

Beyond %NBS: understanding user needs and international approaches to communicating seismic risk

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ABSTRACT

The percent New Building Standard (%NBS) has become New Zealand's default metric for evaluating and communicating seismic building performance. However, its use has expanded far beyond its intended scope, often leading to confusion and unintended consequences for building owners and tenants. While %NBS provides a relative indication of life safety, it fails to capture other performance dimensions such as damage, functionality, and reparability, all critical for informed decision-making.

This research presents findings from a gap analysis exploring how international frameworks for communicating building performance, including %NBS, align (or misalign) with end users' information needs. Drawing on interviews with building owners, tenants and wider building system stakeholders such as lenders, insurers and lawyers, we identify the information and decision-making needs of these different user groups. We compare these needs with components of international rating systems to highlight opportunities for improving New Zealand's seismic risk communication approach. The analysis highlights key considerations for the development of a more user-centred system, and evidence for reimagining how seismic performance can be assessed and communicated.

1 INTRODUCTION

The Percent New Building Standard (%NBS) has become the most widely adopted indicator of seismic performance in Aotearoa New Zealand. Introduced through the 2016 Earthquake-Prone Building (EPB) legislation, %NBS was intended as a screening tool to identify buildings that pose a higher seismic risk compared to a similar new building designed to current codes (Building Act, 2004; MBIE, 2020). However, its application has extended far beyond this original purpose, shaping decisions on building closure, tenancy, purchase, and retrofit strategies (Blake *et al.*, 2021; Brown *et al.*, 2021). Despite its widespread use, %NBS is not a comprehensive seismic performance metric. It provides only an indication of relative life-safety risk and does not account for other critical dimensions such as expected damage, disruption to functionality, or

recovery time, factors that strongly influence societal and economic resilience (Abeling *et al.*, 2023; Ferner *et al.*, 2022).

These challenges underscore the need for a user-centred approach to seismic risk communication. Understanding what end-users, including engineers, building owners, tenants, insurers, and regulators, want to know about seismic risk of buildings, and how they interpret different information, is essential for developing approaches that enhance trust and support good decision-making. There is an urgent need to articulate user needs and to test perceptions of, and responses to, different forms of seismic risk information, including the current %NBS system. Seismic risk mitigation requires balancing regulatory and non-regulatory levers, driving reasonable and affordable seismic risk reduction over time. Effective seismic risk communication serves as a key mechanism to connect these regulatory and non-regulatory levers.

This research aims to reimagine how seismic risk could be best communicated by examining stakeholder information needs and evaluating how seismic risk information is communicated internationally. To understand end-user needs, we conducted interviews with a diverse range of stakeholders. Insights from these interviews and a review of international systems for seismic risk communication are presented herein. This research lays the foundation for future work exploring structured systems for communicating seismic risk.

2 CURRENT INTERPRETATIONS OF %NBS

The primary rating system for seismic building performance in Aotearoa New Zealand is known as %NBS. %NBS is a metric used to express the expected performance of an existing building relative to a ‘new’ building designed to the current seismic performance requirements within the Building Code (MBIE, 2022). It is understood as an “index used to characterise the expected seismic response of a building to earthquake shaking” and “helped identify buildings that represent a higher seismic risk than a similar new building” (MBIE, 2022).

While %NBS was originally developed as a screening tool for identifying earthquake-prone buildings (i.e., buildings with a %NBS rating of less than 34%), its application has expanded significantly beyond its intended scope (Ferner, 2018). This includes being used as a marker of building safety, used to make building occupancy or purchasing/leasing decisions, as well as being used as a marker of robust seismic performance beyond occupant safety (Filippova, 2016). This misapplication of %NBS has created multiple unintended consequences, including unnecessary building closures, stress for building owners and tenants, and poor or missed opportunity for investment in other key aspects of seismic strengthening (Brown *et al.*, 2021; Miranda *et al.*, 2025).

People find it challenging to understand that building assessments focus solely on the risk to life, and do not consider aspects like disruption, continued occupancy, and the extent of the damage (Ferner *et al.*, 2022). Researchers have found discrepancies between public expectations and the actual objectives of the New Zealand building code. These studies suggest that the general public has a misunderstanding or misinterpretation of government regulations and objectives regarding seismic risk and rating systems and the use of metrics like %NBS is adding to the confusion.

