CASE STUDY | Article in Press

Crisis impacts on the construction workforce in New Zealand: a comparative analysis of the global financial crisis, earthquakes, and COVID-19

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Received: 29 September 2025 / Revised: 10 July 2026 / Accepted: 1 September 2026
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Abstract
Despite a growing body of research on crisis impacts in construction, limited attention has been given to how workforce disruptions compare across different crisis types. This study examines how the New Zealand construction workforce was impacted by three major crises: the Global Financial Crisis (2008), the Canterbury and Kaikoura Earthquakes (2010–2016), and the COVID-19 pandemic (2020–2022). Employing a qualitative multi-method approach, we conducted a structured review of the literature and qualitative thematic analysis of sixteen semi-structured interviews with construction professionals. The findings are organised across three core domains: workforce availability, coping mechanisms, and long-term career shifts. Labour Market Shock Models, Human Capital Theory, and Adaptive Capacity concepts are used as complementary analytical lenses. Distinct disruption mechanisms were identified across crises: economic contraction triggered widespread redundancies during the financial crisis; natural hazards created labour surges but introduced health and safety risks, while pandemic-driven border closures and health protocols produced cyclical labour shortages. To support cross-crisis comparison, the study develops a Crisis Impact Matrix and uses a complementary Disruption Dynamics Framework, to illustrate how workforce disruptions evolve over time. Together, they provide a structured way of comparing workforce disruptions across crisis contexts and examining how their impacts evolve over time. The findings highlight recurring workforce vulnerabilities, including dependence on migrant labour, limited domestic skill pipelines, and reactive policy responses. The findings also identify implications for workforce planning, immigration policy, local skills development, and long-term workforce resilience.

Keywords Construction workforce · COVID-19 · Global financial crisis · Canterbury and kaikoura earthquakes · Job loss · Labour shortage · New Zealand

Introduction

The construction workforce is central to the stability and productivity of national economies yet remains chronically vulnerable to systemic disruptions. Globally, crises such as economic recessions, natural disasters, and pandemics have repeatedly exposed fragile labour markets, revealing persistent weaknesses in recruitment pipelines,

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https://doi.org/10.1186/s43065-026-00216-9

Published online: 11 September 2026

skills development, and workforce continuity [12, 39, 50]. These vulnerabilities are particularly acute in the construction sector, where project delivery depends heavily on skilled labour availability, site-based operations, and complex subcontractor networks. Workforce instability not only disrupts individual livelihoods but compromises the sector's overall capacity to recover from crisis events, contributing to project delays, cost overruns, and declining productivity [6].

In this study, a crisis refers to any event or circumstance that disrupts normal operations and places the stability, performance, or continuity of social, organisational, or economic systems at risk, necessitating immediate adaptive action [3]. Disruption is defined as the interruption or degradation of normal workforce operations caused by an external shock, consistent with established crisis and operations literature [15, 33]. Disruptions differ in onset speed, duration, and mechanism. Natural hazards such as earthquakes trigger rapid-onset disruptions through physical damage, displacement, and urgent reconstruction demands [14]. Man-made or economic crises, such as the Global Financial Crisis, create slow-onset disruptions that constrain investment, reduce labour demand, and erode human capital [59]. These distinctions clarify the comparative focus of the paper and allow a more precise analysis of how different disruption mechanisms shape workforce vulnerabilities and adaptive responses.

Existing studies often focus on single events, limiting the ability to draw comparative insights about workforce resilience across crisis types [2]. Previous studies have drawn on a range of theoretical perspectives to explain workforce disruption, including Human Capital Theory [5], Labour Market Shock Models [7, 19], and the Adaptive Capacity Framework [52]. However, these studies have typically focused on individual crisis contexts, limiting understanding of how workforce vulnerabilities and responses compare across different types of disruption. Accordingly, this study is guided by two research questions designed to clarify how different crises generate workforce disruptions: (1) How have New Zealand construction workers experienced, absorbed, and adapted to the impacts of three major crises, the Global Financial Crisis, Canterbury and Kaikoura earthquakes, and the COVID-19 pandemic? (2) What cross-crisis lessons can be drawn to strengthen the resilience, stability, and adaptive capacity of the construction workforce?

This study addresses this gap by comparing workforce disruption across three major crises affecting New Zealand's construction sector: the Global Financial Crisis, the Canterbury and Kaikoura earthquakes, and the COVID-19 pandemic. Drawing on a structured review of prior research and semi-structured interviews with construction professionals, the study examines workforce availability, coping responses, and long-term career shifts across these crisis contexts. Labour Market Shock Models, Human Capital Theory, and Adaptive Capacity concepts are used as complementary analytical lenses to interpret disruption mechanisms, workforce outcomes, and organisational responses. The study develops a Crisis Impact Matrix to support structured cross-crisis comparison and uses a complementary Disruption Dynamics Framework to illustrate how workforce impacts evolve over time. By adopting a comparative perspective, the study identifies recurring workforce vulnerabilities and adaptive responses that are difficult to observe through single-crisis analyses.

This study builds on the authors' prior research on crisis impacts in the construction sector [40, 41, 42], extending earlier findings through a cross-crisis comparative design and a longer-term analytical perspective.

Background

Existing research on construction workforce resilience has largely examined crisis impacts within single-event contexts, including economic downturns, natural hazards, and health-related disruptions. Studies on financial crises primarily focus on employment contraction, labour market instability, and skill erosion [39], while disaster-focused research emphasises post-event labour surges, reconstruction demands, and workforce displacement [12]. More recent studies on COVID-19 highlight supply-side constraints, including labour shortages, mobility restrictions, and health-related absenteeism [45]. While these studies provide valuable insights, they remain fragmented across crisis types and rarely offer integrated, cross-crisis analysis of workforce dynamics.

This body of work recognises that economic, environmental, and health-related crises rarely occur in isolation; rather, they interact over time to produce cumulative impacts that progressively erode adaptive capacity, institutional preparedness, and workforce stability beyond the effects of single disruptions [53]. Collectively, this literature suggests that repeated crises can create cumulative workforce pressures that extend beyond the effects of any single disruption. In labour-intensive sectors such as construction, this cumulative dynamic is particularly consequential, as workforce continuity underpins not only sectoral productivity but the broader national capacity for economic and physical recovery.

Within this international context, workforce fragility has been widely identified as a structural and systemic condition of the construction sector, not merely a crisis-induced anomaly. Comparative research across Europe, North America, and Asia suggests that common vulnerability drivers include reliance on migrant labour, project-based and subcontracted employment arrangements, limited investment in domestic training systems, and weak skill pipeline redundancy [20, 39]. These structural features create a workforce that is simultaneously indispensable to post-crisis recovery and highly exposed to disruption.

Evidence from earthquake recovery contexts, including New Zealand, further shows that acute skilled labour shortages were often addressed through emergency international recruitment, providing short-term relief while reinforcing longer-term dependency on external labour markets [12]. COVID-19 research across multiple countries highlights the structural exposure of site-based workforces to supply-side shocks, where limited ability to transition to remote work amplifies labour shortages during mobility-restricting crises [2, 47]. While more recent crises have prompted improvements in coordination and policy intervention, these responses remain uneven across firm size and institutional context, reflecting ongoing gaps in systemic workforce resilience planning.

