



# Building risk management strategies into the vertical construction sector

A preliminary report

Alice Chang-Richards  
Charlotte Brown  
Nicky Smith

Project LR10481, The Building Research Levy 2018/2019



Funded from the  
**Building Research Levy**



## Preface

Our work has focused on what the vertical construction sector can learn from the horizontal sector to better manage project risks and work processes to move the industry forward towards heightened productivity and performance. This report is the outcome of wide-ranging discussions across both vertical and horizontal sectors on risk management practice and the enabling factors that drive better risk management practice and productivity performance. The aim is to help initiate practice change in supporting the construction sector to improve risk management behaviours, boost confidence and enhance performance of the sector.

This report presents the preliminary findings from interviews with a number of practitioners. A questionnaire survey will be deployed at a later stage to quantify the effects of different risk behaviours and risk allocation/mitigation measures on projects, construction businesses and the sector as a whole. A system dynamics model will be developed to allow users, such as policy agencies and construction sector leaders, to drill down and identify key differences between the horizontal and vertical sector, and locations where risks arise and leverage points are to enhance sector performance and productivity. In the future, this could be applied to address other pressing issues such as resourcing, technology changes, quality assurance and information management.

## Acknowledgements

The authors would like to thank BRANZ for sponsoring this project through the Building Research Levy.

We are grateful for the time and sharing offered by industry practitioners who participated in the interviews for this project. We also extend our appreciation to David Kelly (Chief Executive of the Registered Master Builders Association), Rick Herd (Chief Executive Officer of Naylor Love), Dr Grace Schaefer (Business Development Manager, McConnell Dowell Constructors Ltd) and Greg Preston (Manager of Quake Centre, University of Canterbury) and Dr Ying Fei (Senior Lecturer, Auckland University of Technology) for their support and assistance.

## Disclaimer

The information provided in this report draws on multiple perspectives and views from interviewees limited to the subjects discussed. This report is not meant to be used, or should it be used, to measure or assess the performance of the construction sector. The authors are not responsible for accuracy of information collected from the interviews.

# Contents

---

<b>Executive summary</b> .....	<b>iv</b>
<b>1. Introduction</b> .....	<b>1</b>
<b>2. Methodology</b> .....	<b>2</b>
<b>3. Interview findings</b> .....	<b>3</b>
3.1 <i>Characteristics of vertical sector in comparison to horizontal sector</i> .....	3
3.2 <i>Challenges faced in risk management practice</i> .....	5
3.3 <i>Levers/enablers that drive better risk management practice and productivity performance</i> .	7
<b>4. Conclusions and recommendations</b> .....	<b>10</b>
<b>5. Next steps</b> .....	<b>11</b>
<b>References</b> .....	<b>12</b>
<b>Appendix: Interview questions</b> .....	<b>13</b>
<i>Interview questions for construction companies in the horizontal sector</i> .....	13
<i>Interview questions for construction companies in the commercial/vertical sector</i> .....	14

## Acronyms

ECI	Early contractor involvement
DB	Design and build
PPP	Public private partnership
KPIs	Key performance indicators
NZTA	New Zealand Transport Agency
TCO	Total cost ownership
QS	Quantity surveyors
NCTIR	Northern Canterbury Transport Infrastructure Recovery
EPC	Engineer-procure-construct
IPD	Integrated project delivery

## Executive summary

---

Achieving a high level of productivity in the construction industry remains challenging. Within the sector, there are also differentiated performance outcomes between the horizontal and vertical construction sector. The recent successes of horizontal infrastructure projects such as the Northern Toll Road Gateway, Waterview Project, and Christchurch Infrastructure Recovery are in contrast to ongoing challenges faced by the vertical construction sector and hence present a unique opportunity for cross-sectoral learning. To understand what causes the varied performance between the two sectors, interviews were undertaken with fifteen industry practitioners. The focus was on understanding the differences between the two sectors, the factors that contribute to difficulty in managing risks, and the measures taken by the horizontal sector that have proven to be effective risk management mechanisms, resulting in heightened productivity.

Compared to the horizontal sector, most projects in the vertical sector by nature tend to be more complex, involving a larger number of activities, trades, specialists, and construction materials; and coordination of all these prove to be more challenging and difficult, creating opportunity for risk. Vertical construction is also largely dominated by private investment and is strongly affected by commercial clients' procurement methods. The current trend of 'lowest price bid' favoured by most clients in the vertical sector has aggravated the level of competition in the market, pushing the margin to a low point. This, combined with 'fixed price' contracts offered by some contractors to win projects, can have significant financial consequences for those whose balance sheet is not strong enough to absorb risks. As a result, staff turnover is higher in the vertical sector, further exacerbating skills shortage and capability problems.

The factors that influence how risks can be managed are multi-faceted and systemic. Structural issues in the construction sector, such as fragmentation of sub-sectors, trades, and contracts, and a lack of labour availability and capability, constrain the sector somewhat from effectively managing some risks and improving productivity and performance. Some contractual risk allocation practices are reflective of market behaviours of many commercial clients as well as norms of risk transfer within construction sector supply chains. There are also a number of factors that construction businesses have certain control, either on their own or collaboratively, and provide opportunities for better risk management. Attention should be given to better performance measures for incentivising professionalism and work ethics, better understanding of risk profile (including pricing risks and understanding contractual risks), risk culture and capability, and more prudent decision-making.

