

FROM AWARENESS TO ACTION: UNDERSTANDING HOUSEHOLD-LEVEL BARRIERS AND STRATEGIES FOR FLOOD-RESILIENT RETROFITTING

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ABSTRACT

Flood-resilient retrofitting (FRR) is a vital solution for mitigating riverine flooding impacts on residential properties. However, empirical evidence reveals that its practical application remains limited, particularly among vulnerable communities. This study examines barriers and strategies that shape retrofitting decisions through an in-depth household survey conducted in Shepparton, Victoria, one of Australia's flood-affected regions. While most residents reported direct experience with flooding and many demonstrated awareness of retrofitting solutions, actual implementation is notably limited.

Relative Importance Index (RII) analysis of Likert-scale responses identified financial constraints as predominant barriers to implementation, with lack of financial incentives as the most significant impediment, followed by prohibitive initial costs, insurance-related limitations, and income constraints. In contrast, institutional and social barriers were rated relatively low in significance. Residents expressed strong support for government-led solutions, including financial subsidies, regulatory reform, and technical support. These findings offer policy-relevant insights for designing effective flood resilience strategies in vulnerable communities.

Keywords: Flooding, Flood resilience, Retrofitting, Barriers and strategies, Residential properties, Australia

1. INTRODUCTION

Floods are among the most prevalent and dangerous natural disasters in Australia, second only to bushfires in occurrence (BOM and CSIRO 2022). Flooding has been responsible for over 20% of all disaster fatalities since 1900 (Australian Government 2023), with recent riverine flood events across Victoria causing extensive damage to homes, infrastructure, and communities (VICSES 2022). A large portion of Victoria's housing stock is vulnerable, particularly older homes built before the introduction of modern planning and building codes, which have left them more exposed to flood risk (Atkinson et al. 2023).

Old residential properties constructed before flood risk factors were considered at the planning and building stages (mid to late 1970s) have high physical exposure to flooding (AIDR 2017; Melbourne Water 2018). Such homes often lack fundamental flood-resilient design elements, such as elevated floor levels, reinforced foundations, or waterproof materials, due to outdated construction methods (de Ruiter et al. 2021; Mason et al. 2012). While the Building Code of Australia (BCA) included climate-responsive provisions as early as 1996 (ABCB 1996; Atkinson et al. 2023), explicit reference to flood resilience became evident only following changes in 2006, such as compliance with standards like AS/NZS 1170.1:2002 (ABCB 2012). Consequently, many of the older houses in rural flood-exposed towns, such as Shepparton, remain structurally unsuitable to withstand flooding, underlining the need for targeted retrofitting measures to strengthen resilience in the current housing stock. Therefore, implementation of practical mitigation actions is currently required to enhance flood resilience among residential neighbourhoods (O'Donnell 2020; Wilby and Keenan 2012).

Research has shown that private precautionary measures can reduce losses from flood hazard events (Hudson et al. 2014; Poussin et al. 2015; Sairam et al. 2019). However, these measures are often implemented at low rates and tend to increase only after a flooding event has occurred (Joseph et al. 2015; Owusu et al. 2015). As a result, there has been minimal effort to mitigate damage before such crises occur (de Vet et al. 2019). The implementation of FRR measures faces several challenges (Alabbad et al. 2022; Gordon and Yiannakoulis 2020; Kousky and Kunreuther 2018). Common barriers to widespread adoption include insurance constraints, financial limitations, technical inadequacies, and a lack of awareness among homeowners and policymakers

(Barendrecht et al. 2020; Hartmann et al. 2019; Kousky and Kunreuther 2018; Price and Dupont 2023; Silvis et al. 2024). To overcome these challenges, a thorough analysis of various strategies that could lead to successful retrofitting programs is necessary (Priest et al. 2016). Although recent studies have considered technical fixes and economic compromises, a significant knowledge gap still exists regarding how barriers work at the household level, particularly in the Victorian context. There is also limited evidence regarding which solutions are perceived to be most effective or feasible by householders themselves.