The construction sector is particularly susceptible to crisis-related disruptions due to its reliance on site-based work, project-specific employment, subcontractor networks, and international labour mobility. Shocks affecting either the supply or demand of labour frequently generate both immediate and long-term instability across workforce systems [30, 39]. New Zealand has experienced multiple large-scale crises over the past two decades that have repeatedly exposed these vulnerabilities with significant consequences for workforce availability, organisational resilience, and national recovery capacity.

The Global Financial Crisis (GFC) of 2008 triggered a significant contraction in construction activity, reducing investment, delaying projects, and contributing to widespread redundancies across both skilled and unskilled occupations [55]. As firms sought to reduce costs and preserve cash flow, many workers exited the industry, while training and workforce development activities were curtailed [1]. The effects extended beyond immediate job losses. Reduced investment in skills development and prolonged periods of unemployment contributed to the erosion of sector-specific knowledge and experience, limiting the availability of skilled labour during the recovery period (Council of Europe, [16, 39]). These impacts exposed pre-existing weaknesses in New Zealand's construction labour market, including limited domestic training capacity, cyclical employment patterns, and growing reliance on migrant labour to address persistent skill shortages [38, 62]. Consequently, the GFC highlighted how demand-side shocks can have long-term implications for workforce resilience by weakening both labour availability and the human capital base upon which future recovery depends.

The Canterbury and Kaikoura earthquakes disrupted the construction workforce through mechanisms that differed substantially from those observed during the GFC. Rather than reducing labour demand, the earthquakes generated an immediate and sustained need for reconstruction, creating significant shortages across engineering, project management, site supervision, and specialist trade occupations [12, 54]. The scale of rebuilding activity exceeded local workforce capacity, prompting government interventions aimed at attracting skilled overseas workers through initiatives such as the Christchurch Rebuild Visas. Although international recruitment helped address immediate labour shortages, demand remained particularly acute in specialised areas including structural and geotechnical engineering, highlighting the limited capacity of domestic workforce development systems to respond rapidly to large-scale reconstruction requirements [28, 29]. The 2016 Kaikoura earthquake reinforced many of these challenges. While geographically smaller in scale, the event caused significant disruption to infrastructure, buildings, and local labour markets [27, 57]. Government support measures assisted workforce

retention during the early stages of recovery, but reconstruction activity further intensified pressure on an already constrained labour market [44]. Together, these earthquake events demonstrated how sudden increases in labour demand can expose structural shortages in skilled labour and increase reliance on external workforce sources during recovery.

The COVID-19 pandemic introduced a different form of workforce disruption, characterised primarily by constraints on labour availability rather than fluctuations in labour demand. Border closures restricted the arrival of new migrant workers, while isolation requirements, illness, and public health restrictions reduced the availability of workers already employed within the sector [21, 22]. At the same time, social distancing measures and site operating restrictions required firms to modify work practices, resequence activities, and operate with reduced workforce density [32, 45].

Unlike the GFC, which reduced demand for labour, or the earthquakes, which generated a surge in reconstruction activity, COVID-19 constrained workforce supply despite continued construction demand. Employers reported difficulties attracting and retaining skilled workers, while some employees left the sector entirely due to uncertainty, family separation, or longer-term health impacts associated with the virus [47]. As a result, the pandemic highlighted the complex interdependencies between labour mobility, public health measures, migration policy, and workforce resilience.

Although these crisis types differ substantially in their causes and disruption mechanisms, they repeatedly expose similar workforce vulnerabilities, including skill shortages, labour market rigidity, dependence on migrant labour, and uneven organisational capacity to respond. Existing studies have typically examined these crises independently, making it difficult to distinguish crisis-specific effects from recurring structural weaknesses. A comparative perspective is therefore needed to identify which workforce challenges are unique to particular crises and which persist across disruption contexts.

Theoretical framework

The selection of Human Capital Theory, Labour Market Shock Models, and the Adaptive Capacity Framework is based on their complementary ability to capture distinct but interconnected dimensions of workforce disruption. Specifically, Labour Market Shock Models explain the immediate mechanisms of disruption in terms of supply–demand imbalances; Human Capital Theory captures the longer-term consequences of these disruptions on skills, employability, and workforce retention; and the Adaptive Capacity Framework provides a systems-level perspective on how organisations and institutions respond and adjust to these shocks. The study draws on these frameworks as complementary analytical lenses.

Human Capital Theory

Human Capital Theory conceptualises skills, knowledge, and experience as forms of capital that require investment and are subject to depreciation under conditions of disruption. Within construction, human capital is particularly vulnerable to disruption due to the sector's reliance on skilled labour, project-based employment, and limited redundancy in training systems [20, 39]. Crises such as economic downturns or pandemics can lead to workforce displacement, skill atrophy, and reduced investment in training, thereby weakening long-term sector capacity [45]. Human Capital Theory therefore provides a critical lens for examining how crises reshape workforce capability, career trajectories, and long-term employability.

Labour Market Shock Models

Labour Market Shock Models explain how external disruptions affect employment systems through sudden changes in labour supply and demand [7, 36]. These models distinguish between demand-side shocks, such as

those caused by economic contraction, and supply-side shocks, arising from labour shortages, mobility restrictions, or health-related absenteeism [26]. This distinction is particularly relevant in construction, where labour availability is highly sensitive to both macroeconomic conditions and physical constraints on site-based work [31]. In this study, Labour Market Shock Models are used to analyse how different crisis types, economic, environmental, and health-related, produce distinct patterns of workforce disruption, including redundancies, shortages, and regional imbalances.

Adaptive Capacity Framework

The Adaptive Capacity Framework [23] provides a useful lens for examining how organisations and institutions respond to workforce disruption. Within this study, it is used specifically to interpret coping responses and adjustment strategies adopted during and after crises, including workforce redistribution, policy interventions, and operational adaptation. Rather than focusing on the broader adaptive capacity literature, the framework is applied here as a means of understanding how construction organisations responded to changing workforce conditions across different crisis contexts. Adaptive capacity refers to the ability of systems to absorb shocks, reorganise, and maintain core functions under changing conditions [63]. In the construction sector, adaptive capacity is reflected in organisational strategies such as workforce redistribution, work resequencing, reliance on alternative labour sources, and policy-driven interventions [8]. This framework is particularly relevant in multi-crisis contexts, where repeated disruptions require not only recovery but also institutional learning and transformation over time [58].

Complementary analytical lenses

The study draws on three complementary analytical lenses, each serving a distinct purpose within the analysis. Labour Market Shock Models are used to identify the mechanisms through which different crises affect workforce supply and demand. Human Capital Theory supports interpretation of longer-term workforce consequences, including skill erosion, workforce exit, and employability. Adaptive Capacity concepts are used to examine how organisations and institutions responded to workforce disruption through operational and policy adjustments. Together, these lenses support interpretation of the findings from different perspectives, while avoiding reliance on any single theoretical explanation of workforce resilience.

Operationalisation in this study

The theoretical lenses informed interpretation of the findings rather than serving as a basis for theory development. Labour Market Shock Models were used to interpret disruption mechanisms, Human Capital Theory informed analysis of workforce capability and career impacts, and Adaptive Capacity concepts supported interpretation of organisational and policy responses. Together, these lenses provided a consistent structure for comparing findings across crisis contexts.

