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COMMUNICATING SEISMIC BUILDING RISK WITH COMMERCIAL BUILDING TENANTS

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ABSTRACT

In Aotearoa New Zealand, the interpretation of seismic risk information and the subsequent demands put on building owners and developers to address seismic risk are shaping the performance of our building stock. Commercial building tenants in particular can significantly influence property developers and landlords, who respond to tenant preferences to ensure they can lease and make a return on their property investment(s). However, there are many cases that indicate commercial building tenants do not fully understand the seismic risk information they receive nor how to incorporate the information into their decision-making regarding leasing or vacating a building.

This research identified key challenges with current approaches for communicating seismic building risk with commercial building tenants through a series of interviews with commercial building tenants, property managers and structural engineers.

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INTRODUCTION

Most seismic risk communication and behaviour research focuses on building owners [1-3] while few studies have explored how commercial building tenants understand and perceive seismic building risk, and how this translates into occupancy and leasing decisions. Commercial building tenants have the potential to influence the seismic resilience of buildings significantly. Developers and owners, driven by a need to ensure they can lease and make a return on their investment, naturally respond to tenant demands for building performance [4]. However, tenants' perceptions of risk, leasing requirements, and willingness to pay for more seismically resilient buildings are influenced by their understanding of seismic risk. Recent evidence suggests that building occupancy and leasing decisions made by commercial building tenants have led to sub-optimal outcomes, such as suddenly vacating seismically vulnerable buildings [2, 5] or not seeking buildings with greater seismic performance despite good economic and social reasons to do so [6]. To enable tenants to make informed decisions that improve seismic resilience, communication needs to be catered to tenants' needs and priorities.

This work explores tenants' priorities, preferences, and understanding of seismic building risk, as well as how these influence building leasing decisions. This exploration involves investigating the perspectives of both commercial building tenants receiving and acting upon seismic building risk information, and those responsible for communicating this information.

To unpack commercial building tenants' priorities, preferences, and understanding of seismic building risk, semi-structured interviews were conducted with commercial building tenants (the decision-makers and communicatees), and property managers and structural engineers (the communicators). Consequently, the work presented includes a cross-case analysis of two reflexive thematic analyses of two groups: (1) communicators: property managers and structural engineers, and (2) communicatees: commercial building tenants. Analysing these two groups separately provides insights into the different perspectives on seismic building risk and potential difficulties or "noise" affecting communication. Understanding these perspectives and opinions can ultimately contribute to identifying more effective methods of communicating seismic building risk.

This paper first discusses the management of seismic building risk to provide a context for which tenants are situated, followed by an overview of seismic risk communication. It then outlines the method, analysis, and results of this study and discusses what it means to communicate seismic risk with commercial building tenants.

MANAGING SEISMIC BUILDING RISK

Building codes have played a vital role in reducing the impact of earthquakes on the built environment [7, 8]. Building codes set the minimum requirements of seismic building performance for new buildings, focusing on ensuring life safety during significant seismic events. While building codes establish a baseline of life safety of occupants, they often do not address higher performance levels that would limit damage or ensure continued functionality after an earthquake. Although higher performance can be achieved, factors like economic pressures and a lack of understanding of what the code delivers by the general public who commission works, contribute to the vast majority of buildings being designed to satisfy the minimum—life safety [7, 8].

However, building codes require continuous updates as engineering knowledge for designing buildings to face earthquakes evolves. Consequently, buildings constructed prior to current building code requirements may have greater seismic vulnerabilities than newer buildings. This has resulted in a need to develop procedures to assess the vulnerability of existing older buildings and strengthen them to current standards [9-11].

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To move forward from life-safety targets, other design philosophies have become popular, such as performance-based earthquake engineering, low-damage design, and functional recovery. Guidance on this topic are still evolving and, so far, targets engineers.

Aotearoa New Zealand Context

In Aotearoa New Zealand, several resources have been developed to support different users in applying or understanding the Building Code and related policies. For example, the Seismic Assessment of Existing Buildings Guidelines [12] provides a technical basis for engineers to carry out seismic assessments of existing buildings within New Zealand, which aligns with the Earthquake-Prone Building regulations and methodology. Engineers communicate seismic assessments in the context of such guidance. In terms of other resources, the Ministry of Business, Innovation and Employment (MBIE) [13] has also prepared the New Zealand Building Code Handbook with the aim of providing extensive context and information about the Building Act, Regulations, and Code (including purpose, objectives, and responsibilities), including minimum life safety building requirements.

The Building (Earthquake-prone Buildings) Amendment Act [14] was enacted in 2016 to create a national framework for identifying and remediating buildings considered 'earthquake-prone'. Earthquake-prone buildings (EPBs) are considered to pose the greatest life safety risk to the public. The Act requires local authorities to identify potentially earthquake-prone buildings, and requires building owners to obtain a seismic building assessment and undertake remediation based on the assessment outcomes. The assessment is carried out against the strength of an equivalent new building, resulting in a rating expressed as the Percentage of New Building Standard (%NBS). Each element in a building that could pose a life safety risk is given a %NBS score, with the %NBS rating given to a building being based on the most vulnerable building element. %NBS ratings aim to provide a relative assessment of seismic risk and are not designed to influence building occupancy decisions or building design decisions [15].

Buildings with a %NBS rating of <34%NBS may be considered earthquake-prone. A building rating assessed as greater than 33% NBS means that the building is outside the requirements of the earthquake-prone buildings provisions of the Act, and the law requires no further action. A rating of 67%NBS or more means the building is not considered an earthquake-risk building [14, 15].

The %NBS rating can be obtained by an Initial Seismic Assessment (ISA) or a Detailed Seismic Assessment (DSA). While an ISA reports an indicative %NBS for a building, determined based on building records, plans and visual inspections, a DSA instead involves modelling, tests, and detailed calculations, which provides a more reliable %NBS rating and includes recommendations on potential mitigation actions.

The EPB framework requires the retrofit of EPBs within 7.5 and 35 years depending on the seismic hazard at the building location and whether a building is considered a priority building (based on construction, type, use or location), and even allows for further extension for heritage buildings. EPB owners and territorial authorities have expressed growing concern about the feasibility of meeting current deadlines. An extension of 4 years has recently been granted to building owners while a review of the EPB regulations takes place.

While promoting retrofit, the EPB regulations have had some unintended consequences. For instance, Ferner [16] argued that there are clear misunderstandings of %NBS being used to identify a building as "safe" or "unsafe", resulting in the need to vacate. To tackle these issues, MBIE [15] put together guidance on seismic building risk to help users understand seismic assessments and make informed decisions about their buildings. Efforts have been made to emphasise that %NBS should be viewed as indicative of the engineer's confidence in the expected seismic performance of the building, rather than an exact prediction level [15]. Despite this, building users often make decisions about building occupancy (e.g., stay, go, retrofit, etc) based primarily on a %NBS rating [17], without necessarily considering other dimensions of seismic risk and performance beyond that provided by the %NBS rating.

Seismic Risk Communication

Although regulatory levers to improve seismic performance are important in any country vulnerable to earthquakes, if risk communication is not effective and useful for end users, there can be a significant gap between policy and practice. Effective risk communication is critical to motivate behaviours toward fit-for-purpose seismic risk management.