Procurement is a primary lever for influencing risk levels and practices within the sector. It affects the behaviour/conduct and competitiveness of construction businesses operating in the sector. Interviewees from the horizontal sector highlighted the benefits of using early contractor involvement (ECI), integrative design and build (DB) delivery approaches, target value design processes, and public target on Public Private Partnership (PPP) projects for better risk sharing and allocation among project stakeholders.

For long-term improvement of productivity in the vertical sector, better understanding of the implications of risk allocation and procurement practices for both clients and construction sector organisations is needed. Greater collaborations and partnerships (e.g. forming alliances or joint ventures) among construction businesses are also needed, especially for the small-scale players to build up their capability and skill base in addressing the risks and productivity losses caused by fragmentation in trades and contracts. In addressing the risk factors identified in this research, use of technology, better staff key performance indicators (KPIs), certainty of construction pipelines, and better alignment of training and demand were also suggested, which would have implications for productivity performance of individual companies and the sector as a whole.

# 1. Introduction

---

The construction sector has been a perennial underperformer in the New Zealand economy [1]. Its low productivity performance to some extent reflects very challenging operating characteristics (e.g., order-based production, low-task repetition, site-specific operations) [2]. There are reasons to expect that the low productivity may be symptomatic of poor risk management practices. Of particular concern is the vertical construction sector, which has been plagued by productivity volatility [3], quality issues, low organisational resilience [4] and high enterprise failure rates. While some turnover is to be expected and is part of the normal creative process driving productivity improvement, under-efficient and non-systematic risk management is also a key productivity issue. It can lead to underutilisation of capital for productivity-enhancing investments [5], greatly increase transaction costs, and divert funds towards conflict resolution [6]. Uncertainty and disruptions are also stressful, and thus costly for society in themselves.

A recent BDO construction survey report distinguished two tiers of businesses across the industry: one tier made up of good operators with strong balance sheets and robust cash resources, and the other tier being fragile businesses susceptible to industry challenges [7]. The stress factors in the sector, including for example rising construction demand, capacity constraints, escalating input costs (such as regulatory compliance), and onerous contractual risk allocation, if not managed well, are likely to lead to exits of many fragile businesses from the market, further impacting on the wider industry [8]. There have been a series of well-publicised articles in the media about the failure and collapse of some construction firms over the past year. Construction cost risk transfer from the client to the contractor has been cited as a major reason for these failures <sup>1, 2, 3, 4</sup>.

On the bright side, there are some encouraging signs for the construction sector afforded by the success of recent horizontal infrastructure projects such as the Northern Toll Road Gateway, Waterview Project, and Christchurch Infrastructure Recovery. Anecdotally, the success of these projects may be partly linked to the use of alliance project structures, and clear processes for identifying, allocating and, where necessary, sharing risk [9]. Such mechanisms allow project teams to enhance productivity and project quality through better resource usage, reduced time wasting, and more efficient problem solving [6]. It is likely that strong organisational resilience has also played an important role [4, 10]. A significant opportunity exists to learn from these successes, to verify and validate the role of risk management and organisational resilience practices in productivity and, where possible, transfer outcomes to the wider construction sector.

The purpose of this report is to delve deeper into the fundamental underlying factors that drive different performance outcomes between the horizontal construction sector and the vertical construction sector through interview-based research. The vertical sector refers to construction of buildings whereas the horizontal sector refers to ground level construction, such as roads, tunnels, pipes, and bridges. In this report, we also consider lessons learned from the horizontal sector and the changes and opportunities needed for improving risk management practice, and productivity, in the vertical sector.

---

<sup>1</sup> Contractors say Arrow's collapse shows high risk of construction, New Zealand Herald, 28 February 2019

<sup>2</sup> Saving the construction industry, Newsroom, 17 August 2018, <https://www.newsroom.co.nz/2018/08/16/195217/saving-the-construction-industry?preview=1#>

<sup>3</sup> Why our construction industry is broken, and how it can be rebuilt, Spinoff podcast, 16 April, 2019, [thespinoff.co.nz/podcast/for-auckland/16-04-2019/why-our-construction-industry-is-broken-and-how-it-can-be-rebuilt/](http://thespinoff.co.nz/podcast/for-auckland/16-04-2019/why-our-construction-industry-is-broken-and-how-it-can-be-rebuilt/)

<sup>4</sup> NZ Vertical Construction Sector fall out – what is next? Twenty two blog, 24 September 2018, <http://www.twentytwo.co.nz/blog/nz-vertical-construction-sector-fall-out-whats-next>

## 2. Methodology

Semi-structured interviews were conducted with fifteen industry practitioners between April and August 2019 (See Table 1). The interview process was approved by the University of Auckland Human Participants Ethics Committee (Reference number 022977). A range of organisations across the vertical and horizontal construction sector were interviewed and each interview lasted up to two hours. The aim was to develop a full understanding of the sector and facets of the construction process including supply chain, governance, contracting and procurement, industry and regulatory environment, and risk management processes. The selection of interviewees was based on criteria such as the interviewee's position and organisation for which the person works, and their experience and work relevance in the construction sector.