The operationalisation of these frameworks was guided by explicit criteria applied consistently across the dataset and aligned with the study's theoretical lenses. For the Crisis Impact Matrix, each finding was classified by crisis type, then interpreted as either a demand-side or supply-side shock in line with Labour Market Shock Models, and subsequently mapped to the workforce domain (availability, coping mechanisms, or long-term career shifts), most directly affected. For the Disruption Dynamics Framework, findings are interpreted in relation to their temporal position relative to each crisis: immediate impacts are classified as shock-phase dynamics, organisational and policy responses as adjustment-phase dynamics, and longer-term structural changes as transformation-phase outcomes. This temporal, process-based lens supports a cross-crisis interpretation of how disruptions evolved from initial shock through to long-term workforce transformation.

Analytical framework for cross-crisis comparison

The Crisis Impact Matrix and the Disruption Dynamics Framework are used as analytical tools to support the comparative interpretation of workforce disruptions across crises. They were developed to organise recurring patterns identified across the literature review and interview findings. Rather than representing standalone theoretical contributions, these tools provide a structured means of organising and interpreting the study's findings.

The Crisis Impact Matrix provides a structured representation of how different types of crises generate distinct workforce disruptions across the three analytical domains. It classifies workforce disruptions by systematically mapping crisis type (economic, environmental, or health-related), the associated disruption mechanism (demand-side or supply-side shocks), the resulting workforce impacts (availability, coping responses, and long-term career shifts), and their corresponding theoretical interpretations, including labour market shocks, human capital effects, and adaptive responses.

While the Crisis Impact Matrix provides a comparative overview of workforce impacts, the Disruption Dynamics Framework offers a complementary temporal perspective by illustrating how workforce disruptions evolve over time. It is used to interpret the progression from initial disruption through organisational adjustment to longer-term workforce outcomes.

Shock phase Initial disruption triggered by external events, including economic contraction, physical damage, or mobility restrictions. This phase is characterised by immediate labour market imbalances such as redundancies or shortages.

Adjustment phase Organisational and institutional responses aimed at stabilising operations, including workforce redistribution, policy interventions, and operational adaptation. This phase reflects varying levels of adaptive capacity across firms and institutions.

Transformation phase Long-term structural changes in workforce composition, including career shifts, skill erosion, and changes in labour market participation. This phase captures the cumulative effects of disruption on human capital and sector resilience.

Figure 1 presents the Crisis Impact Matrix and the Disruption Dynamics Framework, illustrating how disruption mechanisms and temporal phases interact across different crisis contexts.

Figure 1 comprises two complementary components. Panel A presents the Crisis Impact Matrix as a structured table mapping crisis types (economic, environmental, health-related) against disruption mechanisms, workforce impacts, and theoretical lenses. Panel B illustrates the Disruption Dynamics Framework as a temporal process flow across three phases (shock, adjustment, and transformation) showing how disruptions evolve into cumulative workforce outcomes.

Methodology

This study adopts a qualitative multi-method design in which a structured review of the literature is used to establish an analytical baseline, and semi-structured interviews are employed to extend these findings through empirical insights. The objective was to compare workforce disruptions across three major crises affecting New Zealand's construction sector: the Global Financial Crisis, the Canterbury and Kaikoura earthquakes, and the COVID-19 pandemic. The integration of these two complementary methods allowed for a comprehensive examination of both documented impacts and lived experiences, enabling a structured comparison between established patterns identified in the literature and emergent insights derived from interview data [49].

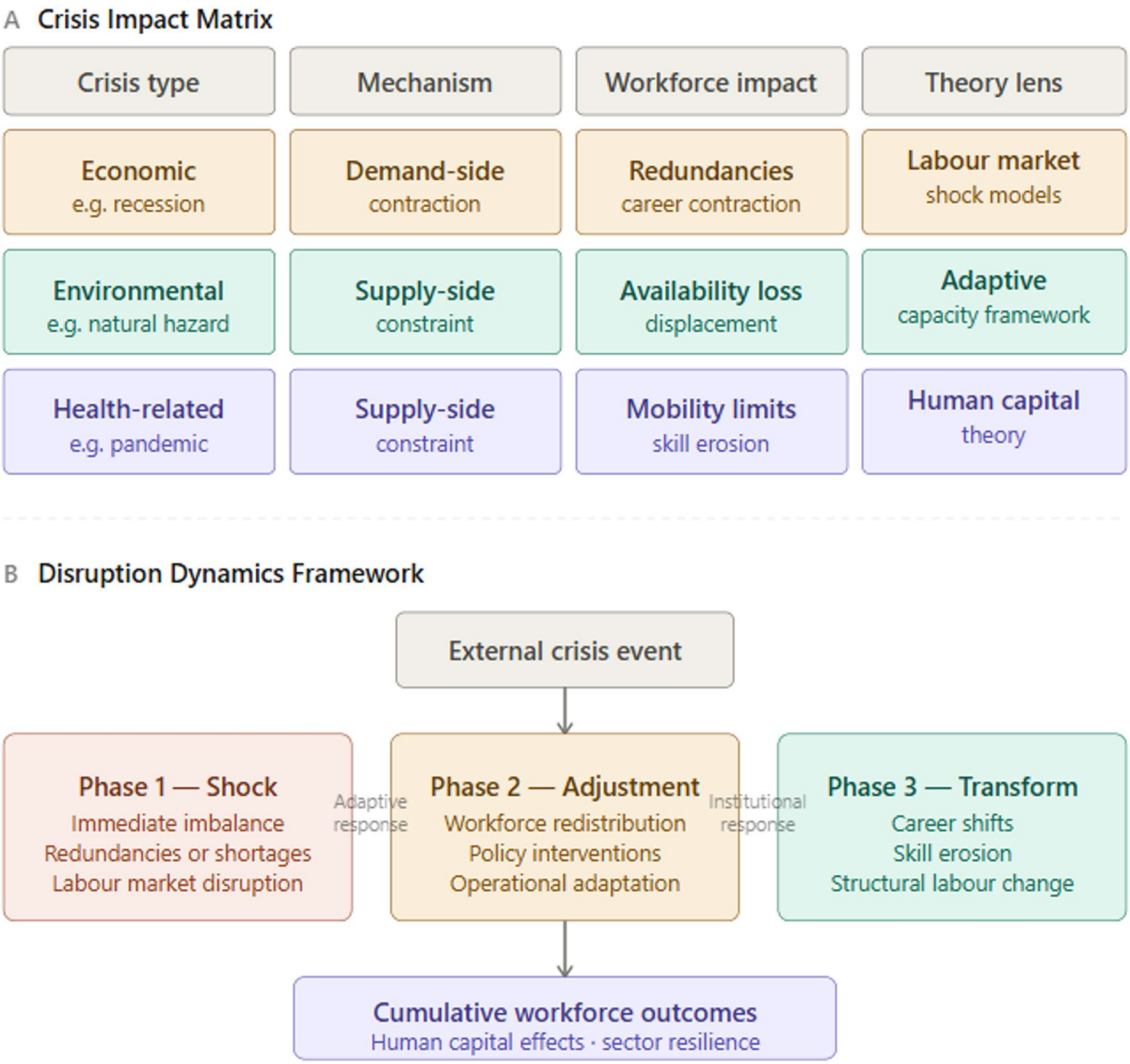


Fig. 1 Analytical structure used to compare workforce disruption across crisis contexts

The study was informed by three theoretical perspectives that supported interpretation of the findings. Human Capital Theory was used to examine workforce capability and employability outcomes, Labour Market Shock Models informed interpretation of labour supply and demand disruptions, and Adaptive Capacity concepts supported analysis of organisational and policy responses.