This study addresses this gap by examining household decision-making regarding FRR through a localised survey in Shepparton, a flood-risk regional city in Victoria, to bridge the knowledge-implementation gap. Specifically, the study aims to: (1) identify and rank the key barriers to FRR adoption; and (2) provide policy-relevant insights to enhance community-level flood adaptation. By anchoring its investigation in real household perspectives and utilising statistical tools such as the Relative Importance Index (RII), this study provides practical empirical evidence for the formulation of inclusive and context-responsive retrofitting policies in regional Australia.

2. LITERATURE REVIEW

2.1 Riverine flooding in Victoria

Given the variety of climates and river systems found in Victoria, riverine flooding is one of the most common and costly natural hazards in the state (Gu et al. 2020; Wenger et al. 2013; Wilby and Keenan 2012). These flooding always causes negative impacts (Gautam and van der Hoek 2003). Both rural and urban populations have been impacted by flooding, which has often been observed in places near major rivers like the Murray, Yarra, and Goulburn (Hart et al. 2020; Wilby and Keenan 2012). When a property floods, water can enter the building from the outside through a variety of channels, which can cause the building, its contents, and its structure to be destroyed (Adedeji et al. 2018). Devastating floods like those in 2011 and 2022 have wreaked havoc on Victoria's infrastructure, homes, and farms over the years (VICSES 2022). Accordingly, these floods caused damages of over AU\$432 million in 2022 (Deloitte Access Economics 2023) and AU\$1.3 billion in 2010 (AIDR 2020). As per the records, 400 houses in the 1934 floods, 3000 in the 1993 floods, and 5017 houses in the 2022 floods have been damaged from past riverine floods in Victoria (AIDR 2020, 2022; VICSES 2008, 2022). Moreover, 36 deaths in the 1934 floods, one death in the 1998 floods, one death in the 2007 floods, one death in the 2011 floods, and two deaths in the 2022 floods have occurred from past riverine floods in Victoria (AIDR 2019, 2022; Deloitte Access Economics 2023; VICSES 2008, 2022).

2.2 Flood-resilient retrofitting concept for existing residential properties

The concept of resilience is fundamental to many flood risk management (FRM) related research initiatives. It is frequently used in the field to identify the behavioural features of elements at risk when exposed to flooding dangers (Manojlović 2016). Accordingly, resilience can be defined as the capacity of an individual, community, town, or nation to withstand, bounce back, or absorb from an unexpected collapse or event incident, like severe flooding, and/or effectively adjust to a recent issue or a change in circumstances in a timely and efficient manner (Rezendea et al. 2019). For all strategy-development and decision-making processes in FRM to successfully handle and respond to impending problems and unpredictability, resilience and adaptation are therefore necessary (Manojlović 2016). The act of updating or enhancing existing structures to make them more resilient to floods is known as FRR (Nguyen et al. 2019; Proverbs and Lamond 2017; Shamout et al. 2021).

Retrofitting techniques typically adjust to the specific characteristics of the built environment and the anticipated danger of flooding (Attems et al. 2019; Barsely 2020). Buildings in flood-prone areas, for instance, might be elevated above the initial flood level to lessen the damage caused by flooding (de Moel et al. 2014; Proverbs and Lamond 2017). Additionally, installing flood-resistant windows and doors, sealing off flooding access sites, and strengthening foundations are all possible steps in the retrofitting process (FEMA 2016). These safeguards should be in place to lessen the adverse effects of flooding, such as property damage, evictions, and disruptions to vital services (Bier 2017; Perry and Lindell 2002). FRR techniques are also helping to lessen the impact of flooding events on structures and occupants and residual risk (Barendrecht et al. 2020; Barsely 2020). Compared to post-disaster rehabilitation and recovery efforts, retrofitting is usually less costly (Alexander 2004). By investing in retrofitting techniques in advance, communities can avoid the high costs associated with rebuilding demolished structures and repairing flood-related losses (Burby 2001;

Marvi 2020). Due to its effectiveness in reducing flood risks and vulnerabilities, retrofitting should be emphasised as a proactive approach to increase the resilience of existing residential properties against flooding (Adedeji et al. 2018).