To effectively communicate seismic risk, it is crucial to acknowledge the diverse perceptions, priorities, and limitations of decision-maker groups [18, 19], such as owners and tenants and those who provide key technical input to them, such as engineers. Effective seismic risk communication also requires not just the probability of risk or potential consequences to be presented, but also guidance on how to minimise that risk [19, 20]. Research has also shown that the format of how risk information is presented influences risk tolerance and consequent actions. For example, negative framing of risk might lead to higher judgements of risk, and consequently, they would be more effective in reducing risk tolerability [21], possibly influencing behaviours. Similarly, communicating the positive or negative benefits of an action will lead to the decision-makers inferring the risk to be low or high respectively [22]. Along these lines, the Building Code or current guidance might not be reflecting end users' perceptions. While codes typically focus on life-safety, there is evidence of growing expectations for more than building life-safety to be considered, and a desire towards, for example, inclusion of social and economic resilience [3, 7, 23]. Studies have also shown that people generally do not understand the philosophy behind the Building Codes and their focus on life safety [8, 17, 24]. This gap between engineering definitions and people understandings has led to false expectations of damage to buildings [17].

Understanding building safety or current minimum standards might be a also privilege. Blake *et al.* [17] found that although people living in Wellington, Aotearoa New Zealand (a high seismic hazard area) might be informed about building risk, how they take seismic risk into account in making decisions of where to live depends upon the connection between their ability to understand the risk issue and how to mitigate it appropriately, as well as their financial capability to then carry out those mitigation actions. This raises questions about the role experts have in policy decisions for seismic risk management, which extends beyond simply establishing regulations or minimum standards; it also involves creating an environment where all community members are equipped with the knowledge and resources to make decisions considering their needs. In turn, effective risk communication serves as a crucial non-regulatory tool that helps bridge the gap between regulatory minima and what people desire or need given their organisational context [25]. By clearly conveying the risks and mitigation strategies, risk communication can empower individuals and organizations to make informed decisions that go beyond mere compliance with minimum standards, fostering a more resilient and proactive approach to risk management.

Much of the existing research on risk communication focuses on individuals. Research shows that individual decision-making

is based on the idea of maximising outcomes, which are logical and linear. On the other hand, organisational decision-making can have a structured approach to risk-taking leading to systematic and formalised risk management practices, and hierarchical authority [26]. Organisational decision-making, such as those taken by commercial building tenants, aggregates both individual and group perspectives [27] impacting the way decisions are made within and by organisations. Hence, the first step is to identify those involved in the communication.

Commercial leasing agents and property managers play a critical role in communication and decisions about risk. Filippova [4] found that commercial leasing agents, for example, deal directly with landlords and tenants and often get involved with other stakeholders, such as engineers, on behalf of their clients (landlords). Engineers are also identified as key communicators of seismic risk information, and hold a significant responsibility in providing clear and trustworthy information. Miranda *et al.* [3] highlighted the role of engineers in motivating structural strengthening by meeting the needs and expectations of decision-makers.

Another important step when unpacking risk communication is identifying factors influencing such communication—for example, trust. Trust emerges as a central element in decision-making processes in an organisational context, particularly concerning risk interpretation and information sources. Paton *et al.* [28] emphasize the critical link between trust in information sources, such as engineers, and the adoption of preparedness measures. Moreover, Khan *et al.* [29] argue that trust fosters cooperative behaviour and facilitates information flow—essential components in navigating risk in an organisational context.

Effective communication is critical in building and maintaining trust. Fisher [30] suggests using language that resonates with stakeholders and emphasises collective action. Rather than relying solely on technical jargon, incorporating familiar references and highlighting shared challenges fosters a sense of unity and enhances trust in decision-making processes in an organisational context [19, 31].

METHOD

As engineering research shifts more towards systems that include people's perceptions and needs [24, 32-34], where human behaviour and organisational context play important roles, there is an increasing demand for the insights offered by qualitative research [7]. Consequently, this qualitative project uses semi-structured interviews to undertake research and unpack perceptions and priorities of decision-maker groups communicating and receiving seismic building risk information.

Procedure

This study was divided into two phases, based on the participant's role in the communication process of seismic building risk with commercial tenants. These roles and their interactions will be further explained in the Analysis section.

Phase One covered interviews with engineers and property managers (communicators), and Phase Two included interviews with commercial tenants (communicatees).

Participants were invited to participate via email containing an information sheet and consent form. The information sheet outlined the purpose and value of the research, how data might be used and gathered, how to withdraw information and confidentiality.

Interviews were conducted both in-person and online, and were recorded. The 60-minute semi-structured interviews included questions varying among the interviewee groups to reflect their roles, perceptions and needs regarding seismic building risk communication. Questions are listed in Table 1, where the questions were aligned by topic on different rows. In total sixteen semi-structured interviews were undertaken to examine perceptions and priorities of key groups.

This project was evaluated by peer review and was considered low-risk. Consequently, it was not reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are thus responsible for the ethical conduct of this research (Low Risk Ethics Notification Number: 4000028247).

Participants

Phase One involved interviews with five structural engineers who were experienced in communicating seismic risk information to building users, and five property managers who were experienced in dealing with seismic risk issues with commercial building tenants. Engineers were from Auckland and Wellington, and they had led engineering projects throughout the country. They had communicated seismic risk information with a spectrum of commercial building tenants, from large corporate tenants with multiple buildings to smaller tenants managing individual properties. Property managers were also selected to represent different seismic hazard areas in Aotearoa New Zealand, including Wellington, Auckland, and Hamilton.

Phase Two involved interviews with six commercial building tenant representatives. Commercial building tenants interviewed for this project were large organisations that tenant multiple buildings in different seismic hazard areas in Aotearoa New Zealand. Large building portfolio operators were targeted because of their greater experience and familiarity with receiving and interpreting seismic risk information.

Interpersonal recruitment was used in this study, engaging directly with individuals through personal networks, word-of-mouth communication, and one-on-one outreach to invite participation. This approach emphasises building relationships and trust with potential participants to ensure successful recruitment and trust in the information provided [35].

ANALYSIS

To provide a framework for analysis, we next introduce our initial understanding of the communication process with regards to seismic risk information. This framework was used to guide participant selection and structure and interpret our analysis.

Communication Process: A Conceptual Framework for Analysis

Figure 1 shows an initial understanding of the communication process of seismic risk with commercial building tenants, including the communication pathways and interactions between the three stakeholders. This framework was developed based upon an initial concept of information flow, drawing from established communication theories and frameworks [18, 19]. Key stakeholders in the seismic risk communication process—engineers, property managers, and tenants—were identified based on the literature. By analysing the typical pathways and interactions in information dissemination among these stakeholders, a flow that captures the essential elements of effective communication, including encoding, transmitting, decoding, feedback, and noise, was mapped out. This serves as a conceptual framework that guides the research into how seismic risk information is communicated with commercial building tenants. The framework's consideration of the communication pathways and interactions provides a structure for the analysis of the effectiveness and challenges in the

communication process. While the framework was used to guide participant selection and structure the analysis, it was also refined and validated as part of this research through the semi-structured interviews.