**Table 1: Participants in the interviews**

SECTOR	INTERVIEWEE CODE	TYPE OF ORGANISATION*	NZ WORK EXPERIENCE
<b>HORIZONTAL (8 PARTICIPANTS)</b>	HC1	Contractor (lead)	30+ years
	HC2	Contractor (lead)	15 years
	HC3	Contractor (lead)	8 years
	HC4	Contractor (lead)	20+ years
	HSC1	Subcontractor	16 years
	HL1	Client	25 years
	HL2	Client	20+ years
	HE1	Engineering consultancy	10+ years
<b>VERTICAL 7 PARTICIPANTS)</b>	VC1	Contractor (lead)	5 years
	VC2	Contractor (lead)	12 years
	VC3	Contractor (lead)	7 years
	VC4	Contractor (lead)	20+ years
	VSC1	Subcontractor	7 years
	VSC2	Subcontractor	10+ years
	VE1	Engineering consultancy	10 years

*\*Note that 'contractor(lead)' refers to contractors that typically hold the head contract for large-scale construction projects.*

The design of interview questions included a common structure of questions to gather the same type of information from each participant (see Appendix 1 for the main interview questions). While a list of

questions was provided to interviewees one week prior to the interviews, the actual interview was undertaken in a discussion format, with a focus on, but not limited to, the following information:

- Differences between the horizontal and vertical construction sector
- The greatest risks and where they exist in a project or in the sector
- Risk management practices
- Enablers/barriers to effective risk management
- Risk transfer and its effects
- Measures that can be taken to reduce the chance of company failure/collapse

### 3. Interview findings

---

Opinions of participants clearly indicate that there is a striking difference between the horizontal construction sector and vertical construction sector. It was commonly considered that the horizontal sector has, in general, higher productivity and its businesses are more stable and have gained higher profit margins than their counterparts in the vertical sector. It was also expressed that compared to the horizontal sector, more competitive pressures are felt by the vertical sector, which prevents a focus on sensible decision making, and leads to a 'must win project' mind-set that is subject to high risk.

#### 3.1 Characteristics of vertical sector in comparison to horizontal sector

Interview participants suggested a number of characteristics of the vertical sector that are different from the horizontal sector, including:

- **The construction process seems to be more complex for vertical buildings**, and thus the number of players on a project is greater. The number of physical activities occurring on site, types of materials and products required, and number of subcontractors and trades involved are in general larger than required for an infrastructure project such as a civil horizontal roading project (except for some tunnelling, resources, and marine projects which have a lot of technical complexity). Interviewee HC4 highlighted that in comparison to the vertical sector, the horizontal sector is more prescriptive. According to HC4,  
*'... [In certain roading projects] clients already specify the design, and all competitors virtually follow the same recipes, so the only ways of maintaining competitive are either pushing the suppliers of materials and subcontractors to give more discount, or through innovation, offering alternative solutions, for instance, we can suggest to our client to build a culvert, other than a bridge, to achieve more efficient, cost-effective results. But in the vertical sector, the complexity of a building makes it hard for contractors to innovate by suggesting alternative designs.'* (Quote from HC4)
- **Competition for work is higher in the vertical sector**. Interviews highlighted the fact that in facing high competition in the market, most construction companies in the vertical sector have to cut the margin down to keep a continual flow of work and keep workers employed. Project time in the vertical sector is often shorter than that of horizontal infrastructure projects, and this has put more pressures on bidding and tendering. However, nearly half of interviewees considered this competitive nature of the vertical sector a result from an appetite of 'lowest price tender' of most clients. This is reflected in a comment made by interview participant VC2, that

*‘Overly competitive pricing and absorbing risk has become an acceptable business practice for some main/lead contractors and this has flow-on effects on the subcontractors who would also carry the same mind-set and practice to remain competitive. Unfortunately, such a practice or attitude has evolved and become a market behaviour nowadays.’ (Quote from VC2)*

- **Margins for construction firms in the vertical sector are much tighter.** Clients’ favouring of lowest price tender and high competition in the sector means that lead contractors and subcontractors will take a risk of failure by squeezing the tender price to win the contract. It was reported that most construction businesses in the vertical sector operate at a margin between 2% and 7% whereas those in the horizontal sector have a higher margin between 10% and 15%. One participant VC1 particularly highlighted that  
*‘2% margin is sometimes accepted by some vertical contractors in order to have work which in turn intensifies competition in the industry’.* (Quote from VC1)
- **Clients for commercial buildings can be individually different, and their investment in a construction project can be one-off.** The clients in the horizontal sector are usually regular asset owners (who do projects year on year), such as Councils, the New Zealand Transport Agency (NZTA), Watercare, etc. and they tend to invest time and effort in putting the best practices, work procedures, and design specifications in place to yield positive outcomes and are deeply invested in the long-term quality of the construction project. However, many clients for commercial building projects are from the private sector and their drivers for project success can be more short-term from those in the horizontal sector.