3 SEISMIC RISK COMMUNICATION THROUGH RATING SYSTEMS

There are numerous examples from around the world of seismic risk rating systems for buildings that support communication of seismic risk information. These examples can help to inspire elements New Zealand might want to integrate to enable better decision-making by end users.

In the United States, the Earthquake Performance Rating System (EPRS) was developed by the Structural Engineers Association of Northern California (SEAONC, 2015). Building Ratings Committee (BRC), a sub-

committee of SEAONC's Existing Buildings Committee (EBC), created the system to enhance seismic risk communication and achieve consensus on how seismic risk is communicated. While it is not a seismic evaluation method itself, it is a framework for summarising and presenting results from existing assessment methodologies. The EPRS seeks to translate and summarise evaluation results and includes not only a final report but also a presentation. The EPRS includes three rating components: life safety risk, repair cost following a seismic event, and building functionality post-event. Stars are used to communicate the assessed expected outcome across each of these components, on a 5-point scale. The highest rating levels (5 stars) can be assigned only rarely and only where the building's design explicitly sought exceptional performance relative to a typical new building of normal occupancy.

Based on the EPRS, a New Zealand system was developed to evaluate seismic building performance: QuakeStar (2017). The QuakeStar system considers a 500-year shaking intensity, and ratings are presented in three components (risk of harm, damage and repair time) using stars (one to five stars) and colours (five different colours).

Another voluntary building assessment for buildings was developed by the Federal Emergency Management Agency (FEMA) and Applied Technology Council (ATC) targeting typical residential wood-frame houses. The rating systems (FEMA P-50) comes along with its accompanying retrofit guidelines (FEMA P-50-1) to be applicable in all high seismic areas of the United States. FEMA supported this work not to promote the use of a residential rating system, but to provide a tool that communities or other entities could then use to encourage the seismic retrofitting of residential structures. The FEMA P50 (2012) assigns weighted numeric penalties for observed seismic deficiencies. The resulting Structural Score is combined with information on regional seismic hazards to assign a Seismic Performance Grade (letters) that reflects the performance that is generally expected in future damaging seismic events.

The Resilience-based Earthquake Design Initiative (REDi™) Rating System was developed for new buildings in the United States. It seeks to provide owners and other stakeholders a framework for implementing "resilience-based earthquake design", a holistic "beyond-code" design, planning and assessment approach for achieving much higher performance when thinking about new buildings. The building is categorised into three tiers (Platinum, Gold, or Silver), considering Organisational Resilience, Building Resilience, Ambient Resilience, and Loss Assessment. Organisational Resilience includes contingency planning for utility disruption and business continuity; Building Resilience includes expected damage to structural, architectural and mechanical/electrical/plumbing (MEP) components; Ambient Resilience includes external earthquake-induced hazard damage or risks affecting site access; and Loss Assessment includes evaluation of financial losses and downtime. The REDi™ Rating System uses a design level earthquake referred to as the 475-year return period earthquake.

Another international rating system is the Building Resilience Index (BRI), which is a web-based hazard mapping and resilience assessment framework developed by the International Finance Corporation (IFC), a member of the World Bank Group. It is designed to help stakeholders in the building sector, including developers, banks, insurers, governments, and occupants, assess, improve, and disclose the resilience of buildings to natural hazards and climate-related risks, including earthquakes, wind, water, fire, and temperature-related events. BRI uses a letter-grade rating system (NR, B, A, AA) to communicate building resilience.

4 PROJECT OVERVIEW

To enhance the communication of seismic risk and explore alternative ways to structure seismic risk information (such as a rating system), this research was carried out in three parts, as illustrated in Figure 3. Results presented herein include Part A and practically Part B. Part C will be covered in future publications.