In general, Figure 1 highlights that the communication process begins when a sender or communicator (i.e., engineers or property managers) wishes to convey some idea, facts, information, or opinion to the receiver or communicatee (property managers or tenants). The communicator is at the communication system's starting point and represents the communication source. The communicator encodes (E) the message, which is the process of turning ideas, facts, information or opinions into communication, and uses a 'medium' to send the message—a phone call, email, text message, face-to-face meeting, or other communication tool (e.g., engineering reports). The process of translating the encoded message into an effective language, which can be understood by the receiver (i.e., tenants or property managers), is known as decoding (D). The communicatee then decodes, or interprets, the message for themselves. In Figure 1, it can also be observed that there is Feedback and Noise. While feedback might ensure that the communicatee has received and understood the message or might have questions, noise might affect the message. Noise in communication refers to any interference, disruption, or distortion that affects the transmission, reception, or interpretation of a message between a communicator and a communicatee. Noise can be, for example, prior experiences influencing the interpretation of the message or context (e.g., communicator and communicatee located in two different hazard zones).

Table 1: Semi-structured interview questions for engineers, property managers and commercial building tenants.

Engineers	Property managers	Commercial building tenants
• Could you please describe your organisation's role in assessing the seismic risk of buildings, and your own role within the organisation?	• Could you please describe what your organisation does, and your own role within the organisation?	• Could you describe what your organisation does, and your own role within it?
• In your experience, what you see as some of the key challenges of communicating this seismic building risk?	• Briefly, can you describe what seismic building risk means to you?	• Briefly, can you describe what seismic building risk means to you?
• As a structural engineer, could you please describe your understanding of your own role in relation to communicating seismic building risk information to end users?	• In your role managing buildings/engaging with commercial tenants in buildings, what information do you/does your organisation know/want to know about the seismic risk of these buildings?	• What are your primary source(s) of seismic risk information for the buildings occupied by your organisation?
• What type of seismic building risk information do you communicate / provide end users with?	• Thinking about the seismic risk information you obtain / are presented with about buildings your tenants occupy, what do you pass on to tenants?	• Why do you seek seismic risk information from the sources you have stated above?
• How do you generally communicate this seismic building risk information with end users?		
• In your experience, how is this seismic risk information typically received and/or interpreted by commercial tenant organisations?	• In your experience, how have tenants typically reacted to receiving this seismic risk information?	• What is the process within your organisation for considering relevant seismic building risk information and making tenancy and occupancy decisions regarding seismic building risk?
• In your experience, how do you think seismic building risk should be communicated to tenants?		• When thinking about seismic performance of a building, what is important to you and your organisation?
• What do you think would help tenants better understand seismic building risk?	• What do you think would help tenants better understand seismic building risk?	• In your experience, how would you like seismic building risk to be communicated to you and other building tenants?

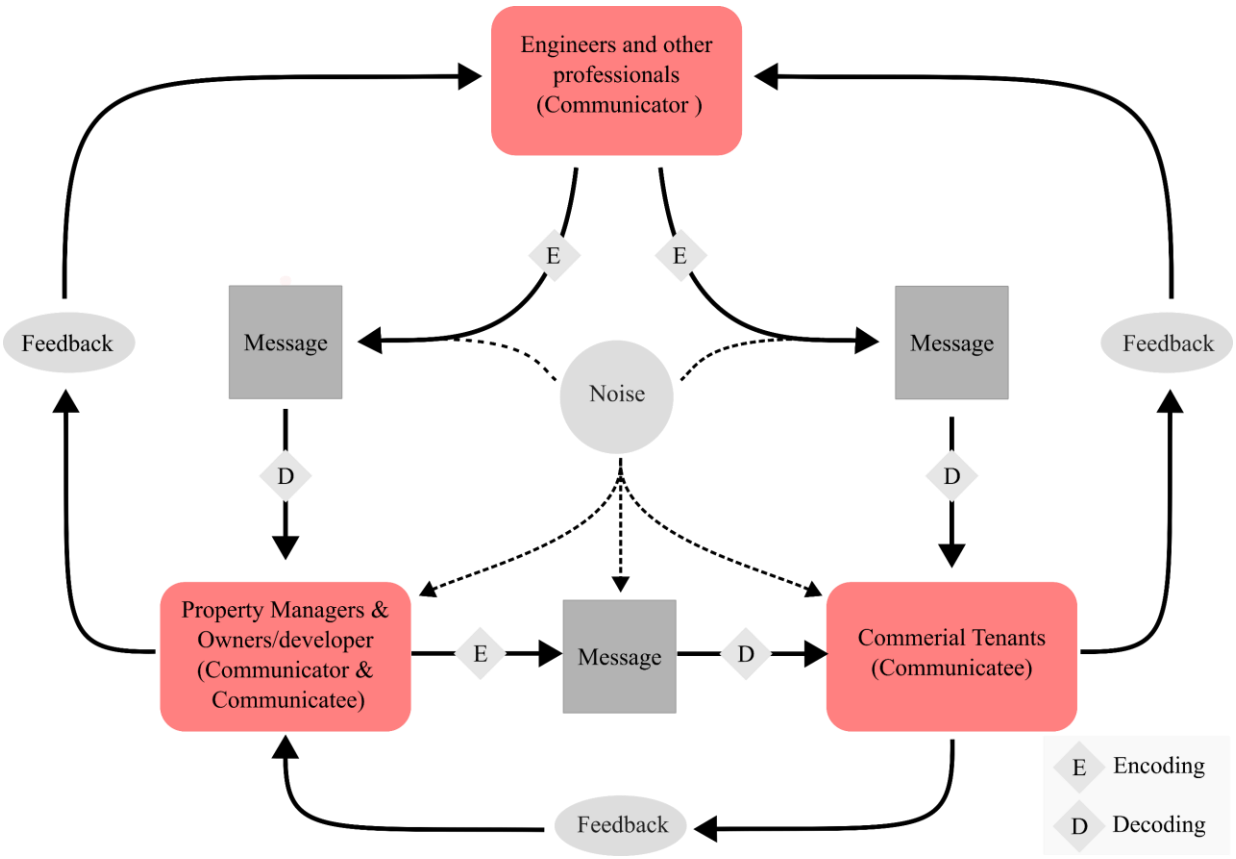

Figure 1: Representation of the communication process between structural engineers, commercial property managers/owners, and commercial building tenants.

Qualitative Interview Analysis

Interview recordings were transcribed and analysed in two phases: Phase One of the project included the analysis of interviews with five structural engineers and five property managers, and Phase Two included the analysis of six interviews with commercial building tenants. All interview recordings were analysed using the reflexive thematic analysis procedure described by Braun V. *et al.* [36] and Byrne [37] since the project seeks to explore and interpret the data and tell a story about patterns of seismic risk communication with commercial building tenants. Two thematic analyses were carried out, one in Phase One with Group 1 (Engineers and Property Managers) and another one in Phase Two with Group 2 (Commercial Tenants).

In both thematic analyses, data were read carefully to identify meaningful codes relevant to the research. Codes that were dealing with the same issue were grouped together in themes. All codes and themes were systematically reviewed to ensure that category and definition support identified themes.