Commercial building clients can also have varied management styles that can be challenging to work with and price for. One interviewee, VC3, highlighted that for commercial building projects that are foreign-invested, there seems to be a lack of trust between the client and contractors. *‘Telescope everything’* and *‘micro-manage’* were descriptions given by several interview participants as the way some commercial clients manage their projects. However, interviewee VC2 and VC4 reported a more proactive and prudent approach observed among those clients who will build year-on-year.

The variable client base can in the vertical sector also contribute to variable workflow. Horizontal infrastructure investment tends to be more consistent, with higher forward visibility, than the vertical construction sector. This allows for better work planning and investment in and training of staff. Horizontal sector capital works projects are also often supplemented by on-going infrastructure maintenance contracts.

- **High staff turn-over in the vertical sector,** and low risk margins means that vertical construction companies are less likely to invest in staff training. A common notion from the interviews is that uncertainty caused by the cyclical nature of the building industry contributes to low investment in skills and training by the sector. On average, there is a 30% labour turnover in the construction sector in New Zealand [11]. Interviewees suggested that intensified labour turnover has become a real pinch for many vertical companies over the past several years. Interviewee VC1 commented that  
*‘An interesting fact in some major building projects is that when an employee survives one year working on the same project, he or she will throw a party to celebrate that. Considering one year is a short time period for staff retention, staff turnover needs to be*

*symmetrically addressed if vertical sector companies want to ensure better outcomes of their projects.’ (Quote from VC1)*

Several interview participants shared concerns over the issue of an aging workforce and difficulty in retaining the wealth of experience held by skilled workers. Interviewee VS2 pointed out that

*‘We not only have a labour retention problem, but also an experience retention problem. We have talented people in the country, but they do not stay around for long, for many different reasons; as a result, once they are gone, all the good learnings and experience from previous people are also gone. There needs to be a way to retain the ‘wisdom’ of these people, which will benefit businesses and projects.’ (Quote from VSC2)*

In addition to the differences described above, interviewees suggest that fixed price, or lump sum, contracts is a common source of risk in both sectors. Several participants voiced concerns that lump sum tender pricing is often required to stay competitive. Rising material costs and cost escalation from the labour between time of tender to project completion may exacerbate risk transfer from the client to the lead contractor. The fixed price contract often leads to requests for variation and extension of time, but in most cases, commercial clients in the vertical sector are reluctant or unwilling to approve these variations. According to interviewees V1, V2, V3, and V4, in some vertical projects, the client refused to pay even with clear evidence of variation requirements. It can also take a long time for the client and contractor to agree on variations, thus creating delays, cost overruns, and confusion for all parties working on site.

## 3.2 Challenges faced in risk management practice

Our research indicates that there is a level of frustration regarding how the industry currently operates and how it could operate. All interview participants recognise that the vertical sector as a whole needs to change. There are a number of factors which both create generate risks and contribute to the challenge of effectively managing risks. While some of the factors are seen as being flaws in the business model of companies, others are considered as industry-wide issues beyond the control of individual companies. The factors suggested by the interviewees include:

- **Fragmentation of the sector and lack of capability:** The vertical construction sector has a predominance of small firms and specialised trades which lack the scale and balance sheet to be able to invest, grow, and manage their businesses during uncertain times. They often have little stake in the process as they are usually organised in a trust structure so they can simply liquidate the entity if necessary without any financial risk to the owners or directors. A lack of labour availability and capability of some firms may force design changes, causing delays in the project. The increased trend to use subcontractors adds the complexity of projects due to the additional contracts required, which further impact on productivity and create opportunities for risk. A comment made by the interviewee VC3 explained well how this factor affects their ability to manage risks on site.

*‘We have so limited local skills and resources, to an extent that in other countries we might have only one subcontractor to complete one package of construction activities while here we have to cut the package into eight or more small packages and engage eight subcontractors for the job – this has significantly increased the complexity of project control and supervision, as well as the difficulty for the lead contractor to manage the project.’ (Quote from VC3)*

- **Lack of balance sheet strength:** Cash flow is a big issue especially for small- and medium-sized subcontractors. Typically they have to pay upfront for materials and labour but lead contractors usually keep payment in check and only release after 6 months or so. The lead contractors may

have their own difficulties when clients choose not to pay variations and charge high sums of liquidated damages (LD) on each day of contract delay. The majority of interview participants expressed the view that

*'Cash is the king in the construction industry. One of the main reasons some key players in the market collapsed is primarily due to the fact that they don't have enough cash flow to operate although they have more projects to come.'* (Quote from VC4)

- **Fragmentation of contracts:** Contracts that separate design and build activities constrain the ability of lead contractors to mitigate construction risks at the design stage. The use of competitive procurement models, especially in the vertical sector, often leads to 'cracks and leaks' in project management process and emergent risks where there is no clear risk owner.

The pros and cons of using design and build (DB) type contracts were discussed in the interviews. One big issue cited was underestimation of contract scope due to optimistic design during DB tenders and the cost to the contractor of preparing designs in competitive DB tenders. Some contracting techniques such as '*novated design construction contracts*' (where the lead contractor takes over the client's design consultant team, completes the design with the team, and also takes full responsibility for all design) were questioned by some of the interview participants. However, there seems to be an observed trend for design consultants to push the risk to the contractors due to the tightening of the Professional Indemnity Insurance market (i.e., design related claims increasing the cost of premiums and the availability of insurance). A notion in common with interviewees was that for DB contracting and procurement processes to work to their optimal potential, the build team and design team need to belong to one single organisation.