- Part A investigated end-user information needs through semi-structured interviews with a diverse set of stakeholders, including building owners, public and residential tenants, professional technical service providers (e.g., architects, project managers, quantity surveyors), real estate agents, legal practitioners, lenders, and insurance providers. Insights from these interviews informed the development of eight persona profiles, each representing user requirements and interactions with seismic rating systems.
- Part B synthesised findings from Part A and coupled them with a review of international seismic risk rating frameworks, principles of risk communication, and expert consultation to design alternative mechanisms for communicating seismic risk. These alternatives incorporated multiple performance dimensions (life safety, disruption, and damage) alongside varied hazard scenarios and communication formats.
- Part C employed focus groups to evaluate the alternatives developed in Part B, receiving feedback on user preferences, interpretation, perceptions and potential use of the information.

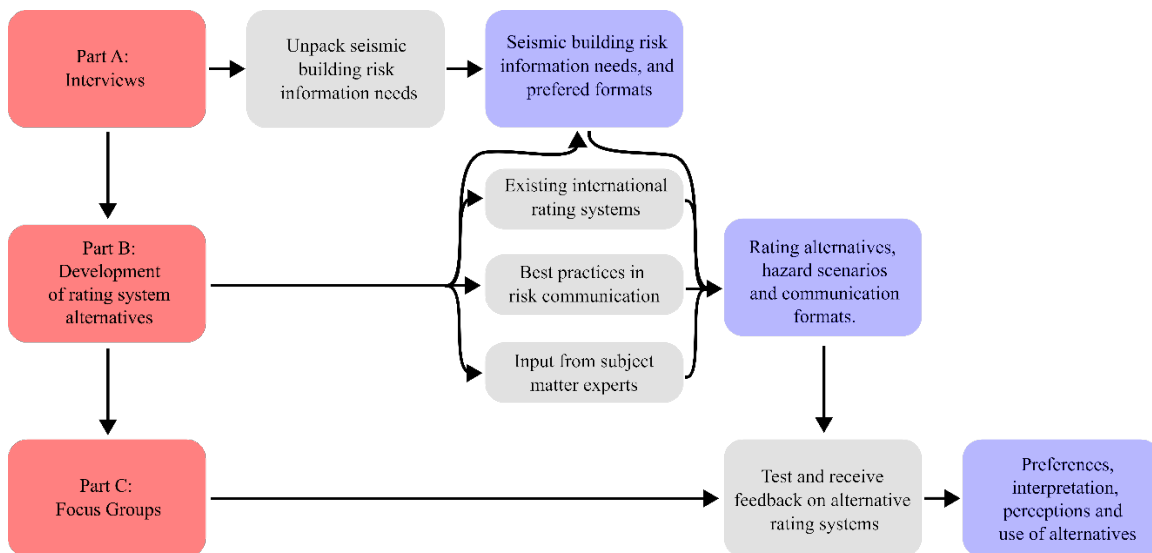


Figure 1 Project overview. (A) interviews, (B) development of rating system alternatives and (C) focus groups

4.1 Methodology

Part A included interviews with building owners and stakeholders, during which information needs, usage, and preferences were explored. To identify interview participants, a long list of building owners and building system stakeholders was generated. Building owners were categorised based on three criteria:

- owner-occupancy status (owner only, owner-occupied),
- building criticality (critical and non-critical functions, vulnerable occupants, buildings with occupants mandated to use the building (e.g. schools and prisons)) and
- organisational context (size, public/private/residential).

Stakeholders were categorised based on:

- organisational context (public/private individual), and
- familiarity with the building system.

To shortlist the profiles, we used two parameters to score each group: i) the participant's potential influence on the EPB system (with a preference for strong influence), and ii) existing knowledge gaps in our understanding of the participant's needs (with a preference for where there is low knowledge).

The shortlist was finalised following some adjustments to ensure a good balance across building owner and stakeholder categories, and a review by MBIE and our advisory panel. Within-case and cross-case analysis was conducted across stakeholder groups to understand the commonalities and contrasts in the data. This process enabled the identification of information needs and the use.

In total, 46 interviews were held face-to-face or via video conferencing (Teams) between February and March 2025, each lasting 60 to 90 minutes. The interviews were recorded with the participant's consent. A structured interview questionnaire was used that included both open-ended, closed, and ranking questions. The interview data was transcribed and tabulated using the coding framework. Within and cross-case analysis was conducted across the groups. In this way, we could see whether preferences differed between the various profiles.