Interviews in Phase One (with engineers and property managers) resulted in 59 codes that were grouped into four themes. Interviews in Phase Two (with commercial building tenants) resulted in 51 codes that were grouped into four themes. Using a cross-case analysis, themes of reflexive thematic analyses from both groups were compared and analysed. Themes and codes mostly matched without the intention of doing so, and codes were aligned by identifying similarities. Theme matching is shown in Table 2. For example, Theme 1: %NBS as a tool to explain seismic risk (Engineers and Property Managers) was aligned with Theme 1:%NBS as a dominant tool to explain and quantify seismic building risk (Tenants). This matching facilitated comprehension, exploration, and interpretation of the data, which enabled a narrative that enhanced the understanding and communication of seismic risk with commercial building tenants. This narrative is informed by commercial tenants' perspectives and reinforced by insights from engineers and property managers.

Table 2: Theme matching of Phase One (with engineers and property managers) and Phase Two (with commercial building tenants).

Phases and Themes	Phase One (with engineers and property managers)	Phase Two (with commercial building tenants)
Theme 1	%NBS as a tool to explain seismic risk	%NBS as a dominant tool to explain and quantify seismic building risk
Theme 2	Communicating seismic risk is complex	Tenants' interpretations of seismic risk information
Theme 3	Tenants' demands influencing the market	Tenants' attitudes towards seismic building risk influence the market
Theme 4	Several factors influencing risk perception and consequent actions	Tenants' motivators to consider seismic risk

RESULTS

Theme 1: %NBS as a dominant tool to explain and quantify seismic building risk

A dominant focus on %NBS ratings to understand seismic building risk was prevalent throughout interviews. When asked how they understand seismic building risk, tenants emphasised the %NBS rating as a primary tool for explaining and quantifying this risk. Evident was the association of a %NBS rating with the expected risk to life safety and building damage in an earthquake, as below:

> *"If the building was lower than 67% it's got an earthquake risk, which my understanding is that it could suffer damage in an earthquake but doesn't necessarily mean that the building would collapse or that there will be human lives lost. And lower than 34%, my understanding is that it is earthquake prone. That is obviously much more significant where potentially the building would collapse". (Tenant)*

The engineers and property managers also mentioned the use of %NBS to explain and quantify seismic building risk. However, engineers and property managers indicated there are several misunderstandings about %NBS. Engineers and property managers discussed how tenants don't really understand the seismic risk or %NBS since this last is understood as simply a numerical value. So, this value has been used by tenants to identify a building as "safe" or "unsafe", and decisions are made based on the number (e.g., vacate). Engineers and property managers mentioned that they struggle to articulate that %NBS as indicative of the expected seismic performance of the building's elements rather than an exact prediction.

Although communicators (engineers and property managers) considered that %NBS has been misinterpreted, tenants explained that, as %NBS has emerged as a straightforward method to explain, understand, and quantify seismic building risk, it also provides the simplest way of incorporating seismic risk into internal policy regarding building occupancy (e.g. policy set by organisations as to whether they will lease a building and/or continue to occupy an existing building).

> *"Since Christchurch, we had a policy around the seismic performance of our buildings… when this policy was developed, and this matrix [picture of %NBS, location and decisions] was developed." (Tenant)*

Tenants suggested they have made decisions to begin or continue leasing a building, based on both an ISA or a DSA. In some cases, this was influenced by the initial %NBS rating of the building or the location (seismic hazard zone). For example, if the %NBS is 'high enough' to satisfy their internal company policy at the ISA and/or the building is located in an area of lower seismic hazard (i.e., Hamilton, Auckland), they would be comfortable with the %NBS provided by the ISA. On the other hand, some tenants have indicated that due to prior experiences and the greater uncertainty behind ISAs compared with DSAs, they would prefer just to consider DSAs.

> *"We used to rely on ISA and have realised they are useless. So, we now require a DSA on all our buildings." (Tenant)*

Tenants also indicated that they generally require a seismic risk assessment report from landlords before leasing a building, so they can identify the %NBS rating of the building. In some instances, tenants indicated that when there is no information about the seismic rating of buildings, they might get their own assessment completed, at their own expense, to get the %NBS rating, as highlighted below:

> *"It's part of due diligence for new sites, we require either a DSA or an ISA from the landlord confirming that the rating meets our rating [organisation's minimum acceptable rating]." (Tenant)*

The %NBS requirements are part of tenants' internal policy, which can include a minimum %NBS rating as a baseline requirement, which, in some cases, must be maintained throughout the lease. Due to the ongoing updates to guidelines, new information about the building, or moves from an ISA to a DSA, the %NBS may fluctuate and potentially decrease from its initial value.

If a %NBS rating dropped below the minimum level accepted by the tenant organisation's internal policy, some tenants expressed that they might vacate their building(s) if the landlord was unwilling to appropriately strengthen the building(s). However, while this possibility was floated by tenants, it is not necessarily the option of first choice. For instance, tenants would first want to understand the reasons for the %NBS dropping (e.g., how the %NBS was obtained, buildings' elements affecting the overall %NBS, etc.), and explore mitigation options, before the sudden vacation of buildings. For example, a retail tenant indicated that they wouldn't vacate the building, but they would stop trading.

> *"If the [%NBS rating] goes below our policy, we don't break the lease, we would stop trading" (Tenant)*

When participants were asked about their understanding of enhanced performance or functionality, two different perspectives were observed. Some engineers indicated that larger building developers are more familiar with terms such as building functionality or low-damage design, particularly with projects in high seismic areas like Wellington and Christchurch. On the other hand, commercial tenants stayed focused on %NBS, indicating that conversations about functionality or low-damage design are not common among commercial tenants, particularly among smaller tenants.

Theme 2: Tenants' interpretations of seismic risk information

Engineers and property managers indicated that the primary way they communicate seismic building risk information with commercial building tenants is through the information provided in engineering seismic assessment reports (e.g., ISA, DSA). Tenants indicated that they, however, read the first few pages of the reports. Generally, the first pages would include a summary, recommendations and declaimers, and the rest of the report includes engineering calculations and terms that tenants indicated as challenging (if not impossible) to understand.

These reports, seismic building assessments, can be requested from engineering consultant companies by tenants, property managers and/or building owners. On that note, engineers stressed in the interviews that these assessment reports should only be used by those commissioning them. For instance, if a building owner commissions a seismic building assessment, the assessment report should not simply be forwarded to their tenant(s) for them to interpret the information. One reason

engineers provided for this includes the often challenging and/or complex nature of the information provided in the reports. Additionally, they emphasised the importance of allowing the perspective of the report's authors (i.e., the engineers) to be clearly articulated to the receiver of the report, to reduce the possibility of information being misinterpreted. For instance, misinterpretations might arise because the information provided in reports might not incorporate details of external conversations engineers have had with those who directly commissioned the report. An example of this might include the limitations of information available to inform the building assessment, which is determined by what engineers can obtain and what clients choose to provide. One engineer noted that these factors create a reluctance among engineers to share information about seismic building risk.