- **Unreasonable contractual risk allocation:** There is a reported trend of clients to push risks on to lead contractors, who in turn pass risks on to suppliers and subcontractors using bespoke conditions in the contract (including significant amendments to NZS3910/3916). This increases the time and cost of contract negotiation at the start of a project. In the end, the risks are being either 'swallowed' or absorbed by contractors at the tender stage, expected to be justified during construction, or 'priced' in the final delivery of services, which increases overall cost-to-build.
- **A drive for lowest price bid and low cost procurement:** Interview participants report that in most cases, '*race-to-the-bottom procurement*' meant that companies are bidding for construction contracts at prices lower than could be realistically delivered. The winner of the lowest price bid often needs to reduce allowances for project planning and management tasks, and taking a leap of faith that things will go as well as wished. However, any changes and complexities that emerge during construction will cause cost increases – the term a '*domino effect*' was used by the several interviewees (HC1, HC3, HL1, VC2, VSC2) to describe the consequences of 'lowest price bid'.
- **Skills shortages and professionalism issues:** The majority of interviewees also highlighted the role professionalism of workers plays in project delivery. In some cases, raised by interviewees HC2, HC4, VC1 and VC4, careless and ignorant behaviours were observed at the workplace and/or on the construction site, and some people are reluctant to take responsibility to solve issues and problems that arise during construction. Such comments are common among those interviewees who have had construction work experience in other countries and can draw a comparison. For instance, interviewee VSC1 commented that

*'I worked in Hong Kong before for many years. When I came back to New Zealand to work in the construction sector, I had a bit 'cultural shock' – surprised at the number of project*

*problems we have encountered – some of them are due to human errors. And there is a lack of robust performance measures that can incentivise people to perform better for the benefit of the project.’ (Quote from VSC1).*

Lack of ‘professionalism’, ‘rigour’, ‘responsibility’, ‘good work ethics’ as well as ‘skills and training’ are the key words commonly raised in the interviews. According to several interviewees, to improve productivity performance of a construction project, due diligence is needed not only by all organisations involved, but also by individual workers who participate in the project.

### 3.3 Levers/enablers that drive better risk management practice and productivity performance

Interviews with industry practitioners stress the importance of 1) integrated design and construction, in particular front-loaded design and project planning; 2) skills availability and competence; 3) professionalism of workers, and 4) a holistic view of project management – all critical elements for changing risk management performance in the industry. The following measures have been cited as being levers/enablers used in the horizontal sector to drive better risk management practice and productivity performance.

#### 3.3.1 Front-loaded design and project planning

From the total cost ownership (TCO) perspective, the capital cost (initial construction) is high relative to the lifetime costs of a project, and this cost is commonly determined during the design and engineering process. A notion in the interviews was that an often incomplete or faulty design as a result of the client’s under-investment in the design and planning stage can lead to under-estimation of the construction cost. Alarming, most projects adopt the build-as-design approach, and their construction begins before detailed scoping and planning have taken place. To achieve substantial improvements in construction productivity and to reduce risks of incorrect budgeting and pricing, the following mechanisms were highlighted/commented as being effective and useful:

- **Early Contractor Involvement (ECI):** Most interviewees highlighted the importance of ECI in the pre-tender stage to assist the client and other parties to better understand the project and its potential risks. This provides an opportunity for contractors to consider possible mitigation measures for the risks identified. While there have been increased efforts in the horizontal sector to involve contractors early in the design process to mitigate construction risks, the scope of its use is still limited. Several interviewees (HC1-3, HSC1, HL1, HE1) suggested that ECI should be not only used in the pre-tender planning stage, but also during the entire design and engineering stage, ideally engaging the main contractor, subcontractors, and suppliers. Interviewee HL2 suggested that the ECI process should involve finalisation of the price, including risk, which would include involvement of independent estimators.
- **Integrative design and build (DB) delivery approach:** When asked about where risks exist and why they are hard to detect, the interviewees in the vertical sector revealed that these risks commonly occur where there is a change of project activity and/or procedure, referred as ‘cracks and leaks’ of project sequence, requiring the coordination between different players. Key messages and information often get lost during the change-over process.

Several interviewees (HL2, HC2, VC3, VSC2, VE1) suggested that to ensure successful know-how transfer across phases of construction, a dedicated construction team or a project manager can be embedded in the engineering team, while others suggested for a single company who have the in-

house skills to undertake design, engineering, and construction in order to achieve the success of design and build. Only a few interviewees (HC1, HC3, and HC4) mentioned the use of an integrated project delivery method such as an alliance which has been successfully used in several horizontal infrastructure projects in New Zealand. The DB project delivery method is a call for action to shift away from the conventional design-bid-build approach to a more integrative approach.

- **Target value design process in an alliance:** This method was applied in the infrastructure reconstruction projects managed by the Northern Canterbury Transport Infrastructure Recovery (NCTIR) alliance, which incorporated the engineering design teams as part of the alliance, in addition to asset owners and delivery contractors. The effectiveness of this method is yet to be evaluated fully, however, two interviewees (HC2-3) in the horizontal sector spoke highly of such a method and the benefits of savings observed.