Structured review of the literature

The first phase of the research involved a structured review of the literature to synthesise existing knowledge concerning workforce disruptions within New Zealand's construction sector across multiple crises, with the specific purpose of establishing a theoretical and empirical baseline to guide and contextualise the subsequent interview analysis. The literature review was designed to identify dominant workforce disruption themes across crisis contexts rather than to provide an exhaustive synthesis of all resilience-related scholarship.

Relevant literature was identified through structured keyword searches across major academic databases and industry sources. Studies were selected based on relevance to construction workforce impacts across the three crisis contexts. Key workforce impacts and response patterns were extracted and synthesised thematically.

This multi-source approach allowed the review to capture a comprehensive and nuanced representation of workforce challenges across the selected crises.

Thematic analysis of interview data

In the second phase of the study, semi-structured interviews were conducted to generate first-hand accounts of how the COVID-19 pandemic specifically impacted the construction workforce in New Zealand. These interviews provided rich, contextualised insights that complemented the retrospective data generated from the literature review, allowing for direct comparisons across crisis events.

Participants were recruited using purposive sampling, followed by snowball sampling to expand the participant pool through professional referrals [46, 51]. Initial contacts were identified through professional networks, LinkedIn groups, and industry organisations. Eligibility criteria required participants to have a minimum of five years of professional experience in New Zealand's construction sector and to have worked in the industry during the COVID-19 pandemic.

Sixteen professionals participated in the study, representing diverse roles within the construction industry, including project managers, site engineers, quantity surveyors, planners, operations managers, and general managers. Participants represented both large firms and SMEs across the construction sector (Table 1). This sampling diversity enabled the collection of both strategic and operational perspectives, enhancing the depth and breadth of the data. Recruitment was completed when data saturation was reached, which occurred after the thirteenth interview. Three additional interviews were conducted beyond the saturation point to confirm the absence of disconfirming cases and to ensure adequate representation across firm sizes and roles. Beyond this point, subsequent interviews yielded no new themes or categories, consistent with accepted saturation thresholds in qualitative research [25].

Semi-structured interviews were conducted in accordance with institutional ethical guidelines. The semi-structured interview format allowed for guided conversation while also permitting interviewees to elaborate on issues they deemed important [24]. This format enhanced the richness of the data by enabling participants to discuss specific experiences, perceptions, and organisational responses to workforce disruptions.

Table 1 Profile of interviewees

Interviewee	Current role	Experience (years)
R1	Project manager	15
R2	Project manager	11
R3	Project manager	19
R4	Quantity surveyor	19
R5	Planner	17
R6	Quantity surveyor	11
R7	General manager	35
R8	Site engineer	7
R9	Operations manager	30
R10	Planner	12
R11	Operations manager	15
R12	Site engineer	6
R13	Quantity surveyor	7
R14	General manager	22
R15	General manager	32
R16	General manager	25

Interview data were transcribed using transcription software and subsequently verified for accuracy. The transcribed data were then uploaded to NVivo software for coding and thematic analysis [11]. Interview data were coded using a structured thematic analysis approach, with intercoder agreement ensuring consistency (Cohen's Kappa = 0.81) [48].

Thematic analysis followed the structured approach proposed by Braun and Clarke [9] and further elaborated by Kiger and Varpio [34]. The researchers engaged in iterative rounds of reading, coding, and theme development, ensuring that identified themes were firmly grounded in the data. Three dominant themes emerged from this process: workforce availability, coping mechanisms, and long-term career shifts. These themes provided the analytical structure for synthesising the interview findings with the literature review and for applying the theoretical frameworks that shaped the study.

Prior to the full data collection, a pilot study was conducted to test the clarity and relevance of the interview questions [17]. Two initial interviews were completed during this phase, leading to minor refinements in question wording and sequencing to enhance participant comprehension and ensure alignment with research objectives. The pilot interviews were also included in the final dataset after confirming their consistency with the full sample.

The combined multi-method approach allowed the study to examine both historic and contemporary workforce disruptions across different crisis types while ensuring methodological rigour through triangulation, data saturation, pilot testing, and intercoder reliability procedures.

Findings

Findings are derived from an integrated analysis of literature-based evidence and interview data, structured through the application of the Crisis Impact Matrix and the Disruption Dynamics Framework. The matrix is used to classify disruption types across crises, distinguishing between demand-side and supply-side mechanisms, while the dynamics framework supports analysis of how these disruptions evolve over time across shock, adjustment, and transformation phases.

Workforce availability

The structured review of the literature indicates that workforce disruptions across crises are reflected in shifts in labour supply and demand dynamics, with economic crises typically reducing labour demand and hazard-related events generating acute labour shortages. Findings indicate that across all three crises examined, the Global Financial Crisis, the Canterbury and Kaikoura earthquakes, and the COVID-19 pandemic, disruptions to workforce availability consistently exposed the structural vulnerability of the New Zealand construction sector. The nature and timing of workforce shortages differed between crises, but each indicated systemic weaknesses in labour supply resilience. This pattern reflects a prolonged shock phase within the Disruption Dynamics Framework, followed by an extended adjustment phase characterised by operational resequencing and workforce redistribution.

During the Global Financial Crisis, workforce levels initially contracted as project cancellations and firm closures triggered large-scale redundancies, reflecting a contraction in labour demand consistent with demand-side shocks [43]. However, as the economy recovered, the loss of experienced workers and diminished training investment led to the re-emergence of skills shortages [39]. This outcome illustrates the human capital erosion caused by prolonged unemployment, as displaced workers either exited the sector or faced de-skilling that undermined their re-employability [5]. Within the Crisis Impact Matrix, this pattern is classified as a demand-side contraction occurring during the shock phase, resulting in immediate workforce displacement and subsequent human capital erosion.

In line with findings from the literature, the Canterbury and Kaikoura earthquakes generated immediate surges in labour demand. Reconstruction efforts created acute shortages across specialist trades, seismic design, project management, and engineering disciplines [13, 54]. Labour market supply chains were unable to adjust quickly,

leading to the adoption of targeted immigration programmes such as the Christchurch Rebuild Visas to attract overseas workers [28, 54]. Although international recruitment addressed some shortages, high-skill roles in structural engineering and supervision remained difficult to fill [29], highlighting continued reliance on external labour sources for specialised skills. In the Crisis Impact Matrix, this represents a supply-side constraint emerging during the shock phase, where sudden increases in labour demand exceeded available workforce capacity.

The COVID-19 pandemic introduced a different labour supply disruption, characterised by cyclical shortages resulting from both domestic and international mobility constraints. Several interviewees confirmed the severity of these workforce reductions. One general manager (R14) estimated that, "We were possibly 20% short before COVID; now we're up around 80,000 people short in the industry." Another planner (R10) added that, "At the peak of Omicron, we were often working with less than half the staff available on-site."