> *"[the sharing of reports] is a bit of a concern, and I think most engineers are very careful about allowing [clients] to share reports, just ensuring that the work we do, what we do is for our clients' benefit and no one else's, just that we, in the end, we do know the client will often share it, but that's the client's risk." (Engineer)*

Engineers, property managers, and tenants alike noted that meetings are a necessary component of articulating the outcomes of assessment reports. Engineers mentioned the importance of having discussions with clients to articulate the outcomes of a report, rather than simply providing the report itself. This helps to provide greater context for clients, beyond just the metric of %NBS, which enables better informed decision making. The following quote from a tenant illustrates that both engineers and tenants desire communication beyond written reports, where tenants also seek to understand the reports they have commissioned.

> *"Usually, after reading the report, we set up a meeting to talk about it too, because the report itself doesn't always answer all questions or doesn't answer them clearly. So, it's usually a report plus a meeting and then often an amended report". (Tenant)*

Engineers mentioned that during these conversations with clients, they typically explain the philosophy behind the building code, stressing the focus on the occupants' life safety and not the building's integrity. Engineers indicated they also have a responsibility to explain the wider context of seismic building risk (beyond life-safety), including key vulnerabilities in the building and how this might be mitigated. Similarly, tenants indicated that they rely on engineers to understand and interpret assessment reports, potential building vulnerabilities, and strengthening options. The engineer's responsibility and the tenant's need for support have resulted in long-term and trusted relationships. Some tenants have indicated they usually work with the same consulting engineering companies over time, where they have a mutual understanding of their needs, and how to articulate engineering terminology.

> *"We've got a relationship with [an engineering consultant firm]… and I think they sort of understand now where we are coming from, and so they know how to talk to us, in sort of layman's terms… we don't get into the details of how the [%NBS rating] is calculated. What we talk about is what does that mean in terms of the various elements of the building. Therefore, what is the real risk." (Tenant)*

The quote above also highlights the issues of communicating seismic building risk, where there is a conflict between tenants wanting plain language information and engineers wanting to avoid certain terminology. Common or plain language does not always have the precision that engineers seek, and there are legitimate fears that the use of words such as 'safety' might be inappropriately interpreted. One engineer noted the importance of avoiding certain wording in their reports, including terms such as "life safety" and "acceptable damage". While these terms can be commonly used in engineering contexts, they have different interpretations depending on discipline, standard protocols or policy, culture, and values, in turn triggering uncertainty or raising additional questions for non-engineers (i.e., commercial tenants).

> *"There are certain things, like the word safety, it is not a word that we use very often. Because it is a term that … depends on the person you are talking to, like when people say 'is this building safe?' Everything is relative to the risk. And so, as soon as you say—it's safe. What does that actually mean? It can mean completely different things to different people." (Engineer)*

The reluctance of some engineers to use certain plain language terms when communicating seismic risk information is aggravated by concerns of liability and specialised terminology that go beyond engineering issues. For example, the quote below by an engineer shows that they would not use the word 'safety' since it might have subjective interpretations and also because they can be liable if things go as unplanned.

> *"It would be very rare to find the S [Safety] word in a report… that was sort of borne out a little bit after doing assessment works after earthquakes because that would be a question that would come up a lot as the same building is safe to go back into... So if you go in and say, well, this building is safe just because I didn't see any damage, and it's not necessarily true. You could have a different type of earthquake the next day, and it all falls over, and you find yourself liable to that. And in that case, we do try to, I guess, canvas what we've done, and what it means." (Engineer)*

In continuing the search for how to communicate seismic risk with clients, engineers mentioned they use risk comparisons. The engineer below mentioned that there are a lot of risk comparisons they could make, but sometimes those comparisons get lost in context.

> *"And yeah, there's lots of examples out there saying, well, you know, you've got more chance of getting hit by lightning and dying, than being in a 20% NBS building in Auckland. There are lots of those sorts of comparisons, which are kind of useful as trying to provide some context to what the actual overall risk is that we're talking about. But it does maybe lead to just hearing the sort of risk of wearing your seat belt when driving down 100 miles an*

hour, and it becomes a little bit of a story rather than a good message." (Engineer)

When communicating with tenants about seismic building risk information provided by engineers, property managers indicated they are also conscious of their obligations to disclose certain types of information, such as indicated by the quote below. Where a Property Manager indicated that any risks from the building to occupants are required to be disclosed as per the Real Estate Agents Act 2008 or the Health and Safety at Work Act.

"Another piece of legislation that intersects with this [seismic risk] is the Real Estate Agents Act 2008. There are duties to disclose under that. If you're acting in an agency capacity also from a Health and Safety at Work, you've got a duty to disclose as well. So, landlords can't have this information and hold it close to them. If they do, they're certainly breaking the Health and Safety at Work Act. If you're acting in a managing agent capacity or a leasing agent capacity, if you know it, you gotta say it." (Property manager)

Continuing with the challenges of understanding seismic building risk, tenants indicated seeking different sources that communicate information about seismic building risk in clear and non-technical language, such as the tenant below who indicated that even websites of local councils of lower seismic hazards zones provide some information.

"I found it funny enough that the Auckland Council website has a fair bit of information on it, and it's all in pretty simple English." (Tenant)

Although the willingness to communicate and understand seismic building risk exists, questions have been raised about whether the use of %NBS terms might have added complexity to the overall seismic building risk issue. For example, engineers mentioned that although there is guidance on the EPB assessment methodology, the assessment procedure ultimately relies on the individual judgement of the engineer undertaking the assessment. Engineers, as the one quoted below, are aware of the disparities among assessment outcomes, and they attribute this to the lack of experience, ambiguity of and access to information.

"…our guidelines aren't perfect. There are issues with them. We do have conflicts with other engineers on a lot of that understanding or application of those disagreements." (Engineer)

Such disparities between assessment reports can contribute to tenants' confusion and misunderstandings about seismic building risk, if this information is not effectively communicated. Tenants noted that communication of this information is not always consistent.

"…sometimes the landlord will get a DSA done, we will have our engineer peer review it, and then usually a discussion occurs because they might have different opinions… Some engineers are better than others at communicating the information to lay people like myself. Some reports are easy to read and some aren't." (Tenant)

Also contributing to confusion and/or misunderstandings of seismic risk information among tenants are changes to relevant guidelines and policy, which may, in turn, alter the seismic risk profile of a building and associated obligations (e.g., strengthening). This adds complexity to the communication and understanding of seismic building risk and the uptake of appropriate action. The quote below from an engineer underscores the complexity of explaining these guideline updates to commercial tenants and emphasises how these updates can influence their perceptions of the importance of addressing seismic risk today.