2.3 Barriers to flood-resilient retrofitting for existing residential properties

As retrofitting techniques are expensive initially, residents are always hesitant to use them (Alabbad et al. 2022). Therefore, while homes with greater values and/or longer tenure tended to choose costly measures, resource-constrained households preferred to embrace low-cost or legally mandated measures (Zinda et al. 2023). Technical barriers, including limited access to skilled contractors, poor information regarding available techniques, and uncertainty regarding effectiveness, also affect FRR adoption (Barendrecht et al. 2020; Laska 1986). Barendrecht et al. (2020); Laska (1986) further stated that in the absence of adequate technical information on retrofitting, homeowners can believe that mitigation is not worth the investment since it is unlikely to be successful. Regulatory barriers, including misalignment among building codes, untrustworthy policies, and lack of coordinated governance institutions can also be identified as barriers for FRR adoption (Hartmann et al. 2019; Priest et al. 2016). Social barriers, such as age, perceived risk, resistance to change, and moral hazard, especially in the case of insured homeowners, can discourage action to adopt FRR (Forsyth et al. 2023; Messenger et al. 2021; Zinda et al. 2023). Information and communication barriers, including poor dissemination of flood risk information, poor outreach, and miscommunication between stakeholders, have all been cited as constraining factors (Hartmann et al. 2019; Silvis et al. 2024).

2.4 Strategies for flood-resilient retrofitting adoption in existing residential properties

Several tactics will be needed for moving beyond every obstacle to initiate mitigation activities (Priest et al. 2016). Therefore, the only way to reduce all costs and mitigate future damage is for collaborations between multi-stakeholders, namely, government, citizens, construction professionals, property managers, and insurance businesses, etc. (Athauda et al. 2025; Manojlović 2016). Improved access to financial incentives, low-interest loans, and subsidies, for instance, is required to partially offset the high upfront costs that deter building owners from renovating their structures (Athauda et al. 2025). Athauda et al. (2025) further stated that the retrofitting process is further eased by simpler legal frameworks, such as flexible building rules, which lessen the burden of FRR adoption for homes. Athauda et al. (2025) also emphasised the importance of raising public awareness through education initiatives and information sharing among stakeholders to establish a more flood-resilient residential community. Moreover, insurers also have a role to play in mitigating these barriers by considering ways to deploy insurance premium reductions to encourage investment in efficient, cost-saving mitigation solutions like FRR (Kousky and Kunreuther 2018).

3. METHODOLOGY

3.1 Research design

A descriptive approach is well suited to studies seeking to capture prevailing conditions, perceptions, and predispositions in a defined population. This study adopts a quantitative descriptive approach to exploring household-level constraints and facilitation strategies for FRR in Shepparton, Victoria. Because this research focuses on a qualitative phenomenon, which comprises evolving questions and processes, data is generally collected in the context of the participant, analysis of data progresses from specific to broad themes, and the researcher's interpretation of the data's significance (Creswell and Creswell 2018; Grover 2015). On a methodological level, the study was guided by the need for empirical evidence of behavioural and systemic factors affecting retrofit take-up in flood-risk regional towns.

3.2 Case study area: Shepparton, Victoria

Shepparton, which is located around 180 km from Melbourne on the floodplains of the Goulburn River in northern Victoria, is a major urban and agricultural centre of rural Australia (RDA 2023). It is the administrative and service centre of the Greater Shepparton local government area, comprising surrounding towns such as Mooroopna, Tatura, Merrigum, Murchison, Dookie, Toolamba, and Grahamvale (Greater Shepparton City Council 2024). Climatically, Shepparton occurs within an intervening zone of cold semi-arid

to Mediterranean climates, with hot, dry summers and cool, cloudy winters (Greater Shepparton City Council 2025b). The geographical context of Shepparton is depicted in Figure 1 below.

Figure 1: Case study area - Shepparton



Source: Adopted from © OpenStreetMap contributors. Tiles style by CycloSM, hosted by OpenStreetMap France.