The reliance on physical presence further magnified COVID-19's impact, as most construction work could not transition to remote modalities [18, 45]. This high physicality of work is a defining vulnerability within the sector's labour supply chain. The Adaptive Capacity Framework highlights that the inability to substitute or reconfigure labour inputs during crises reflects low systemic redundancy [23, 52].

In sum, while the Global Financial Crisis reduced labour demand, both the earthquakes and the pandemic imposed severe supply-side constraints. Across crises, the inability to rapidly mobilise skilled local labour repeatedly necessitated reliance on international recruitment, exposing a chronic deficiency in domestic workforce development pipelines.

Coping mechanisms

The structured review of the literature highlights that organisational responses to crises in the construction sector typically evolve from reactive cost-cutting measures to more adaptive and coordinated strategies over time. Organisational coping responses varied across crises but consistently involved a combination of government interventions, operational adjustments, and ad hoc workforce management strategies. The Adaptive Capacity Framework offers particular explanatory value here, as organisations attempted to absorb shocks and modify internal processes to sustain operations under uncertainty [23, 52]. These responses correspond to the adjustment phase in the Disruption Dynamics Framework, where organisations implement strategies to stabilise operations following initial disruption.

Following the earthquakes, government policy played a central role in facilitating labour inflows, including expedited visa processing and rebuild visa schemes [54]. Financial subsidies, such as the Earthquake Support Subsidy, also helped firms retain staff during the early recovery phases [44]. However, despite these measures, recruitment difficulties persisted for highly specialised positions, underscoring the limits of external labour sourcing as a resilience strategy [60].

Coping responses were most extensively developed during the COVID-19 pandemic, reflecting both previous crisis experience and the unprecedented nature of the disruption. Government wage subsidies, initiated under the COVID-19 Economic Response Package, played a critical role in retaining staff by offsetting payroll costs [56]. Several interviewees emphasised the importance of these subsidies. One operations manager (R11) noted that, "We topped up the government subsidies and paid full salaries to our staff, redundancy was not an option." This strategy aligns with Human Capital Theory, which stresses the long-term organisational value of retaining trained personnel during downturns [5].

Operational adjustments also formed a key coping mechanism. Firms re-sequenced work programmes to minimise the simultaneous exposure of multiple trades to infection risks. One site engineer (R8) described this approach, "We sequenced the trades so that when Omicron hit, not all trades were affected at the same time. It allowed us to keep sites operating even at reduced capacity." This operational flexibility exemplifies adaptive capacity in practice, where organisations dynamically modify workflows to absorb external shocks [23, 52].

Firms also increasingly sought local procurement and labour solutions to compensate for disrupted international supply chains. One quantity surveyor (R13) reflected, "We shifted towards procuring locally wherever

possible to reduce the reliance on imported materials and overseas labour." However, smaller firms reported limited financial capacity to compete for scarce local talent, highlighting intra-sectoral disparities in adaptive capacity. As one general manager (R7) observed, "Small businesses simply cannot afford recruitment costs or wage competition at the same level as larger firms."

The pandemic therefore catalysed both innovation and inequality in coping strategies. Larger firms demonstrated greater flexibility and resource buffers, while smaller firms faced more precarious conditions. Across crises, coping responses evolved from reactive cost-cutting during the Global Financial Crisis to more proactive adaptation during COVID-19, reflecting a maturing but still uneven development of adaptive capacity within the sector.

Long-term career shifts

Crises also produced long-term structural shifts in career pathways and employment patterns within the construction workforce. Labour Market Shock Models suggest that dislocations during crises often lead to durable labour market exits, skills atrophy, and occupational shifts [35, 36]. These outcomes align with the transformation phase of the Disruption Dynamics Framework, capturing long-term structural changes in workforce composition and human capital.

During the Global Financial Crisis, widespread redundancies led many displaced workers to permanently exit the sector or transition into alternative industries perceived as more stable [37]. The erosion of sector-specific skills during these extended absences further reduced re-employment prospects, diminishing the overall human capital stock available to the industry post-crisis [5].

The earthquakes also triggered career shifts, though through different mechanisms. Displacement from both residences and workplaces created regional labour market imbalances. For example, the Christchurch central business district saw approximately 50,000 job displacements immediately following the February 2011 earthquake [61]. Although reconstruction generated substantial demand for construction workers, some displaced workers from non-construction sectors were unable to transition into rebuilding roles due to skill mismatches and limited retraining pathways [4].

Health and safety concerns further complicated workforce stability following the earthquakes. Concerns regarding exposure to asbestos and other occupational hazards delayed site re-entry and, in some cases, contributed to longer-term workforce exits [10]. This interplay between safety perceptions and labour availability highlights additional dimensions of adaptive capacity related to occupational risk tolerance.

During the COVID-19 pandemic, long-term workforce shifts were driven by a combination of health, psychological, and logistical factors. Although redundancies were largely avoided due to government subsidies, voluntary exits occurred as some workers chose to leave the industry altogether. One project manager (R2) explained, "Some staff simply decided the uncertainty wasn't worth it. They moved into other industries or returned to their home countries." Other interviewees described workers relocating within New Zealand to avoid travel restrictions or family separation (R14).

Post-infection health impacts also constrained the return of some workers to physically demanding roles. Several interviewees reported instances of workers experiencing persistent fatigue, vertigo, or cardiovascular symptoms following COVID-19 recovery, limiting their ability to resume work at height or operate machinery (R10). This emerging dynamic introduces a novel dimension to human capital degradation, where crisis-induced health impacts diminish both physical capacity and the return on prior training investment.

Across all crises, long-term career shifts compounded existing skill shortages, reinforcing systemic workforce fragility. The sector's limited capacity for rapid retraining and reskilling exacerbated these patterns, contributing to sustained recruitment challenges long after the immediate crises had passed.

Figure 1 Panel A presents the conceptual categories (crisis type, disruption mechanism, workforce impact, and theoretical lens) that structure the comparative analysis. Table 2 operationalises these categories empirically, applying them to the specific experiences of the New Zealand construction workforce across the three

Table 2 Crisis impact matrix for workforce disruption in New Zealand construction

