud computing remained positively associated with perceived organisational competitiveness. Microsoft Office or similar tools retained a weak positive association at the uncorrected 0.05 significance level, whereas project management software remained non-significant. The results therefore support the main pattern observed in the original analysis, indicating that these associations were not fully explained by differences in firm size or sector involvement. However, adjustment for these characteristics does not establish a causal relationship.

Table 11. Unadjusted and partial Spearman correlations between digital technology usage and the PC1 competitiveness score.

Digital Technology	N	Unadjusted ρ	Unadjusted *p*-Value	Partial ρ	Partial *p*-Value
Social media	81	0.445	<0.001	0.436	<0.001
Mobile technology	81	0.418	<0.001	0.375	<0.001
Cloud computing	81	0.345	0.002	0.301	0.007
Microsoft Office or similar tools	79	0.237	0.035	0.242	0.034
Project management software	81	0.079	0.481	0.047	0.679

5. Discussion

5.1. Digital Technology Adoption Patterns in Subcontracting Organisations

The findings indicate that digital technology adoption among subcontracting organisations is concentrated around basic operational tools, while advanced technologies remain underutilised, a pattern also observed in residential and SME construction contexts [4].

Technologies supporting coordination with clients, contractors, and suppliers are widely incorporated into daily operations, while tools requiring deeper technical integration remain limited. This pattern reflects incremental digital adoption commonly observed among construction SMEs [50]. The low uptake of BIM and IoT further suggests that many residential subcontractors operate outside digitally integrated project environments.

Overall, the uneven adoption between basic and advanced technologies highlights the fragmented nature of digital transformation in the residential construction sector. While foundational tools indicate progress toward basic digital maturity, limited adoption of advanced technologies suggests that transformation remains shallow rather than systemic, consistent with previous studies of residential and small-scale construction firms [4,51].

5.2. Digital Technology Usage Levels and Competitiveness Outcomes

The results indicate that higher levels of digital technology usage are associated with stronger organisational competitiveness among subcontracting organisations. Organisations reporting more frequent use of certain digital technologies tended to report higher organisational competitiveness scores. This finding aligns with studies showing that competitiveness gains occur when digital tools are embedded in everyday workflows rather than used on an ad hoc basis [4].

Notably, the technologies associated with higher organisational competitiveness were primarily widely accessible digital tools rather than advanced digital systems. Mobile applications, cloud computing, social media, and Microsoft Office or similar productivity tools were all positively associated with competitiveness. These technologies support everyday organisational activities by improving communication between project participants, facilitating information sharing, streamlining administrative processes, and strengthening client engagement. For subcontracting organisations operating in fragmented project environments, the consistent integration of these technologies into routine work practices may therefore provide practical competitive advantages without requiring substantial investment in more advanced digital systems. This supports evidence suggesting that incremental digitalisation delivers more reliable performance improvements for construction SMEs than complex technologies requiring high organisational readiness [2].

However, the relationship between digital technology usage and competitiveness may also be reciprocal. More competitive organisations may be better positioned to sustain higher levels of digital integration due to stronger managerial capability and re-

source availability [51]. Thus, digital technologies appear to enable existing organisational strengths rather than independently determine competitive success.

5.3. Theoretical Interpretation Through the Resource-Based View

The findings are consistent with the Resource-Based View, which argues that organisational value depends not simply on possessing resources but on how effectively they are used and combined with existing capabilities [20,21]. The technologies associated with competitiveness in this study are widely available and can generally be accessed by competing organisations. Their value is therefore unlikely to come from access to the technology alone.

Instead, competitive value may develop through the organisation's ability to integrate these technologies into routine activities such as communication, coordination, information sharing and client engagement. The non-significant result for project management software further supports the argument that using a digital resource does not automatically translate into stronger competitiveness. Its value may depend on complementary employee skills, management practices and integration with the wider project environment.

The findings therefore extend the application of RBV from the possession of digital resources to their routine organisational use. However, because the study is cross-sectional, the direction of the relationships cannot be established. More competitive organisations may also have stronger resources and capabilities that allow them to use digital technologies more effectively.