According to the Climate Council (2025), Shepparton has one of regional Victoria's highest exposures to flooding, as 91.08% of the local properties are at moderate or high riverine flood risk. Specifically, 16,735 properties were in high risk and 559 in moderate risk in 2025 alone. According to VICSES (2023), flood exposure within the city is determined by the interaction of a number of converging river systems: Goulburn River (Shepparton's principal river system), Broken River, Seven Creeks, and Castle Creek. The confluence of these streams creates complex hydrodynamic conditions, so each flood is different based on river dominance and sequence (VICSES 2023). VICSES (2023) further identifies flood typologies of Goulburn River Dominant, Broken River Dominant, and Neutral, with impacts varying based on the sequence and magnitude of cresting. Recurrent riverine floods occurred in 2024, 2022, 2011, 2010, 1993, 1974, 1916, and 1870 in Shepparton (AIDR 2024; VICSES 2023). In 2022, a Goulburn dominant flood occurred with an estimated flood level of 12.03 meters at the Shepparton gauge (English and Warneke 2022; VICSES 2023). However, English and Warneke (2022); VICSES (2023) further stated that the 2022 flood was bigger than the 1974 flood; nevertheless, the location of the river gauge has been modified after 1974, thus causing various recorded heights. Hundreds of rescues were conducted by defence personnel and emergency services (VICSES 2022). 900 properties were flooded by floodwater, with 80 properties wholly or partially demolished (English and Warneke 2022; VICSES 2023). Therefore, case study focused on Shepparton because it has one of the highest exposures to riverine flooding, and recorded flood impacts repeatedly throughout the past century.

As part of trying to mitigate risks, Shepparton has implemented numerous flood mitigation infrastructures, including over 70 flood retention basins, strategic flood pumps, and extensive levee systems running from Knight Street in Shepparton to Furphy Avenue in Kialla (VICSES 2023). Despite these interventions, the frequency and severity of flood events remain massive threats to older housing in the area. Shepparton is particularly typical of the problems associated with legacy housing susceptibility. Many of the houses in the town were constructed prior to Victoria adopting uniform flood-related planning controls and building codes. Given the intersection of high hazard exposure, housing risks, and growing regional development, Shepparton offers a suitable and timely case study through which to explore barriers and interventions in household-level FRR.

3.3 Survey instrument

The household survey instrument was derived from a systematic review of Australian and overseas flood resilience literature, including internationally tested themes of barriers and enabling strategies and tailored to the Victorian context. The survey questionnaire consisted of four sections:

- Demographic and location information (age, tenure, floodplain status, etc.).
- Flood experience and knowledge of retrofitting.
- Perceived barriers (23 Likert-scale items covering economic to social and institutional barriers).
- Enabling strategies (9 Likert-scale items evaluating incentives, support, regulations, etc.).

Answers were collected on a 5-point Likert scale ranging from 1 (Strongly disagree/Not important) to 5 (Strongly agree/Highly important). The survey structure was meant to ensure clarity, reduce respondent burden, and provide the ability to convert subjective perceptions into ranked quantitative indicators.

3.4 Data collection

Data were collected from a sample of 28 households residing in Shepparton's flood-risk areas. Respondents were recruited online and through community outreach. Both physical and online surveys were conducted. A modest sample size is nonetheless indicative of exploratory approaches that seek intensive, context-bound insight rather than statistical generalisability. Other studies have noted that relatively small, purposeful samples can be valid and sometimes better situated to uncover knowledge when examining narrow phenomena, like household-level FRR adoption efforts (Malhotra et al. 2017; Rahi et al. 2019). Thus, a sample size of 28 household surveys is considered adequate for this study, given that the survey aims to gain in-depth insight into a particular phenomenon within a bounded context. This filled dataset represents a real cross-section of the households in Shepparton, with tenure lengths, demographic profiles, and flood experiences that ensure a sufficiently rich basis for descriptive analysis and prioritisation.

3.5 Data analysis

For the quantitative data analysis, the RII was adopted, which is a nonparametric technique for prioritising factors based on stakeholder perception. It is also one of the most common techniques in disaster management and construction research. The RII method has been adopted because it easily transforms ordinal Likert-scale responses into comparable numerical values for the purpose of ranking barriers and strategies transparently. The analysis stage permitted a structured overview of variables such as respondent age, housing type, past flood exposure history, and prior awareness or application of retrofitting methods. To strictly rank the relative relevance of barriers and the importance of suggested enabling mechanisms to FRR, this study employed the RII method. Applying RII added a comparative dimension to stakeholders' perceptions, and interpretations, it converted subjective judgments into numerical measures that are directly translatable to decision-making procedures and policy styles. As a non-parametric evaluation method, RII is well-suited for ordinal data derived from Likert-scale instruments and has been extensively applied in prioritisation studies in disaster management and construction practice. The five-point Likert scale responses for all strategy and barrier items were scored (from 1 = Strongly disagree/Not important to 5 = Strongly agree/Highly important). The values of RII obtained are in the range 0 to 1, with higher values representing greater perceived relevance or importance. RII scores were derived as follows:

$$RII = \frac{\sum W}{A \times N}$$

Where:

- w is the weight given to each response
- A is the maximum score possible (A=5)
- N is the number of respondents (28 respondents)

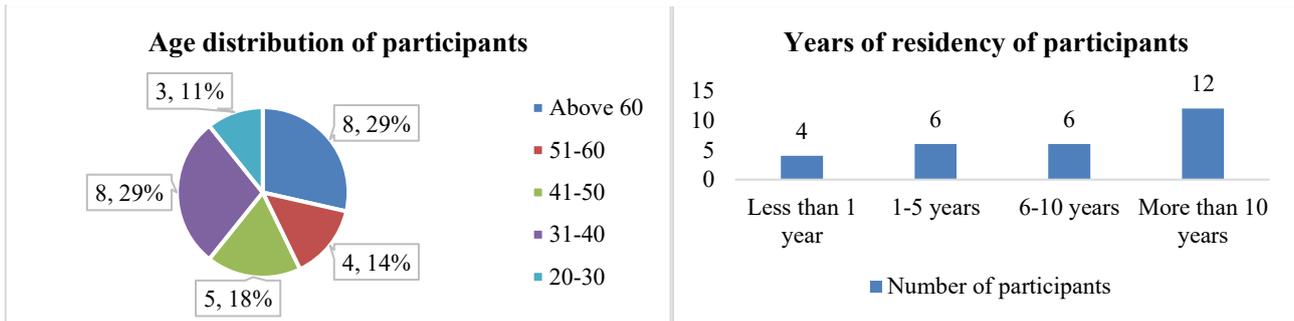
This method ensures clarity of ranking among the factors and helps to identify the most influential barriers for adoption and most preferred enabling strategies. The analytical strategy therefore improves methodological rigour by standardising the processes through which household perceptions were summarised and compared.

4. RESULTS

4.1 Demographics of participants and exposure to floods

Of the 28 households surveyed in Shepparton, 31-40 years and above 60 years were the most common age range (29%), with 41-50 years being the next highest (18%). 43% of them had been in their properties for more than 10 years, with the rest being evenly distributed in less than 10 years' tenure, as in Figure 2 below.

Figure 2: Age distribution and years of residency of the participant group.



71% of participants reported experiencing riverine flooding, with 80% of these reporting multiple occurrences in the last 10 years, as in Figure 3 below. 68% stated their properties were in floodplains, while 18% of them were not aware of it, supporting their physical exposure. Yet, 54% acknowledged FRR techniques, but merely 21% (6 properties) acknowledged undertaking any retrofitting measures. These statistics explain a seeming discrepancy between risk exposure, consideration, and action.

Figure 3: Experience and frequency of riverine flooding impacts on homes.



4.2 Barriers to flood-resilient retrofitting of residential properties

The respondents were asked to indicate the degree of relevance of a series of barriers that have been identified through a systematic review and others that they would suggest in addition to the listed barriers on a five-point Likert scale. The RII method was used to rank these barriers. Figure 4 below indicates the ranked barriers in terms of RII values. To facilitate interpretation, we categorised RII scores across three levels of salience based on absolute cut-offs with the 5-point Likert scale: high for $RII \geq 0.80$, moderate for $0.60 \leq RII < 0.80$, and low for $RII < 0.60$. This straightforward scheme is transparent and consistent across barriers.