Domains	Analytical Dimension	Global Financial Crisis	Earthquakes	COVID-19
Workforce Availability	Labour Market Shock	Sharp contraction of labour demand; widespread redundancies and firm closures	Sudden surge in labour demand for reconstruction; severe regional labour shortages	Acute supply-side disruptions from isolation requirements, border closures, and absenteeism
	Dependency on Migrant Labour	Modest reliance during crisis; global competition for high-skilled migrants; recovery slowed by skill shortages	Influx of migrant workers to meet reconstruction needs; rebuild visa schemes; partial retention post-recovery	Heavy reliance exposed by border closures; inability to replace skilled foreign workers intensified shortages
Coping Mechanisms	Organisational Adaptive Capacity	Limited proactive adaptation; reactive skill development initiatives; firm closures common	Emergent visa facilitation and temporary wage subsidies; moderate operational flexibility	High operational adaptation: resequencing, workforce redistribution, local procurement, and targeted wage subsidies
	Government Policy Response	Minimal targeted construction sector support; broader fiscal stimulus provided limited sector relief	Strong intervention: rebuild visas, Earthquake Support Subsidy, regulatory streamlining for reconstruction	Comprehensive response: wage subsidies, border management, fiscal packages, business continuity planning
Long-term Career Shifts	Human Capital Impact	Long-term erosion of sector-specific skills through unemployment exits and underemployment; reduced human capital stock	High demand for specialised skills (e.g., seismic design); skill mismatches exposed; partial erosion of domestic skill base	Health-related workforce depletion; persistent post-COVID health effects reduced employability in some physical roles
	Workforce Redistribution	Permanent workforce exits; some skill loss unrecoverable	Regional relocation of displaced workers; housing pressure intensified in reconstruction zones	Sectoral shifts into more stable industries; voluntary exits influenced by uncertainty and health factors
	Occupational Health and Safety	Limited direct health risks; financial stress primary vulnerability	Delayed workforce re-entry due to structural damage and asbestos exposure concerns	Significant health protocols; isolation mandates; long-COVID impacts on physical labour capacity
	Post-crisis Labour Market Recovery	Slow recovery of employment levels; skills mismatch persisted; some permanent sector shrinkage	Temporary employment boom followed by regional unemployment risks as reconstruction tapered	Ongoing recruitment pressures exacerbated by global competition for skilled construction workers; intensified wage competition

crisis contexts. Table 2 presents the Crisis Impact Matrix populated with empirical findings, linking crisis type, disruption mechanism, and workforce outcomes across the three crises. The table aligns the empirical findings with the study's theoretical frameworks, Labour Market Shock Models, Human Capital Theory, and the Adaptive Capacity Framework, to demonstrate how different disruption types affected the New Zealand construction workforce through distinct but interconnected mechanisms. While the Global Financial Crisis primarily generated demand-side shocks through widespread redundancies and long-term skill erosion, the Canterbury and Kaikoura earthquakes triggered acute labour demand surges, exposing systemic skill shortages and regional imbalances. In contrast, the COVID-19 pandemic introduced severe supply-side shocks driven by border closures, absenteeism, and evolving public health restrictions, compounding pre-existing vulnerabilities associated with international labour dependency.

The table further illustrates how coping mechanisms evolved across crises, with limited adaptive capacity and policy support observed during the Global Financial Crisis, compared to more coordinated government interventions and operational adaptations during the earthquakes and the pandemic. The integration of occupational health and safety considerations, including pandemic-induced isolation mandates and post-infection health impairments, adds a novel dimension to long-term workforce resilience. Finally, the table highlights how post-crisis labour market recovery remains constrained by persistent skill shortages, wage competition, and reduced sector attractiveness, all of which reinforce the structural fragility of the construction workforce under compound crises. Table 2 presents the primary comparative synthesis of the study. The Crisis Impact Matrix organises findings according to crisis type, disruption mechanism, workforce impacts, and analytical interpretation. The categories presented in the matrix correspond directly to the comparative dimensions illustrated in Fig. 1. While Fig. 1 provides a simplified visual representation of the analytical structure, Table 2 contains the detailed evidence-based

comparison derived from the literature review and interview findings. Each row of Table 2 is labelled according to the workforce-impact domain to which it belongs, Workforce Availability, Coping Mechanisms, or Long-Term Career Shifts, so that the correspondence between the analytical dimensions and the domains illustrated in Fig. 1 is visible directly within the matrix rather than requiring separate explanation. These domains map onto the temporal phases of the Disruption Dynamics Framework: Workforce Availability corresponds to the shock phase, Coping Mechanisms to the adjustment phase, and Long-Term Career Shifts to the transformation phase.

This matrix operationalises the comparative analysis by explicitly linking crisis type to disruption mechanism and workforce outcomes, providing a structured basis for cross-crisis interpretation.

Discussion

Interpreted through Labour Market Shock Models, Human Capital Theory, and Adaptive Capacity concepts, the findings reveal both recurring workforce vulnerabilities and evolving organisational responses across crisis contexts. The cross-crisis comparison highlights patterns of vulnerability, response, and transformation that offer valuable theoretical and scholarly insights.

Across crises, the persistence of skill erosion, workforce exit, and reduced re-entry capacity indicates that the construction sector lacks mechanisms to preserve and regenerate human capital under prolonged or repeated shocks. The evolution of organisational and institutional responses across crises suggests a gradual but uneven development of adaptive capacity. While later crises demonstrate improved coordination and policy intervention, this progression appears reactive rather than systemic, indicating that learning remains event-driven rather than embedded within long-term workforce planning structures. These findings are consistent with prior research documenting the vulnerability of construction labour markets to disruption and the long-term erosion of sector-specific skills following economic and health-related shocks [39, 45]. The comparative perspective adopted here, however, extends this body of work by demonstrating that such vulnerabilities are not confined to individual crisis contexts but persist and intensify across successive disruptions, a pattern that single-crisis analyses are structurally unable to reveal. Thus, while all three frameworks remain applicable across crises, their explanatory power varies depending on the nature of the disruption.

The comparative design of this study offers insights that are frequently overlooked in single-crisis studies. First, while much existing research focuses on the acute impacts of individual crises, this study demonstrates how vulnerabilities accumulate and compound across successive disruptions. As detailed above, the Global Financial Crisis, earthquakes, and pandemic each built upon the vulnerabilities left by the preceding shock. Viewed through this lens, the construction workforce vulnerabilities documented in this study reflect not the impact of any single crisis but the accumulated consequence of successive shocks operating on a sector with insufficient structural redundancy, a dynamic that is particularly damaging in labour-intensive industries where workforce continuity is central to recovery capacity. These insights are further structured through the Crisis Impact Matrix and the Disruption Dynamics Framework developed in this study, which together enable both cross-sectional comparison and temporal analysis of workforce disruptions across crises.

Second, the study highlights how different crisis types activate distinct dimensions of workforce fragility. Economic crises produce primarily financial and demand-driven job losses, while natural disasters and pandemics disrupt workforce availability through displacement, border restrictions, and health-related absenteeism. These distinctions have important implications for understanding systemic resilience and designing context-specific responses. A related question is whether lessons derived from one crisis type translate meaningfully to qualitatively different crises. The findings suggest this depends on the level of analysis. At the level of disruption mechanism, transferability is limited; demand-side contractions driven by investment withdrawal differ fundamentally from supply-side constraints imposed by border closures or acute reconstruction demand, and responses calibrated for one mechanism may prove ineffective for another. At the level of structural vulnerability, however, transferability is strong: migrant labour dependency, training pipeline weakness, and reactive institutional

adaptation recur across all three crisis types, confirming that these are endemic features of the sector rather than situational responses to specific events. Effective resilience strategies must therefore distinguish between mechanism-specific responses, which require context-sensitive adaptation, and structural interventions, which remain relevant across crisis types.

This distinction highlights the added value of a cross-crisis comparative approach relative to single-crisis analyses. While individual crisis studies can identify context-specific impacts and responses, they are limited in their ability to distinguish between structural vulnerabilities and event-specific dynamics. By examining multiple crises within a single sectoral and national context, this study isolates patterns that persist across disruption types from those that vary systematically between them. This enables a clearer identification of which aspects of workforce fragility require structural intervention and which require context-specific responses, providing a more nuanced basis for both theory development and policy design.