5.4. Theoretical and Practical Implications

Theoretically, this study adds to construction digitalisation research by showing that the relationship between digital technology use and organisational competitiveness differs across individual technologies. It supports the RBV argument that the value of digital technologies depends on how they are integrated with organisational knowledge, routines and capabilities rather than simply whether they are adopted. It also extends previous New Zealand research on technology adoption, barriers and productivity by providing organisation-level evidence from residential subcontracting organisations [4,24,35].

Practically, the findings suggest that subcontractors should focus not only on acquiring new technologies but also on making effective use of the technologies already available to them. Mobile applications, cloud computing, social media and common office tools may support communication, information sharing, administration and client engagement when integrated into everyday work. The non-significant result for project management software also highlights the need to consider organisational requirements, employee capability and existing processes before investing in digital systems.

Industry support should therefore extend beyond encouraging technology adoption. Practical training, implementation guidance, knowledge sharing and access to affordable digital solutions may help subcontractors develop the capabilities needed to gain greater value from digital technologies. This may be particularly important for smaller residential subcontractors with limited resources and a strong dependence on other project participants.

6. Conclusions

This study examined digital technology usage and its relationship with organisational competitiveness among subcontracting organisations in New Zealand's residential construction industry. The findings show that basic and accessible technologies, particularly Microsoft Office or similar tools, mobile applications and cloud computing, are used more frequently than advanced technologies such as BIM, IoT and AI.

The results also show that the frequency of digital technology use is associated with organisational competitiveness, although the strength of this relationship varies

across technologies. Social media and mobile applications showed moderate positive associations with competitiveness, while cloud computing and Microsoft Office or similar tools showed weaker positive associations. In contrast, project management software showed no statistically significant relationship with competitiveness. These findings suggest that digital technologies should not be treated as having uniform relationships with organisational competitiveness.

From an RBV perspective, the findings suggest that the organisational value of digital technologies may depend on how effectively they are integrated with existing capabilities and routine practices rather than simply whether they are adopted. However, given the cross-sectional design of the study, the findings demonstrate associations rather than causal relationships. Further longitudinal research is needed to examine how digital technology usage and organisational competitiveness develop over time.

7. Limitations

Each organisation was represented by one respondent, and digital technology usage and competitiveness were measured through the same questionnaire on a single occasion. Respondents' general views of their organisations, social desirability and individual perceptions may therefore have influenced the observed correlations. Although participation was anonymous and the measures appeared in separate questionnaire blocks with different response anchors, these features cannot eliminate common method bias. The first component in Harman's test explained 35.24% of the total variance, indicating no dominant single component; however, this test cannot establish that common method bias is absent. The findings should therefore be interpreted cautiously as associations between self-reported measures. Future research should obtain technology usage and performance measures from different informants or combine survey responses with independent organisational records.

This study focused only on subcontracting organisations involved in residential construction in New Zealand. While this provides a clear and relevant context, it means the findings may not apply to subcontractors working in other sectors, such as commercial or infrastructure projects, where conditions and practices can be quite different.

The analysis was also limited to organisations with 6 to 49 employees. This allowed for a consistent focus on small and medium-sized firms, but it does not represent very small businesses or larger organisations, which may have different resources, capabilities, and approaches to digital technologies.

Finally, the sample size was suitable for the type of analysis conducted, but it may still affect the stability of the results and the ability to identify weaker relationships. Future studies with a larger number of participants would help confirm and strengthen these findings.

Author Contributions: Conceptualization, A.A.A.-K., F.E.R., M.B.P. and M.D.M.P.; Methodology, A.A.A.-K., F.E.R., M.B.P. and M.D.M.P.; Formal analysis, A.A.A.-K.; Investigation, A.A.A.-K.; Data curation, A.A.A.-K.; Writing—original draft, A.A.A.-K.; Writing—review & editing, A.A.A.-K., F.E.R., M.B.P. and M.D.M.P.; Visualization, A.A.A.-K. and M.B.P.; Supervision, F.E.R., M.B.P. and A.G.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was approved by the Auckland University of Technology Ethics Committee (AUTEC), approval number 24/188, on 29 August 2024.

Informed Consent Statement: Informed consent was obtained from all participants through their voluntary completion of the online questionnaire. Participants were informed that completing the questionnaire indicated consent to participate. Responses were anonymous.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to ethical approval conditions.

Conflicts of Interest: The authors declare no conflicts of interest.

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