The alliance type of project delivery has been successfully used in several infrastructure construction projects, and they have core elements such as target cost pricing, shared risks and rewards (pain share, gain share), common information platforms (such as Building Information Modelling - BIM), and cross-functional groups. The challenge with alliances is, however, value for money if there is a 'soft' target cost and all costs are reimbursed. The target value design process adopted by NCTIR, which made all design-team members accountable for creating maximum value within the target cost, incentivised the design teams to invest more time and effort to increase design accuracy and reduce time delays in communication between design and construction.

- **Performance criteria on Public Private Partnership (PPP) projects:** This method was first applied in the Wellington Transmission Gully and had some success, resulting in more public projects using this method to enhance quality for social benefits. This process uses safety and performance indicators/metrics over a 25 year period. The PPP are compensated and penalised based on their ability to meet the agreed performance criteria. The aim of this approach is to better manage and allocate whole-of-life risks for projects.

### 3.3.2 Rigorous risk monitoring and actioning on mitigation

There is a common view that for construction projects, due to 'uniqueness' and individuality, accurate and up-to-date risk detection is challenging. The risks cited by interviewees that will commonly have an impact on a project included:

- health and safety,
- design flaws,
- defects and rework due to poor workmanship,
- supply chain inefficiency,
- increase in material prices, and
- weather change.

The issue for construction companies, however, is not only managing the common risks, but also the risks that are less readily foreseen and mitigating them accordingly. Unexpected risks reported included:

- unexpected soil/ground conditions (including utility services and contamination),
- scope change as a result of changing requirements,
- unavailability of certain construction products specified in the design,
- delayed inspections and consenting as well as Principal/ Engineer/ Architect approvals,

- clashes between construction of structures and services and deciding which has to compromise, and
- delayed remedial and rework.

In addition to contracting and delivery models which are the primary measures to allocate risks, prudent risk identification and analysis were highlighted by most interviewees as key capabilities required for construction companies to manage risks effectively. Interviewees identified the key levers for effective risk management at an organisational level. These were:

- **The calibre of skills** – Interviewees reported that accurate project tender cost estimation requires a high level of experience and/or knowledge from quantity surveyors (QS) and project managers. This is largely because the estimation of likelihood and severity of risk exposure is always subjective and relies on experience. Although most companies/projects have risk management tools, such as a risk register and associated software, having a dedicated role of risk manager to carry out the responsibilities of risk identification, analysis, and mitigation measures, including follow-ups throughout the entire project construction process, is more important.
- **Developing a risk aware culture** – More broadly, most construction companies in the vertical sector have tried to limit risk by using various risk management techniques as described above. However, interviewees reported that this often creates a reliance on the ‘system’, and hinders the wider team to participate in risk management across the construction supply chain. Only by establishing a positive risk culture, according to many interviewees, can the ‘system’ produce better risk management outcomes. In particular, one interviewee (VC2) highlighted that *‘if we care about risk management to the same extent as we care about health and safety, we can deliver better project outcomes and productivity benefits.’*
- **Pricing risks properly and understanding the risks in the contract** - When preparing a tender, companies either underestimate the risks that may exist in a project or do not consider the cost of a ‘what if it all goes wrong’ scenario. Most interviewed felt that inefficiencies in the sector, such as fragmented nature of the sector, skill shortages, combined with high staff turnover and the lowest price procurement culture, have had a massive impact on contractors’ ability to price things right. Almost all interviewees emphasised the importance of reserving a ‘risk budget’ in tenders and considering the risks in the contract that they are signing.

### 3.3.3 Cross-company and sector-led collaboration for change

Interview results suggest that individual companies cannot tackle the ‘risk’ issues on their own. The construction sector is one of the most fragmented sectors in New Zealand and yet relies on a seamless interplay of all participants along the supply chain and throughout the project life cycle to achieve quality and cost effective results. In particular, compared to the horizontal construction sector, the vertical sector is known for the nature of complexities explicit in their activities and implicit in the interaction of its many parties.

The vertical construction sector requires a behavioural change in practice from overly competitive pricing and absorbing risk to more rigorously understanding and managing risks. The vertical sector can learn from the horizontal sector about the benefits gained from incentivising risk management behaviours that improve long-term productivity. The concerted view from the interviews was that to create a ‘game change’ in the sector, companies and sector bodies need to come together and jointly define standards (e.g., around types of contracting and procurement) and agree on common goals. For instance, Australia is

pioneering the standardisation of project alliance agreements and is adopting a model of cooperative partnership to reduce the initial costs.

There is a growing willingness for the government to support the construction sector as evidenced in the creation of the Construction Sector Accord. The majority of our interviewees indicated that a partnering approach between government, the construction industry, and its' clients will provide benefits in addressing systematic problems in the sector. Several interviewees called for coordinated leadership (e.g., Construction Strategy Group, and the newly established Vertical Construction Leaders Group) to establish a set of behavioural best practice guidelines in support of vertical businesses.