The four most relevant barriers were:

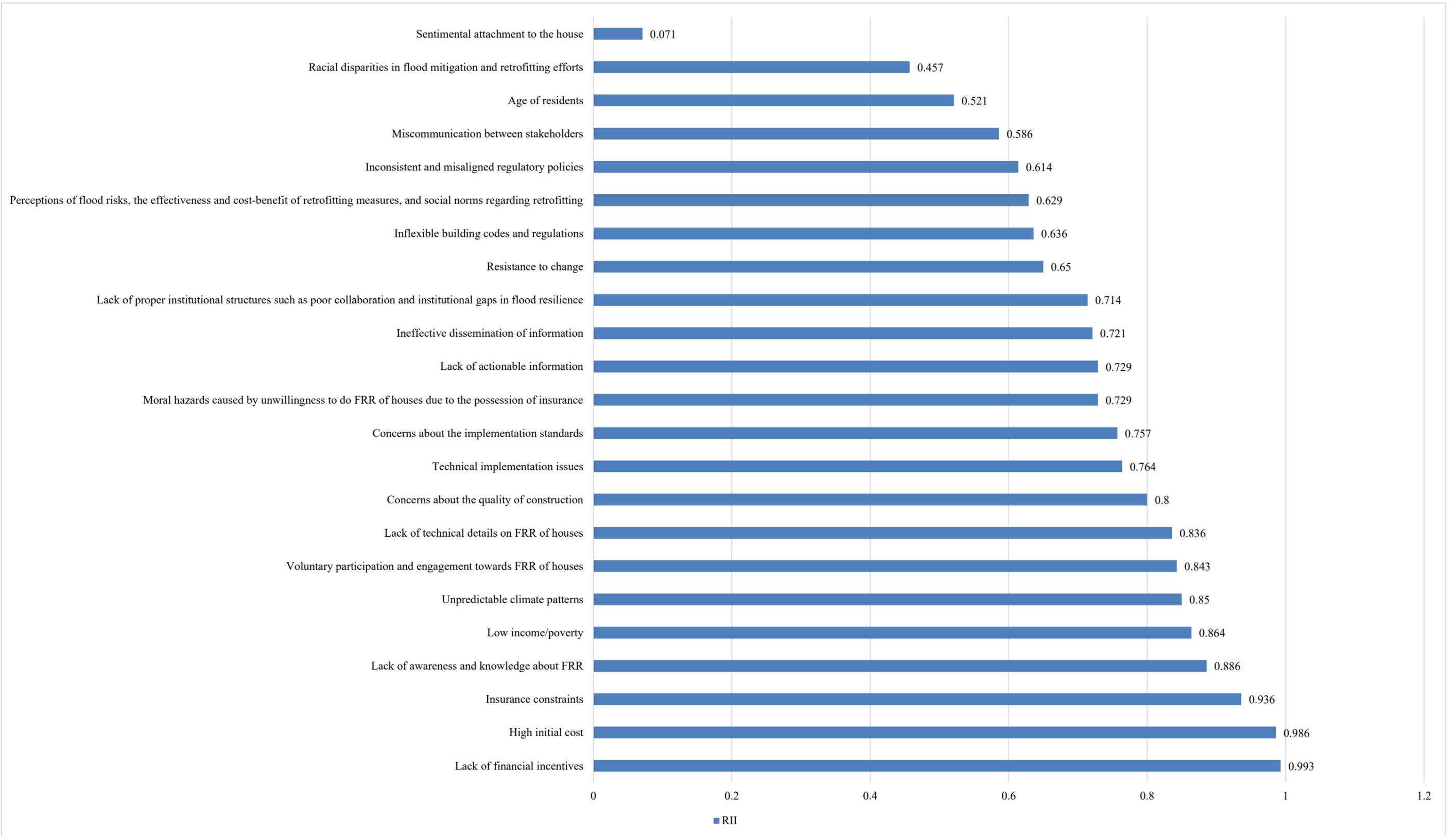
1. Lack of financial incentives (RII = 0.993)
2. High initial costs (RII = 0.986)
3. Insurance constraints (RII = 0.936)
4. Lack of awareness and knowledge about FRR (RII = 0.886)

The least relevant barriers were:

1. Sentimental attachment to house (RII = 0.071)
2. Racial disparities in flood mitigation and retrofitting efforts (RII = 0.457)
3. Age of residents (RII = 0.521)
4. Miscommunication between stakeholders (RII = 0.586)

These findings emphasise that financial constraints are still the main bottleneck, deterring homeowners from retrofitting their buildings on a voluntary basis. Regulatory and technical barriers, such as lack of guidance and builders' lack of understanding, were scored moderately. Social and demographic factors, including older householders and racial disparities, were relatively less relevant but essential in inclusive policy development.