"Tenants are always concerned about what pops up… about the changes that keep coming through all the time… For example, assessments done to early guidelines and now assessments to newer guidelines and they change our performance, ratings etcetera… That's one of the big things that comes out. Why have we now had to reassess these?" (Engineer)

Although there are challenges, the information is received, and it is typically communicated to the wider staff within the organisation in due course. Tenants typically relay information to their staff when they see potential consequences that could impact staff safety, such as a building being labelled earthquake-prone or upcoming strengthening works. However, tenants endeavour to communicate the information in the most suitable manner possible, so to not alarm their staff. Nevertheless, if communication about seismic risk is challenging even among individuals expected to comprehend seismic building risk, conveying seismic building risk to the general public, like staff members, may prove even more difficult, as illustrated below:

"As soon as we see any issue we update them [staff] immediately.... If there is still a big question about the seismic status of the building… we wouldn't just communicate because it will create more uncertainty… We sometimes do get an engineer to come in and talk to the staff….I have had an engineer talk to staff, and it was just the wrong person because he's talking about technicalities, and I think his first statement said that the building could actually collapse… which wasn't the right thing to say." (tenant)

Theme 3: Tenants' attitudes towards seismic building risk influence the market

Tenants, engineers, and property managers mentioned that attitudes towards considering seismic building risk information depend upon whether tenants are large or small tenants, the type of building they occupy (e.g., small building, high-rise building, industrial shed), the nature of the business (e.g., retail, office, storage), and the location across the country (e.g., smaller towns vs. larger cities, or low- and high-earthquake-prone areas). The quote below, for example, indicates that there might be a different perception of seismic risk depending on the building location.

"[asking about seismic risk] depends on which part of the country that we're in. So in

Wellington… if you're going to try and lease a building, then you will be expected to have a relatively recent detailed seismic assessment… recent experience with the government client where they were asked the same thing in Auckland. So I asked the landlord to provide a detailed seismic assessment, looking at the 2018 guidelines… I think the landlord's response was kind of 'why do I need this? we're in Auckland, we don't get earthquakes…' Yeah, but it's that's how the market is." (Property manager)

The quote above illustrates how different contexts can drive different perceptions and influence different behaviours. On that note, tenants have set different %NBS minimum thresholds within their internal seismic risk policy. However, this is true for large corporate, and government tenants who generally have greater resources at their disposal to consider and address seismic risk. For example, the quote below from a property manager indicates that the larger the company, the higher the standards for seismic building risk.

"The greater sort of board and governance that they have, the more risk averse they [tenants] are likely to be. Like, banks or telecommunications companies. They often have requirements quite close to the government requirements, which are the more risk averse and saying, you know, we want the building to be above 67% or 80%, or we need it to be 100% if it's in new space that we're going to occupy." (Property manager)

This might not be true for smaller tenants who often do not consider seismic risk, as stated in the quote below by a property manager.

"Smaller tenants really don't care what that report looks like as long as it ticks the box." (Property Manager)

Another property manager, quoted below, also indicated that smaller tenants not being concerned about seismic building risk might be due to smaller owners' buildings also not engaging with seismic building risk issues.

"Obviously, some of the smaller landlords are not as proactive… they've probably never been asked, and they, in some cases, don't want to know. They haven't bothered." (Property manager)

Engineers and property managers agreed that tenants' attitudes towards and requirements about seismic risk move the rental market. Through the interview, it was possible to unpack that this push from tenants moving the market has affected themselves and others—engineering communities and owners.

Some tenants mentioned that they feel obligated to pursue landlords to upgrade buildings. This is emphasised by a tenant below, who feels burdened with responsibilities around seismic building risk and believes that this responsibility should fall on regulatory authorities.

"As a tenant, we think the law around or the legal obligations that landlords have to upgrade their buildings are way too long and too much time to do it. So, it's been left to tenants to push landlords to do it sooner. There are so many landlords out there that will do nothing unless their tenants push them, and so we feel that the legislation puts much pressure on us [tenants]to do their job, to do the government's job, which is to tell landlords to upgrade their buildings sooner." (Tenant)

Engineers mentioned the burn of keeping up with the market requirements. For example, an engineer mentioned that they are often under pressure to handle large volumes of assessments within tight timelines.

"I mean personally, in my view, the whole system, the whole way, we do this is wrong. Well, we're assessing too many buildings too often and a lot of buildings that are new buildings are being reassessed with everyone's cross-assessing everyone else's work. I mean, it's great for engineers if you really want to do lots of assessments, probably getting a lot of fees. But I think as I see it, you're probably getting more consistency but lack of accuracy." (Engineer)

Owners are also suffering the consequences of the market's needs. Interviewees mentioned that if owners wish to attract specific tenants, such as large corporations, they must meet these tenants' %NBS requirements, which might vary depending on the region, and the types of businesses. This is highlighted by the quote below, where a property manager gave an example of the issues faced by smaller owners, and the significant financial strain in undertaking strengthening efforts.

"…basically to increase the standards of a building, and we'll have a direct correlation to the rent that is required… Cuba Street is a good example in Wellington. Where we've seen a number of buildings in Cuba Street that need to be remediated because of the fact that the earthquake-prone building notice was coming… what happens in those circumstances is that the developer may go and buy the building at a much lower price because someone has to sell it because they cannot afford to remediate it.

… An older investor had a building for many years, and that was kind of their source of their retirement, income. And then someone has to come in and sort of buy that building off them at a knockdown price, and then remediated it.

In that building, previously, there might have been a really cool bar and some really amazing shops that were very much the fabric of the city in terms of how they're really amazing spaces and provide a vibrancy to the city. Then what happens is a developer has to come in and charge $1000.00 a metre rather

than $200.00 a square metre for rental, that is, in order to be able to upgrade the building. Then, what you get is those unique businesses have to move out, and they may not exist any longer. Instead, what you get is a [list of large retails]." (Property manager)

The effects of tenants moving the market influence everyone (owners, engineers, and tenants). On that note, tenants suggested that the country's focus on seismic issues might be disproportionately high. There is a general concern among tenants that seismic investment benefits aren't always evident, as highlighted by the tenant (quoted below) when asked about the benefit of seismic strengthening. This might prompt questions about whether the balance between seismic preparedness and benefits is appropriately maintained.

"There's no more benefit. We don't do any higher sales out of an earthquake resilient building." (Tenant)

In light of the evolving global circumstances, tenants also expressed shifts in their priorities following the COVID-19 pandemic. Many now emphasise the importance of flexibility, particularly regarding remote work arrangements, as a means of adapting to circumstances such as building evacuations or damage. During the interview, questions were focused on seismic strengthening and the potential vacation of the building due to a low %NBS score, however, some tenants, as quoted below, mentioned that they have a contingency plan in case earthquake damage prevents them from working in their offices.

"Employees have a laptop, and they can all work from home… Although we do have a site in Wellington… we would move to Auckland if we got wiped out in Wellington and sort of managed things from there." (Tenant)

Additionally, some tenants mentioned that global mobility and interconnectedness have brought new international companies into New Zealand, which appear to encounter challenges in promptly addressing such seismic building risk requirements. For example, a tenant mentioned that international companies might be slower in taking actions regarding seismic risk compared with New Zealand ones since this might not be an issue where they come from.

"[International-owned company] was quite slow to address seismic issues. Some of the New Zealand companies addressed it a lot earlier, whereas a number of [International-owned] companies have been slower to identify it as a risk or an issue, and therefore address it." (Tenant)

Theme 4: Tenants motivators to consider seismic risk and consequent actions

Throughout the interviews, various motivations for actions were identified. Regardless of the building they occupy, tenants indicated that risk is treated as any other risk, such as asbestos or fire issues. Tenants indicated that the primary reason for worrying about the seismic risk of the building is the safety of their staff, which is followed by the cost associated with the potential loss of the business, fit-out, etc., following an earthquake.