A Low Risk Ethics Notification for the research was submitted and secured from Massey University (Ethics Notification Number: 4000030044). Ethical standards as per the University guidelines were maintained.

Part B explored how the needs of stakeholders and building owners identified in Part A align with global best practices. Part B compares common themes from interviews with features of international rating systems, including EPRS (USA), REDi™ (USA), and FEMA P-50 (USA). This comparison identifies opportunities to integrate multi-dimensional components, scenario-based ratings, and user-friendly formats with the aim to develop a seismic risk rating system fit for user testing.

5 RESULTS

5.1 Needs for a multi-dimensional risk communication approach

The within-case and cross-case analysis conducted across persona profiles revealed that %NBS is deeply embedded in organisational decision-making processes well beyond regulatory compliance. Organisations use %NBS to inform a wide range of decisions, including building occupation and leasing, property lending, insurance policy provisions and pricing, building leases, and property marketing. This reliance underscores the system's influence across financial, legal, and operational contexts. The data shows that there is a diverse web of organisations that now rely on %NBS (as the default seismic risk metric) to make decisions about seismic building risk. Even if %NBS is removed from the regulatory system, it is likely to still be used in a legacy form until a replacement system is generated.

“It might be a DSA or an ISA, right, because that's something that you can measure. if it's non-technical, i.e. this building is safe, that's nothing, you can't measure that, and measurement is critically important for the determination as to whether either party under a commercial lease, can exercise contractual rights. You'd never say if the building is unsafe the tenant can do X, but you might say if the building has a score of less than 80 percent NBS, the tenant can do X.” (Lawyer)

However, this widespread use contrasts sharply with what %NBS actually delivers. The %NBS, a one-dimensional metric, offers simplicity; however, it fails to capture critical aspects such as disruption, reparability, and financial loss. Stakeholders recognise these limitations, yet continue to rely on %NBS because no alternative exists. As another lawyer noted below:

“[NBS]'s an incomplete measure of seismic risk... So far as it focuses on life safety, risks to life safety. There are other angles that you could theoretically take to inform seismic risk in terms of, you know, preservation of the building or perhaps more of a business continuity angle.” (Lawyer)

This gap in understanding is compounded by misinterpretation. Some indicated that people tend to assume a higher %NBS rating means a building is likely to be functional after an earthquake. While others (despite acknowledging that %NBS is limited by a primary life safety focus) still apply the metric to damage and disruption risk assessments, as indicated by a professional technical service provider below.

“What at least I find with our clients is they don't really understand those three points [Life safety, property loss/damage, and continued use/function of a building] well enough to kind of differentiate them... Often people use, you know, 130 %NBS to justify the occupancy decision making. That's not what that means.”
(Professional technical service provider)

When questions were asked about preferences on dimensions of seismic building performance, and three options were presented: Life Safety, property loss and damage, and use or function of a building, the analysis identified that each group (whether public tenants seeking operational continuity, residential occupants prioritising personal safety, or financial institutions managing economic exposure) interprets seismic ratings through distinct lenses shaped by their roles, motivations, and constraints. Table 1 provides examples illustrating these contrasting perspectives across the three dimensions. These differences underscore the need for a multi-dimensional, user-centred rating system that goes beyond life-safety to incorporate disruption, reparability, and financial loss.

Table 1 Participants' insights on the three dimensions: Life Safety, Disruption and Damage

Interested in Life Safety	Interested in disruption	Interested in damage
<i>“Life safety and then continued use, then reducing property loss damage. And I only say that because I mean, they're not our buildings. So, the priority is our people and their safety, and then secondary to that would be whether we can continue to use the site.” (Public organisation tenants)</i>	<i>“So, reducing the safety risk is when we're considering an insurance policy, the least of our considerations... we are, unfortunately, insuring the building and sadly, we don't do life insurance... There's two parts to it. One is the material damage, so the building itself, and then the other part is the loss or interruption of being able to work. So, we're obviously also considering what the impacts of that second part are, because if the building fails we know we're going to have to pay up a lot of money on, what we call, business interruption insurance. So, we have to consider the impacts on both sides of that.” (Insurer)</i>	<i>“I think from an absolute pure human point of view, you'd say reduce the life safety risk, but from, the cold hard, what's the value of our security lending against it, we're going back to the insurance and the type of insurance on the building. So... reducing probably loss or damage would be quite important from a value perspective. The continued use and function of a building, that part of that goes to the loss of rent cover.” (Lender)</i>