## 4. Conclusions and recommendations

---

This research has identified what industry practitioners think are the underlying factors that affect risk management outcomes within and between the horizontal and vertical construction sectors and what measures and mechanisms the vertical sector can learn from the horizontal sector to better manage project risks. The factors that influence how the risks can be managed are multi-faceted and systemic. These emerge from a range of complex and oftentimes mutually reinforcing factors:

- Fragmentation of the sector and lack of capability,
- Fragmentation of contracts,
- Unreasonable contractual risk allocation,
- Skills shortages and professionalism issues,
- Lack of balance sheet strength, and
- A drive for lowest price bid and low cost procurement.

Fragmentation of the sector, lack of capability, and fragmentation of contracts are structural sector-wide issues that further constrain the sector from improving its productivity and performance. Unreasonable contractual risk allocation is reflective of market behaviours of most commercial clients. A general sense from the interviews is that everyone should be on the same page to understand the benefits of improving the performance of the construction sector. It not only delivers better financial outcomes for the industry, but also for clients. It means high quality construction with more cost savings, fewer project delays, and improvements in the ability to innovate. As for factors which construction businesses can impose certain control, either on their own or collaboratively, attention should be given to better performance measures to incentivise professionalism, better analysis of risk profile, and more prudent decision-making. The key levers for a risk management strategy at an organisational level include dedicated risk manager role(s), developing a risk positive culture, pricing risks properly, and understanding contract risks.

Although the vertical sector is different from the horizontal sector in many ways that are related to the nature of building structures and behavioural elements of asset owners, the horizontal sector has a number of lessons to offer. Better utilisation of more integrated procurement and contracting approaches was a recurring theme throughout the interviews. The horizontal sector has demonstrated its better productivity and performance in several high profile infrastructure delivery projects, by using early contractor involvement (ECI), adopting an integrative design and build (DB) delivery approach, using target value design processes in alliances, and value-based payment methods. For achieving better performance of the vertical construction sector, it is critical to also use innovative procurement methods that better allocate project risks.

Different from the vertical construction sector, the horizontal construction sector is closely coupled to government as central and local government are the major purchasers of their works. Government policies

and procurement systems influence the productivity and performance of horizontal sector. To a large degree, the perceived higher productivity performance in the horizontal sector is linked to a more coordinated approach between the government and the industry. A better understanding between commercial clients in the vertical sector and sector players is key to changing its risk-cost behaviours. To improve such an understanding, the following questions should be addressed together by both parties:

- What is the impact of ‘lowest price tender’ and ‘fixed lump sum’ on the lead contractor, its entire supply chain, and consequently on the project and client/owners of the project?
- What are the risks to clients of non-delivery of a project due to unfair risk allocation in the contract?
- How can different procurement/contracting models (Design and Build, engineer-procure-construct, Public Private Partnership alliance, or integrated project delivery) be effectively adopted to improve accountability and manage risks effectively?
- What are the non-monetary attributes for projects to achieve a successful outcome?
- What are the behavioural influences and system conditions that are driving acceptance of high-risk conditions by some contractors?

For long-term improvement of productivity through better risk management practice, there are several recommendations made by interview participants. First, interview participants call for greater collaborations and partnerships (e.g., forming alliances or joint ventures) among construction businesses, especially the small-scale players, to build up their capability and skill base; and to address productivity losses as a result of fragmentation in trades and contracts. While lead contractors may need to be scaled up to have all expertise in house to undertake DB or EPC projects, subcontractors also need to scale up to carry out bigger packages of construction work. Second, many participants suggest using technology, such as design automation, as a potential solution to increasing the precision of design work, reducing design errors and the likelihood of rework caused by design variations or flaws. Although to date it is unknown to what extent emerging technologies can influence productivity [12], it has been commonly suggested in other reports [3,13] that innovation and investment in technology can be a key to unlocking greater productivity in the construction sector. Lastly, several interviewees also advocated for 1) robust key performance indicators (KPIs) to encourage staff retention and reduce ‘finger pointing’ culture, 2) better monitoring and recording of activities onsite and across the supply chain, and 3) alignment between training cycle and demand for construction workforce. Above all, certainty of construction pipelines in the vertical sector is critical in encouraging new entrants to join the industry and lowering turnover among construction workforce.

## 5. Next steps

---

This report presents results from the interviews. It summarises the patterns and themes about risk management practice and its effects on productivity from a comparative perspective between the horizontal construction sector and vertical construction sector. Our ongoing research will map out the cause and effect relationships of the mechanisms/enablers identified in this report and to understand how risks transfer down the supply chain, causing cost overrun and time delays; and most importantly, understand the links between risk management and productivity, by using a system dynamics modelling approach.