"The equipment is more expensive than the building." (Tenant)

Tenants also mentioned a brand issue, where they don't want to be seen as neglecting people's safety. In this context, tenants working as franchises or sub-leases indicated that even though the franchises or sub-leases operate separately, they have been involved in some seismic conversations and supported franchises through the process. Similarly, retail tenants indicated they spend large amounts of money on fit-outs and rent, and they don't want to tell customers that the building is not safe, which could be a deterrent for customers to visit. Tenants do not want to occupy buildings where they have to put a sign by the front door indicating that the building is earthquake-prone, as highlighted by a tenant below:

"…I know in places like Wellington where you then also have to display, the signage to say that the building is either earthquake risk or earthquake-prone and again, you know, I just couldn't come to terms with spending $500,000 on a fit out, and then having to put a sign on the front door on day one telling customers that this building may not be safe. It would just be too big a deterrent for customers to visit." (Tenant)

Where landlords wish to undertake seismic strengthening, some tenants expressed a desire to remain in the building while strengthening is completed. Tenants have indicated that they prefer to stay in their current building rather than move to a new one because relocating would require them to re-invest in fit-outs and find a new building that meets their internal requirements. This is emphasised in the quote below, where a tenant went through seismic strengthening instead of vacating the building, which was possible due to communication with the landlord.

"So we have been through a couple of great strengthening projects now, and where we've had to work in with landlords, umm, touch wood, thankfully, so far we haven't had any situations where we've had to completely stop trading and we've been able to keep trading through all of them, and some have been pretty disruptive…" (Tenant)

In addition, some tenants mentioned that prior experience also influenced the way that tenants approach seismic risk; for example, a tenant, see below, mentioned that they now included in the leases, as part of pre-inspections, some non-structural elements that were damaged after the 2016 Kaikōura earthquake and that stopped operations.

"…one of the learnings out of the Kaikōura and Seddon quakes… this building was damaged structurally as well, but a lot of the in-ceiling services moved around and as a consequence of that damaged the sprinkler system and that building experienced a lot of flooding as a result of that… So as a consequence of that, we now write into our leases, and as part of our evaluation of sites, that those in-celling services have to be seismically restrained." (Tenant)

Although seismic building risk is a priority when talking about people's safety and operational activities, some tenants also mentioned that seismic issues get lost compared to sustainability. Tenants compared seismic and sustainability issues and indicated, as quoted below, that sustainability is a priority for everyone.

> *"There's probably more of a focus on sustainability at the moment… people who are pushing not just green stuff, but all sorts of sustainable products, packaging and all that supply chain… So there's quite a big focus on sustainable, so to be fair, the seismic issues probably tend to get lost." (Tenant)*

DISCUSSION

The interviews with tenants and the two groups of key stakeholders (engineers and property managers) communicating seismic risk with tenants allowed a better understanding of tenants' priorities and preferences related seismic building risk. Consequently, and based on the findings, our earlier representation of the communication process can be updated (Figure 2). Figure 2 is an update of Figure 1 and illustrates the factors influencing seismic building risk communication (i.e., noise) and the mediums used. Figure 2 shows that seismic building risk information is usually distributed through reports, and this message is influenced by various sources of noise. While specific factors influence the way the message is crafted, other factors were identified as affecting the way stakeholders understand (decode) the message.

While tenants heavily rely on %NBS ratings to understand, quantify and support decision-making, engineers argue that tenants don't really understand %NBS. %NBS focuses narrowly only on life safety and does not provide tenants with insight into other building performance attributes highlighted in recent Government-issued guidance [15] and efforts by the New Zealand engineering community, to promote low-damage design and building functionality [38, 39]. Discussions on performance outcomes beyond life safety are limited to a select group of developers and clients, and tenants are not thinking of this opportunity to reduce damage and disruptions post-earthquake, highlighting a need for broader dissemination of information about these emerging and more advanced design principles.

The understanding and interpretation of terminology (e.g., technical jargon) varies across the stakeholders who play a role in the process of communicating seismic building risk. These mismatches can be recognised as noise influencing the effective communication of seismic building risk and are represented across Figure 2. For example, the degree to which tenants prioritise %NBS ratings when selecting buildings, varies based on company size, location, business type, and other factors (see Figure 2: Noise tenants context (e)).

Another factor that influences the communication process making it difficult for tenants to fully grasp seismic risks is the medium of communication. The primary medium for conveying seismic risk is engineering reports, supplemented by meetings. Both mediums present challenges: engineers struggle to simplify technical jargon, and tenants and property managers seek clearer, more digestible information. To mitigate this noise, it would be essential for engineers and property managers to understand the obstacles affecting communication effectiveness, including the tenants' backgrounds, needs, and priorities [30].

Tenants heavily depend upon engineers' advice, with trust emerging as a crucial factor in decision-making. While engineers try their very best to objectively articulate seismic risk information, interpretation of those assessments can be altered by the level of trust that exists. The data also highlight the importance of an ongoing, trust-based relationship between tenants, engineers, and property managers. Consistent with the literature, trust facilitates the adoption of preparedness measures [28, 29]. However, the complexity and inconsistency of engineering reports hinder tenants' ability to trust and understand seismic risk information fully [40].

Trust is identified as a foundation of effective communication between engineers, property managers, and tenants, as indicated in Figure 2: Noise tenants decoding (d). Engineers and property managers feel responsible for informing tenants about seismic building risks, and tenants expect engineers to provide this information. However, trust can be undermined if there is confusion about who should ask for or provide information. This confusion can also affect the flow and outcomes of communicating seismic building risks [41].

Ineffective communication of seismic building risk can lead to several significant consequences. When information is misunderstood, decisions may be made based on incorrect assumptions. For example, buildings may be vacated unnecessarily, or only buildings with a high %NBS rating may be leased. Such actions can have financial repercussions for building owners, potentially leading to loss of revenue and property devaluation.

Moreover, poor communication can result in misinformation being disseminated to staff (see Figure 2: Noise tenants to staff (f)). This can create unnecessary alarm and stress within the community, as people may overestimate the immediate risk or take inappropriate actions. The heightened anxiety can disrupt daily operations, reduce productivity, and strain relationships between property managers, engineers, tenants, and owners.

The analysis, results and insights from this work have contributed to the development of two documents: Seismic Risk Resource for Commercial Building Tenants under MBIE [42] and the Guidance for professionals communicating seismic risk information with tenants under BRANZ [43]. While the MBIE resource targets commercial building tenants and seeks to help tenants make informed decisions about the seismic risk of the buildings they lease and occupy, the BRANZ Guidance is a short guide for those communicating seismic building risk with commercial tenants (such as engineers or property managers). The guide seeks to provide tips on effective communication.

FUTURE DIRECTIONS

There are several gaps in research to support seismic risk communication and understand its effectiveness, and some are listed herein. First, the study's sample was skewed towards larger tenants and engineering consulting companies, which may limit the generalisation of the findings. Nonetheless, insights from property managers and engineers regarding smaller tenants' perspectives were included. Future research should explore the perspectives of a broader range of tenants and consulting firms to develop more inclusive communication strategies.