From the perspective of lenders and insurance providers, current challenges relate to the lack of information about building damage and functionality. Figure 2 summarises interviews on seismic risk information needs, illustrating the preferences of insurers and tenants regarding damage and disruption information needs. They expressed a strong need for more detailed insights into these aspects, often prioritising them over life-safety information. This emphasis stems from an economic stability perspective, as lenders and insurers do not

cover loss of life but focus on financial risk and operational continuity. In this sense, they have used %NBS as a metric to understand building damage and functionality, which has been incorporated into their policies. However, they also mentioned they would like to understand what is wrong with the building beyond the %NBS.

On the other side of the spectrum, tenants are primarily concerned with life safety. Larger commercial tenants often incorporate %NBS thresholds into their internal policies, while smaller tenants rarely use the metric. Sitting between these extremes are building owners, who need information on both life safety and building functionality or damage to make informed decisions about occupancy and investment.

Advisors such as real estate agents and lawyers also share this dual focus, but for different reasons. Real estate agents emphasised the importance of clear seismic information for property transactions, leasing decisions and marketing. They noted that uncertainty around building safety and repair timelines can affect tenant confidence. Lawyers, on the other hand, highlighted the legal and contractual implications of seismic risk. They stressed the need for standardised definitions to reduce ambiguity in leases and contracts.

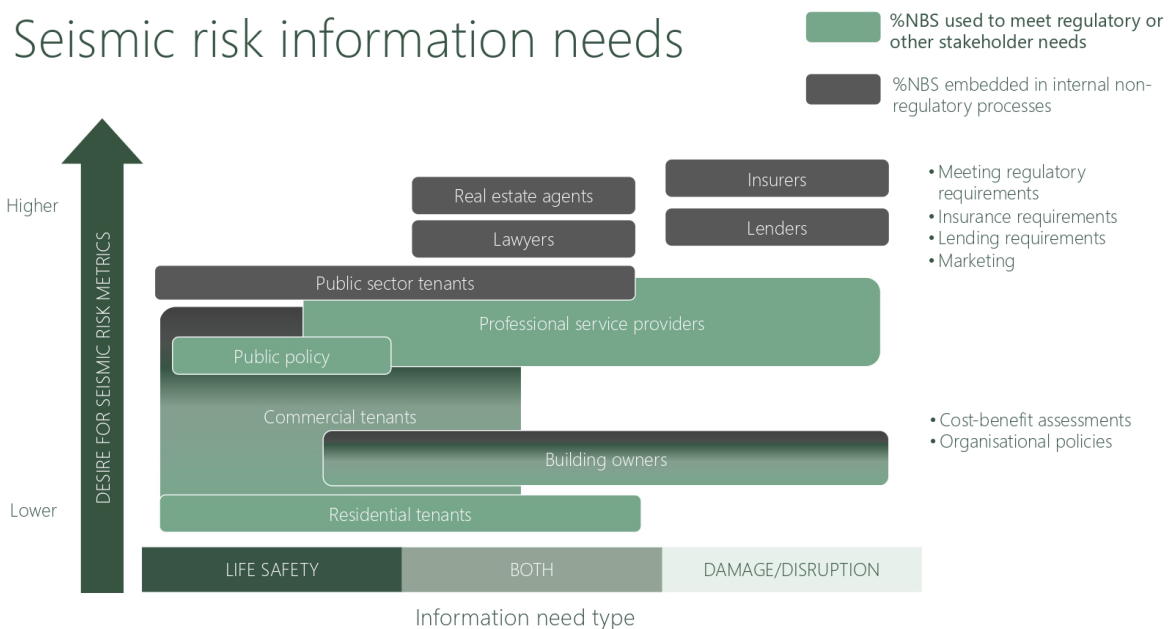


Figure 2 Seismic risk information needs of building owners and stakeholders

5.2 Factors affecting interpretations of seismic risk information

Although stakeholders expressed preferences for specific seismic building risk dimensions, many emphasised the need to understand what is wrong with the building beyond a single %NBS score. A real estate agent explained the limitations of relying solely on a number:

“DSA might state that the NBS rating, it’s 55 percent, in which case the policy of the organisation might say, well, we’re not going to occupy a building that is less than 67 percent or 80 percent... but what we’ve got is a number that has been created by an engineer based on some degree of science, but that doesn’t actually talk to the entire risk of building. It talks to the risk of an element of the building, and that’s why actually getting a good look at the information and actually having that then reviewed becomes really important.” (Real estate agent)

Interviewees also indicated they would like to have layered information, where simple summaries for non-technical users can be used, but also include detailed technical data for those seeking further information.

“Quite often we’ve seen clients in a position where they’ve got a technical piece of advice from their engineer as to the particular structural strength of a building element, but when it comes to the question of, okay, well, what are the consequences of that risk if that building elements were to fail in an earthquake. That’s where the non-technical language, or qualitative language, comes in handy in terms of okay, well, you know, yes, this unreinforced masonry wall would sort of fall in this direction as opposed to this direction, thereby harming people on the outside, not the inside or, or whatever it may be, and it’s that kind of language that helps people without the technical experience make informed risk decisions.” (Lawyer)

A recurring theme was lack of trust in the engineering community, driven by inconsistent ratings and perceived conflicts of interest. Participants questioned whether risk-averse practices and commercial incentives influence assessments:

“Councils and engineers are being really risk-averse. Seeing strengthening solutions in Waikato that are possibly being over cautious. Have seen buildings vacated which probably didn’t need to, but which has a huge cost as a result. I do wonder to what extent and buildings are either over strengthened, or demolished in situations where perhaps they shouldn’t have been demolished, and they could have been re-utilised or re-strengthened more affordably because the, you know, the requirement is possibly too high.” (Architect)

Another architect raised concerns about conflict of interests where engineers are assessing buildings and also designing retrofit approaches. These comments underscore the need for clearer processes and consistent methodologies to restore confidence in seismic assessments.

“I do have concern that there isn’t a separation between those people who undertake the assessments of seismic risk in buildings and those people who are then responsible for undertaking the strengthening. So, quite often the engineers that are saying this is a highly risky building are the same engineers that then are paid to strengthen it. ... there’s a very strong conflict of interest which really there should be a separation between those two functions.” (Architect)

Finally, participants indicated that a future rating system, or mechanism for communicating seismic risk, should enable comparability, not only between buildings but also against other everyday risks. This would help users contextualise seismic risk and make proportionate decisions. For example, framing building safety alongside familiar risks (such as driving or flooding) could reduce misinterpretation and improve trust, although the authors note that risk comparisons must be done cautiously (Das *et al.*, 2025).

5.3 Matching needs and current best practices

To design a seismic risk communication / rating system that reflects both international best practices and local stakeholder needs, common themes from interviews were compared with features of existing global frameworks. This comparative analysis revealed that effective seismic risk communication requires multiple components rather than a single metric. Three components emerged as essential: Life Safety, Disruption, and Damage. Each addresses distinct user priorities and aligns with approaches found in international systems. This analysis was also supplemented by best practices in risk communication and input from subject matter experts in order to develop alternative rating systems alongside varied hazard scenarios and communication formats.

5.3.1 Life safety

An analytical pathway was used to develop alternatives for a rating system based on life safety. This analysis started with stakeholder priorities identified in interviews, then it integrated lessons from international rating systems and risk communication principles, and finally incorporated expert feedback, culminating in two alternatives for the life safety component.

During the interviews in Part A, life safety was consistently identified by participants as the most critical information they need, and it is the core of the current Earthquake-Prone Building (EPB) system. Stakeholders want clear answers to a fundamental question: Will people in the building be safe during an earthquake?

International rating systems also include life safety, typically using five-point scales that incorporate explicit terms such as “injury” and “death”. The EPB system expresses life safety by comparing an assessed building to a new building designed to current codes, a philosophy intended to safeguard occupants. However, research indicates that many users do not fully comprehend this code-based approach, which can result in confusion and misinterpretation.