Third, the findings underscore the value of adopting a cross-crisis perspective when analysing workforce vulnerability. Government interventions that proved limited during the Global Financial Crisis were improved during earthquake recovery and further refined during the COVID-19 pandemic. The cumulative learning across crises suggests that adaptive institutional memory plays a critical role in strengthening future crisis preparedness. However, the findings also reveal important trade-offs and contradictions in workforce resilience strategies that require more critical consideration. While reliance on migrant labour has proven essential in addressing short-term skill shortages, particularly during post-earthquake reconstruction, it simultaneously reinforces long-term dependency on external labour markets and limits the development of domestic human capital. Conversely, efforts to prioritise local workforce development strengthen long-term resilience but are constrained by training capacity, time lags, and the sector's ability to rapidly respond to acute labour demand.

Similarly, the increasing adoption of digital technologies and automation offers opportunities to mitigate labour shortages and improve operational continuity, particularly during disruptions such as COVID-19. However, these advancements may also introduce new challenges, including digital skill gaps, uneven access among small and medium enterprises, and potential displacement of lower-skilled workers. This finding aligns with existing research on digital transformation in construction, which identifies both the potential of technology to enhance operational resilience and the challenges associated with uneven adoption across firm sizes and emerging digital skill gaps [2]. The sector's capacity to leverage technological change as a resilience strategy therefore depends not only on the availability of tools but on targeted investment in digital skills development and equitable access mechanisms, particularly for SMEs. These dynamics highlight that resilience strategies are not inherently neutral; rather, they involve balancing competing priorities between efficiency, equity, and long-term sustainability.

These trade-offs suggest that workforce resilience should be understood not only as the capacity to absorb and adapt to disruption, but also as a process that involves managing inherent tensions between short-term responsiveness and long-term structural stability.

Recommendations

The New Zealand construction workforce has experienced repeated and compounding disruptions due to the Global Financial Crisis, the Canterbury and Kaikoura earthquakes, and the COVID-19 pandemic. These events intensified existing skills shortages and exposed systemic vulnerabilities across the labour supply chain. Drawing on the findings of this study and applying Human Capital Theory, the Adaptive Capacity Framework, and Labour Market Shock Models, this section presents a detailed, evidence-based set of recommendations tailored to the operational realities of the construction sector.

Flexible and crisis-responsive immigration policy

New Zealand's immigration settings must be adapted to allow continuity of essential construction labour supply during future disruptions. During the Canterbury rebuild, targeted visa schemes helped attract foreign workers,

whereas COVID-19-era border closures severely restricted workforce mobility and contributed to project delays and contract breaches. To enhance resilience, immigration policy should include fast-track visa categories for critical construction roles, as well as crisis-triggered exemptions for essential workers. Family reunification mechanisms must also be embedded to reduce psychological strain on migrant workers and enhance retention.

In addition, existing skilled visa pathways should be simplified. Sponsorship obligations are often financially and administratively burdensome, particularly for small and medium enterprises (SMEs). Revising visa frameworks to support portability across employers, while safeguarding worker rights, would increase labour flexibility and help SMEs access the skilled migrant workforce.

Develop and retain local talent

Reducing dependence on overseas labour requires a long-term investment in domestic skills development. Employers, government agencies, and educational institutions must collaborate to expand and enhance pathways into the construction workforce. This includes increasing access to apprenticeships, funding cross-sector training programmes, and supporting on-the-job learning tailored to high-demand roles such as seismic retrofitting, project management, and prefabrication.

Recent government reforms, such as the establishment of Te Pukenga (New Zealand Institute of Skills and Technology), offer a structural foundation for industry-aligned education. However, success depends on adequate resourcing for regional delivery, and culturally responsive engagement with Māori, Pacific, and other underrepresented groups. Targeted scholarships and community partnerships can help address equity gaps while strengthening the national skill base.

Accelerate technology adoption

Digital tools and automation offer practical solutions to labour shortages and operational inefficiencies. During the pandemic, firms that leveraged digital site inspections, remote collaboration platforms, and integrated project management software reported greater continuity and fewer disruptions. Wider adoption of such technologies should be encouraged through industry incentives, training subsidies, and integration into construction contracts. In particular, SMEs need access to affordable, scalable solutions that align with their resource constraints.

Institutionalise workforce risk planning

Workforce planning should be embedded within all national and sectoral crisis management frameworks. This includes developing pre-approved response protocols for seismic events, pandemics, economic downturns, and climate-induced disruptions. Scenario modelling tools, such as the Disruption Dynamics Framework introduced in this study, can help visualise labour impacts and inform contingency strategies. Risk planning should also include long-term monitoring of health-related workforce vulnerabilities, including the effects of long-COVID.

Support SME Resilience and labour retention

Findings from this study show that SMEs face disproportionate challenges in retaining skilled staff during crises due to limited wage flexibility. To reduce attrition and ensure sector-wide capacity, targeted support should be provided to smaller firms. This may include payroll subsidies, access to shared labour pools, and grant funding for workforce development. In parallel, organisations should strengthen internal loyalty through non-monetary incentives, such as job security assurances, transparent communication, and inclusive workplace practices. These strategies align with the Adaptive Capacity Framework, highlighting the importance of anticipatory and participatory responses.

Promote evidence-informed and participatory policymaking

Policymaking must be grounded in lived experience and front-line data. Interview evidence from this study reveals specific gaps in past policy responses, including delays in visa processing, lack of support for subcontractors, and insufficient consideration of health-related absenteeism. Future workforce policy should be informed by ongoing engagement with site workers, project managers, union representatives, and migrant communities to ensure responsiveness to diverse needs. Collaborative policy design will improve legitimacy, uptake, and long-term impact.

Enable multi-stakeholder collaboration

Resilience planning and policy implementation require cross-sector coordination. Government agencies, industry bodies, training providers, and community organisations must work together to create aligned strategies for workforce sustainability. Formal partnerships, supported by shared data infrastructure and regular communication protocols, will ensure coherence between policy goals and industry realities. Regional task forces may offer an effective model for linking national strategies with local labour dynamics.

Together, these recommendations offer a targeted and operationally grounded roadmap for improving workforce resilience in New Zealand's construction sector. They emphasise proactive planning, inclusive policy design, and systems-based coordination to reduce the vulnerability of the workforce to future crises.

Study contribution

Theoretical contributions

This study contributes to the literature on workforce resilience and construction crisis management in two key ways. First, it introduces a cross-crisis comparative perspective, addressing a gap in existing research that typically examines single events or isolated disruption types. By analysing economic, environmental, and health-related crises within a unified framework, the study provides a more comprehensive understanding of how different disruption mechanisms affect workforce dynamics over time.

Second, the study introduces two analytical tools, the Crisis Impact Matrix and the Disruption Dynamics Framework. Their purpose is to support comparative and temporal interpretation of workforce disruption rather than to establish new theoretical models of workforce resilience.

Practical contributions

This study also provides important practical and policy-relevant insights. First, it offers empirically grounded evidence based on semi-structured interviews with construction professionals, providing real-world insights into workforce disruptions during COVID-19 and complementing existing policy- and data-driven studies.