## References

---

1. Conway P., Meehan, L. 2013. Productivity by the numbers: The New Zealand experience. New Zealand Productivity Commission Research Paper, September 2013. ISBN 978-0-478-39537-2.
2. Park, K., Lee, S. and Ahn, Y. 2017. Construction Management Risk System (CMRS) for Construction Management (CM) Firms. *Future Internet*, 9, 5, doi: 10.3390/fi9010005
3. PWC. 2016. Valuing the role of construction in the New Zealand economy: a report to the Construction Strategy Group .
4. Sapeciay, Z., Wilkinson, S., & Costello, S. B. 2017. Building organisational resilience for the construction industry: New Zealand practitioners' perspective. *International Journal of Disaster Resilience in the Built Environment* , 8 (1), 98–108.
5. Froot, K.A., Scharfstein, D.S. and Stein, J.C. 1993. Risk Management: Coordinating corporate investment and financing policies, *Journal of Finance*, 48, 1629-1658.
6. Bing, L. Akintoye, A. Edwards, P.J., Hardcastle, C. 2005. The allocation of risk in PPI/PFI construction projects in the UK. *International Journal of Project Management*, 23, 25-35.
7. Guo, F., Chang-Richards, Y., Wilkinson, S., & Li, T. C. 2014. Effects of project governance structures on the management of risks in major infrastructure projects: A comparative analysis. *International Journal of Project Management* , 32 (5), 815–826.
8. Seville, E., Stevenson, J., Brown, C., Giovinazzi, S., & Vargo, J. 2014. Disruption and Resilience: How Organisations coped with the Canterbury Earthquakes.
9. BDO 2019. Construction Survey Report.
10. Chapman Tripp 2018. What next for infrastructure?, August 2018.
11. Ayodele, O., Chang-Richards, A. & González, V. 2019. Factors affecting workforce turnover in the construction sector: A systematic review, *ASCE Journal of Construction Engineering and Management*, accepted, in press
12. Hasan, A., Baroudi, B., Elmualim, A. & Rameezdeen, R. 2018. Factors affecting construction productivity: A 30 year systematic review, *Engineering, Construction and Architectural Management*, Vol 25 (7), pp. 916-937.
13. New Zealand Productivity Commission 2019. New Zealand, technology and productivity: Technological change and the future of work, Draft report 1, September 2019.

## Appendix: Interview questions

---

Building risk management strategies into the vertical construction sector

- Commissioned by BRANZ and funded by BRANZ 2018/19 Building Research Levy
- Research team:
  - Dr Alice Chang-Richards ([yan.chang@auckland.ac.nz](mailto:yan.chang@auckland.ac.nz) University of Auckland)
  - Dr Charlotte Brown (Resilient Organisations)
  - Dr Nicky Smith (Market Economics)

### Interview questions for construction companies in the horizontal sector

The interview information and your identity will be kept confidential under the Human Participants Ethics 022977.

1. Do you agree that the horizontal sector is doing better than the commercial vertical sector in terms of productivity and profitability?
2. From your experience, where do the greatest risks exist in a) construction projects, and b) in the construction industry? Are they inherent in technical delivery process of a project, organisational risk management culture or in the terms of contract or industry norms, practices and culture?
3. What are the risks that will generally raise the alarm in a project?
4. How are particular risk factors being identified, solved, or impacts being mitigated? Can you give an example?
5. What are the challenges you face that limit your ability to manage risks effectively?
6. What are the levers that drive the productivity performance of the horizontal sector?
7. Apart from investing in risk and/or business management, what other enablers help or could help your business or the industry be more resilient and sustainable? (either enablers in place now or that need to be in the future)

Other questions if time permits:

- Do you feel you have the people in your team sufficiently experienced and or skilled to recognised all the risks inherent in a contract before it is bid?
- What percentage of your projects are unprofitable due to unforeseen risks? (How big is the problem)
- Do you formally record and analyse risks during your bidding process?
- Do you have effective formal systems for managing your projects that you are confident are being adhered to?

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 13/05/2019 FOR 3 YEARS REFERENCE NUMBER 022977.

## Building risk management strategies into the vertical construction sector

- Commissioned by BRANZ and funded by BRANZ 2018/19 Building Research Levy
- Research team:
  - Dr Alice Chang-Richards ([yan.chang@auckland.ac.nz](mailto:yan.chang@auckland.ac.nz) University of Auckland)*
  - Dr Charlotte Brown (Resilient Organisations)*
  - Dr Nicky Smith (Market Economics)*

## Interview questions for construction companies in the commercial/vertical sector

The interview information and your identity will be kept confidential under the Human Participants Ethics 02297.

1. From your experience, where do the greatest risks exist in a) construction projects, and b) in the construction industry? Are they inherent in technical delivery process of a project, organisational risk management culture, or in the terms of contract or industry norms, practices and culture?
2. What are the risks that will generally raise the alarm in a project?
3. How are particular risk factors being identified, solved, or impacts being mitigated? Can you give an example?
4. What are the challenges you face that limit your ability to manage risks effectively?
5. Apart from investing in risk and/or business management, what other enablers need to be in place to help your business or the industry be more resilient and sustainable? (either enablers in place now or that need to be in the future)
6. What measures do you think work well that can help allocate risks more fairly across the value chain? Between clients and contractors, between contractors and subcontractors?
7. What is your view on why the cost of building in the commercial market is so high and the margin so low?
8. What needs to happen to reduce the company collapse or failures in the commercial construction market?

### Other questions if time permits

- Do you feel you have the people in your team sufficiently experienced and or skilled to recognised all the risks inherent in a contract before it is bid?
- What percentage of your projects are unprofitable due to unforeseen risks? (How big is the problem)
- Do you formally record and analyse risks during your bidding process?
- Do you have effective formal systems for managing your projects that you are confident are being adhered to?

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 13 / 05 / 2019 FOR 3 YEARS REFERENCE NUMBER 022977.