A future risk communication approach, like a rating system, should therefore include a life safety component with clear, graduated levels of life safety (e.g., ranging from “minimal injury” to “high likelihood of death”) and, perhaps, maintain a comparison to new building standards.

5.3.2 Disruption

Participants emphasised the importance of functionality and its implications for occupancy. Lenders and insurers indicated that it is important to understand downtime because this would influence the capacity to service debt or insurance premiums on business interruption.

International rating systems commonly include a downtime component, which is defined by the time required for reoccupancy after an earthquake. Additionally, the low-seismic design guidance introduced in New Zealand in late 2025 provides performance goals for functionality (MBIE, 2025). The guidance outlines three indicative building operational state categories: shelter in place, partial functionality and full functionality. It also includes a level named ‘safe egress only’, which represents the potentially non-operational state of a building that only meets life safety objectives of the building code

Feedback from subject matter experts indicated that it would be useful to use wording related to loss of access, since prior experiences have indicated that loss of access affected the function of the building beyond the internal damage.

Combining these insights suggests that a disruption component should capture multiple dimensions: building usability, expected timeframes for recovery, repair requirements, and potential service interruptions.

5.3.3 Damage

Interviews revealed that building owners, lenders, and insurers consistently prioritise information on repairability and associated costs, as these factors strongly influence investment decisions, insurance premiums, and long-term asset value. Tenants, by contrast, emphasised repairability primarily as an indicator of usability and timelines for reoccupation, rather than financial implications.

International rating systems commonly incorporate damage-related metrics, framing them in terms of repair costs relative to building replacement value or expected loss percentages. For example, the Earthquake Performance Rating System (EPRS) uses qualitative descriptors such as “repairable damage” or “irreparable damage,” while REDi™ expresses financial loss as scenario-based percentages of replacement cost. These approaches provide both technical clarity and practical decision support, enabling stakeholders to anticipate economic exposure and plan mitigation strategies.

5.3.4 Hazards and formats

Beyond the three components, interviews revealed that end-users also want information about different hazard scenarios. This aligns with international rating systems, many of which present multiple scenarios rather than a single benchmark, typically expressed as probabilities of exceedance (e.g., 5% in 50 years) or by geographic location.

In addition, international systems vary in how they present ratings, using formats such as colours, letters, stars, or descriptive terms. Given that stakeholders have indicated a preference for formats that can be incorporated into contracts and leases, it is essential to examine how different presentation styles affect interpretation and decision-making.

6 CONCLUSIONS AND FUTURE WORK

This study shows that the metric %NBS has become embedded well beyond its original purpose, shaping operational, financial, legal, and leasing decisions across a diverse web of organisations, even though the metric communicates only relative life-safety and omits disruption and damage. Stakeholders recognise these limitations but continue to rely on %NBS ratings due to the absence of a viable alternative.

Across interviews, user needs call for a multi-dimensional approach that explicitly separates Life Safety, Disruption/Functionality, and Damage/Repairability. Different user groups emphasise different dimensions: tenants prioritise safety and continuity, insurers and lenders focus on damage and downtime, and owners and advisors need both. This reinforces the case for a system that extends beyond a single index and aligns content and format with diverse decision-making contexts. This does not mean that the assessment approaches that are used to determine %NBS are not suitable, but merely that it may be beneficial to improve of the information is interpreted, packaged and enhanced.

Effective communication also requires layered information: clear, non-technical summaries linked to accessible technical details. Interviewees also mentioned concerns about trust and consistency, including variability between assessments. Finally, interviewees indicated they would like a system that can be compared against other risks.

Synthesising interview insights with international practice confirms that a multi-component rating is both feasible and consistent with global frameworks. Proposed components include: (i) Life Safety with graduated descriptors (e.g., “minimal injury” to “high likelihood of death”), potentially including a comparison to a new-building standard; (ii) Disruption, articulated in terms of usability, recovery time, repairs, and loss of access; and (iii) Damage, framed as repairability and loss relative to replacement value.

In addition, there is a need to understand different scenarios and include other formats (letters, stars, colours, descriptors) to support decision-making and integration in contracts.

Future work includes user testing of alternative rating/communication systems. The next phase will involve prototyping alternative rating models and evaluating them through structured focus groups to understand preferences, interpretations, perceptions, and potential uses.

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