Second, the proposed frameworks function as a practical diagnostic and planning tool. The Crisis Impact Matrix enables stakeholders to identify likely workforce impacts based on crisis type and disruption mechanism, while the Disruption Dynamics Framework supports understanding of how disruptions evolve over time. Together, they support more proactive workforce planning, rather than reactive crisis response.

Third, the study provides a replicable analytical structure that can be applied beyond the New Zealand context. By offering a generalisable framework for analysing workforce disruption across multiple crisis types, the research supports policymakers, industry practitioners, and organisations in improving preparedness, workforce stability, and long-term resilience in high-risk sectors.

Conclusion

This study has examined how successive large-scale crises, the Global Financial Crisis, the Canterbury and Kaikoura earthquakes, and the COVID-19 pandemic, have disrupted the New Zealand construction workforce, drawing on a combination of structured review of the literature and qualitative interviews. Through a comparative analysis, the research identified three interconnected domains of impact: workforce availability, organisational coping mechanisms, and long-term career shifts. Each crisis revealed unique stressors on labour market systems, while also exposing common structural vulnerabilities and revealing areas of emergent resilience.

The Global Financial Crisis produced demand-side disruptions, leading to widespread redundancies, de-skilling, and loss of human capital. In contrast, the earthquakes and COVID-19 introduced acute supply-side constraints, including regional labour shortages, migration restrictions, and health-related absenteeism. While policy responses during the financial crisis were limited and reactive, subsequent crises triggered more coordinated institutional interventions and demonstrated greater organisational adaptability, including work resequencing, retention strategies, and reliance on localised procurement and labour sourcing. However, despite these improvements, structural dependencies on international labour and insufficient domestic training pipelines continue to challenge workforce stability.

The study's findings underscore the importance of proactive workforce planning, targeted skills development, and flexible crisis-response mechanisms. They also reveal that resilience is not uniformly distributed across the sector. Large firms were often better positioned to adapt, while smaller businesses faced more severe constraints in accessing resources, retaining staff, and responding to ongoing uncertainty. Moreover, the emerging health impacts of COVID-19 have introduced new human capital vulnerabilities, signalling the need to expand traditional models of workforce risk to include long-term health and wellbeing dimensions.

Limitations and directions for future research

Although the interview sample captured a diverse range of construction roles, frontline workers and temporary migrant labourers were underrepresented due to pandemic-related access constraints.

This study incorporates several methodological and analytical limitations. In terms of validity, the study relies on qualitative data derived from semi-structured interviews and literature synthesis, which are subject to interpretive bias. Construct validity is strengthened through the alignment of empirical findings with established theoretical frameworks; Human Capital Theory, Labour Market Shock Models, and the Adaptive Capacity Framework; while internal validity is supported through triangulation between literature-derived patterns and interview data. However, causal relationships between crisis events and workforce outcomes cannot be definitively established due to the retrospective and interpretive nature of the data.

Reliability was addressed through structured coding procedures, including intercoder agreement (Cohen's Kappa = 0.81), and the use of established thematic analysis protocols. While these measures enhance consistency, qualitative findings remain context-dependent and may not be fully replicable in different research settings.

In terms of generalisability, the study adopts an analytical generalisation approach rather than statistical generalisation. The findings are intended to contribute to theory development by identifying transferable patterns of workforce disruption, rather than representing the broader construction population. As the empirical data are limited to New Zealand, the applicability of the findings to other national contexts should be interpreted with caution.

Furthermore, the conceptual frameworks developed in this study, the Crisis Impact Matrix and the Disruption Dynamics Framework, are analytically derived and have not yet been empirically validated across multiple settings. While they are grounded in both literature and interview data, their robustness and transferability require further testing in different institutional, economic, and labour market contexts.

This study does not explicitly examine the relationship between construction workers and their broader daily life conditions, including housing, commuting, and urban environment factors. The focus was deliberately limited to labour market and organisational dynamics due to the scope of the research design and the nature of the

data collected through industry-focused interviews. However, these socio-spatial factors may significantly influence workforce resilience, particularly in constrained urban labour markets, and their exclusion represents a limitation of the study.

The findings suggest that workforce resilience in construction will face increasing challenges from emerging crisis types. Climate-related disasters, future pandemics, supply chain disruptions, and digital transformations may each introduce new forms of labour market stress. The growing integration of automation, artificial intelligence, and remote technologies will reshape both skill requirements and workforce structures. As construction tasks become more technologically mediated, new vulnerabilities may arise in digital skills gaps, algorithmic management, and cybersecurity risks.

Further longitudinal research is needed to track how post-crisis workforce dynamics evolve over extended recovery periods. In particular, studies that follow displaced workers' career trajectories, health outcomes, and retraining experiences would offer valuable insights into the cumulative effects of multiple crises on human capital development. Comparative studies across national contexts would also enrich understanding of how different institutional systems moderate workforce vulnerabilities.

Future research should also aim to validate, refine, and operationalise the conceptual frameworks developed in this study across different institutional and labour market contexts and adopt a more integrated perspective that incorporates urban, social, and lived-experience dimensions of workforce resilience.

Acknowledgments The authors acknowledge the funding of the New Zealand Ministry of Business, Innovation and Employment, Endeavour Programme Research Grant under contract number MAUX2005.

Author contributions Faezeh Mirhosseini: Conceptualization, Methodology, Investigation, Formal Analysis, Data Curation, and Writing - Original Draft Preparation. Associate Prof. Mostafa Babaeian Jelodar: Reviewing, Editing, and Final Revision. Prof. Suzanne Wilkinson: Supervision and Guidance.

Funding This work was supported by the New Zealand Ministry of Business, Innovation and Employment (MBIE), Endeavour Programme Research Grant, contract MAUX2005.

Data availability Some or all data, models, or code generated or used during this study are available upon request or hosted in a secure institutional repository, in accordance with research ethics and funder data retention policies. Interview transcripts have been anonymised to protect participant confidentiality and are stored securely. Access to these materials may be granted to qualified researchers subject to ethical approval and data use agreements.

Declarations

Human ethics and consent to participate All participants in this study provided their informed consent prior to participation. They were fully briefed on the purpose of the research, the voluntary nature of their involvement, and their right to withdraw at any stage without penalty. Participants were assured that their identities would remain confidential and that all data would be reported in aggregate form only. Written consent forms were obtained from each participant in accordance with the approved ethical guidelines. Ethics approval for this project was formally obtained prior to data collection. From Massey University's Code of Ethical Conduct for Research, Teaching, and Evaluations involving Human Participants' point of view, the proposed research was assessed as meeting the criteria for a low-risk study. The committee assessed this research as low risk. Ethics notification # 4000023852 applies to this research and is approved. To protect participants' confidentiality, all data were anonymised, and no identifying information was included in the transcripts or analysis. Informed consent was obtained prior to participation, with participants clearly informed about the study's purpose, their right to withdraw at any time, and how their data would be securely stored and used. All digital data were stored in password-protected devices.

Consent for publication This study reports only de-identified qualitative data and includes no images or other materials that could lead to participant identification. Therefore, consent for publication is not applicable.

AI-assisted technologies During the preparation of this work the authors used ChatGPT, developed by OpenAI (2024 version) in order to enhance the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Competing interests The authors declare no competing interests.

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