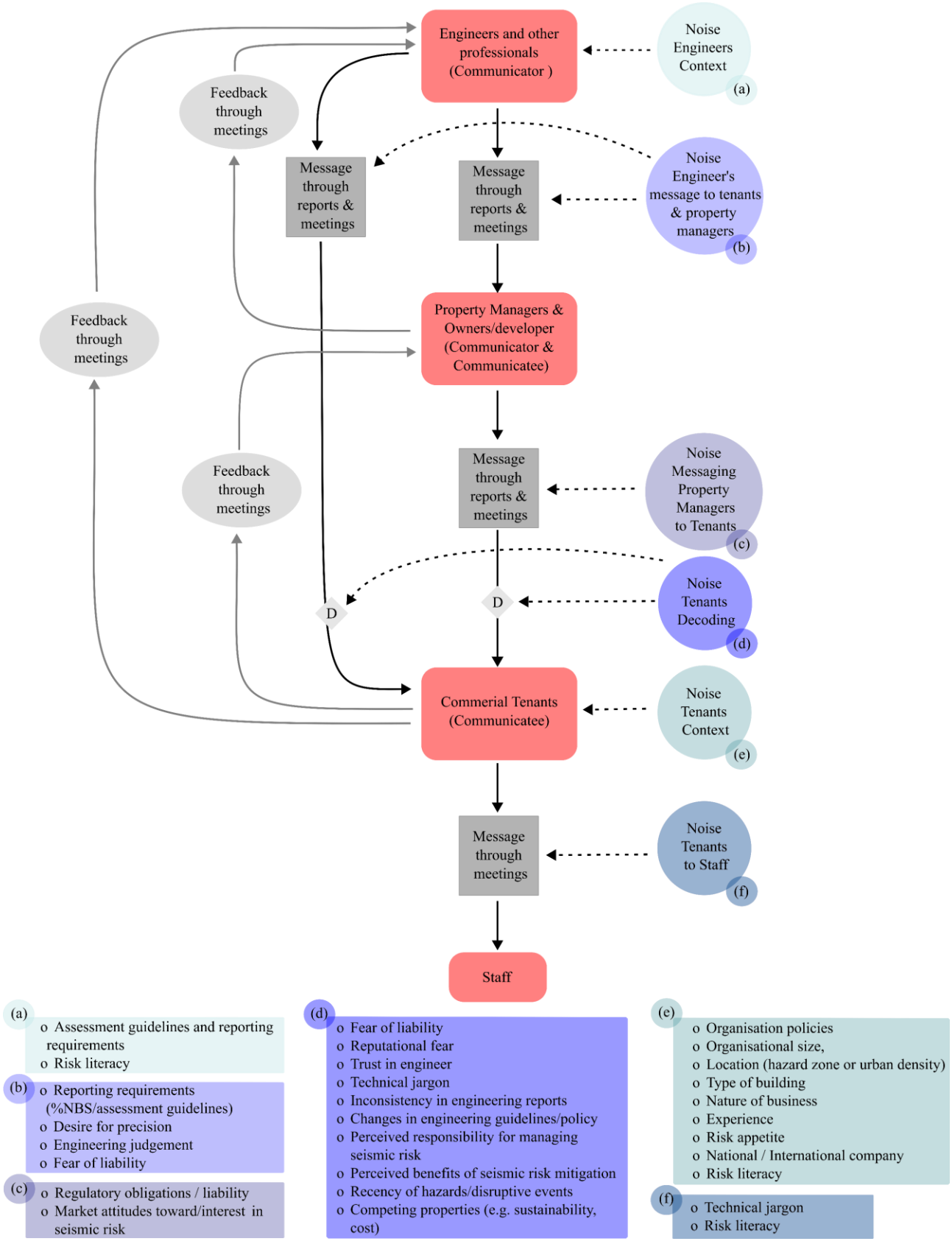

Figure 2: Updated communication process between structural engineers, commercial property managers/owners, and commercial building tenants.

Second, risk comparisons were mentioned by engineers as a tool to explain seismic risk; however, it is not fully clear how risk comparisons have been used or whether the idea of using risk comparisons was initially requested by clients (i.e., tenants). In addition, it is recognised that risk comparisons are complex to communicate, and can cause misunderstanding if inappropriate comparisons are made [44-46]. Hence, future research is needed to unpack the use of risk comparisons and provide guidance for engineers on the appropriate and effective use of risk comparisons.

Third, further research is needed to identify alternative ways to communicate seismic risk and to better explain %NBS to a wide range of diverse audiences, particularly for those who do not have a structural engineering background. This should include understanding how decisions are affected by different presentations of seismic risk information, and how graphical design decisions (e.g., through letters, graphs, colours, etc.), may affect decision outcomes and comprehension efficacy. These visualisations and communications should be assessed against factors such as accuracy, congruence, accessibility, retention, changes in perceived risk, quality and usefulness [47], in order to assess not just their aesthetic quality but their impact upon decisions.

Fourth, while some tenants mentioned that they make decisions to prepare for earthquakes based on prior observation of damage, in general, tenants indicated they don't clearly see the benefit of seismic strengthening. This aligns with prior research that has shown that the cost of seismic strengthening often leads to delays in structural mitigation actions [48, 49], however, other factors can also outrank cost, such as not being a priority [48]. Thus, additional research might be needed to understand commercial tenants' attribution for considering and preparing for earthquakes. For example, how earthquake preparedness can be aligned with other priorities such as sustainability.

Fifth, it was noted that very few tenants discussed the role of non-structural elements in seismic risk, as well as the functionality and use of buildings post-earthquake (i.e., risk understanding beyond life safety). Although research has shown the benefits of strengthening non-structural components [50, 51], this information is not effectively communicated to commercial tenants. Understanding such perceptions, and the role of communication resources to support understanding should thus be explored in future research.

Finally, although many issues were raised by interviews regarding going through seismic strengthening when occupying or leasing a building, there were a few 'successful' stories of tenants going through seismic strengthening while occupying buildings. It would be valuable to explore further how the information on seismic risk and strengthening work was communicated. This could be used to expand current seismic risk communication guidance and motivate seismic strengthening.

CONCLUSION

This research underscores the critical role that commercial building tenants play in shaping the seismic risk profile of buildings in Aotearoa New Zealand. Key findings revealed significant communication challenges, where (1) Engineers often prioritise precision and fear liability, leading to overly technical or inconsistent reporting, (2) Property Managers face pressures related to regulatory obligations and market attitudes, influencing how they convey seismic risk to tenants, and finally (3) Tenants struggle to understand these messages due to technical jargon, inconsistent engineering reports, and evolving guidelines. These factors can also affect the trust in communicators, which remains a critical component in effective communication and further affects tenants' interpretation of seismic risk information.

There is heavy reliance on %NBS ratings to inform building occupancy decision-making. However, these metrics are often misinterpreted, indicating a need for clearer, more accessible, and inclusive communication methods. The development of resources, like the MBIE Seismic Risk Resource for Commercial Building Tenants and BRANZ Guidance for communicators, represents an important step toward bridging these gaps. However, future research must explore alternative communication strategies to clarify complex concepts like %NBS to support informed decision-making. By improving the clarity and accessibility of seismic risk information, commercial tenants, property managers, and engineers can better align their efforts to create a safer and more resilient building stock in Aotearoa New Zealand.

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