Figure 4: RII analysis of barriers.



4.2.1 Financial barriers

Financial constraints are the dominant barriers among all the categories. Lack of financial incentives is the highest ranked barrier, followed by high initial costs ranked second and insurance constraints ranked third. Low income/poverty also comes out as a significant constraint. Insufficient or uncertain awareness of insurance for retrofits is perceived by households, diminishing the economic argument for executing works. Together, the findings indicate initial affordability as the primary household action bottleneck.

4.2.2 Technical barriers

Technical barriers have been ranked at moderate to higher levels (8-11). Lack of technical details on FRR of houses is the highest ranked barrier in this barrier category, followed by concerns about the quality of construction, ranked ninth and technical implementation issues, ranked tenth. Concerns about the implementation standards is the lowest ranked barrier in this barrier category. These rankings stated that even though they are in the middle of the ranking list, while less central than affordability, technical know-how remains a vital barrier to action.

4.2.3 Regulatory barriers

Regulatory barriers score moderate rankings overall (15th, 17th and 19th). Lack of proper institutional structures, such as poor collaboration and institutional gaps in flood resilience, is the highest ranked barrier in this barrier category, followed by inflexible building codes and regulations ranked seventeenth. Inconsistent and misaligned regulatory policies is the lowest ranked barrier in this barrier category. These rankings depicted that although regulation may be a barrier for some households, it is not as decisive as monetary barriers.

4.2.4 Social, behavioural, and cultural barriers

A considerable variation in ranking can be seen in these barriers, which are ranked from lower to higher (4th, 7th, 12th, 16th, 18th, 21st, 22nd, and 23rd). Lack of awareness and knowledge about FRR is the highest ranked barrier in this barrier category, followed by voluntary participation and engagement towards FRR of houses ranked seventh and moral hazards caused by unwillingness to do FRR of houses due to the possession of insurance ranked twelfth. Both resistances to change and perceptions of flood risks, the effectiveness and cost-benefit of retrofitting measures, and social norms regarding retrofitting have moderate rankings. Age of residents, racial disparities in flood mitigation and retrofitting efforts, and sentimental attachment to the house is the lowest ranked barriers when considering all barrier categories. Cumulatively, then, these findings suggest that even if socio-behavioural barriers of vast range of salience, awareness and voluntary participation shortfall, insurance-related moral hazard types are most expensive, resistance to change and risk/benefit balance have only intermediate effect, and demographic characteristics or affective identification are least restrictive, thus most rewards will most likely be derived from information and participation programmes that target. Consequently, the highest short-run returns are expected from targeted information and participation campaigns that close awareness gaps and moderate insurance-related moral hazard. At the same time, demographic and sentimental factors appear incidental in this context.

4.2.5 Environmental and climatic barriers

Unpredictable climate patterns, which is the only stated barrier under this category, score a higher ranking (6th). Therefore, its salience reflects the fact that perceived climatic riskiness is a cross-cutting constraint that raises uncertainty about retrofit adoption, adding to the need for risk-informed guidance and adaptive program design.

4.2.6 Communication barriers

Communication barriers score lower to moderate rankings overall (12th, 14th and 20th). Lack of actionable information is the highest ranked barrier in this barrier category, followed by ineffective dissemination of information, ranked fourteenth. Miscommunication between stakeholders is the lowest ranked barrier in this

barrier category. Accordingly, the main leverage point is to produce locally actionable guidance and extend dissemination channels, as inter-stakeholder miscommunication appears relatively marginal in this case.

4.3 Strategies to overcome barriers to flood-resilient retrofitting adoption of residential properties

The respondents were asked to indicate the degree of importance of a series of strategies that have been identified through the literature and others that they would suggest in addition to the listed strategies on a five-point Likert scale. The same RII method was used to rank these strategies. To facilitate interpretation, the same categorisation of RII scores across three levels of salience; high, moderate, and low, was done as described in the barriers analysis. Figure 5 below indicates the ranked strategies in terms of RII values.

The four most important strategies were:

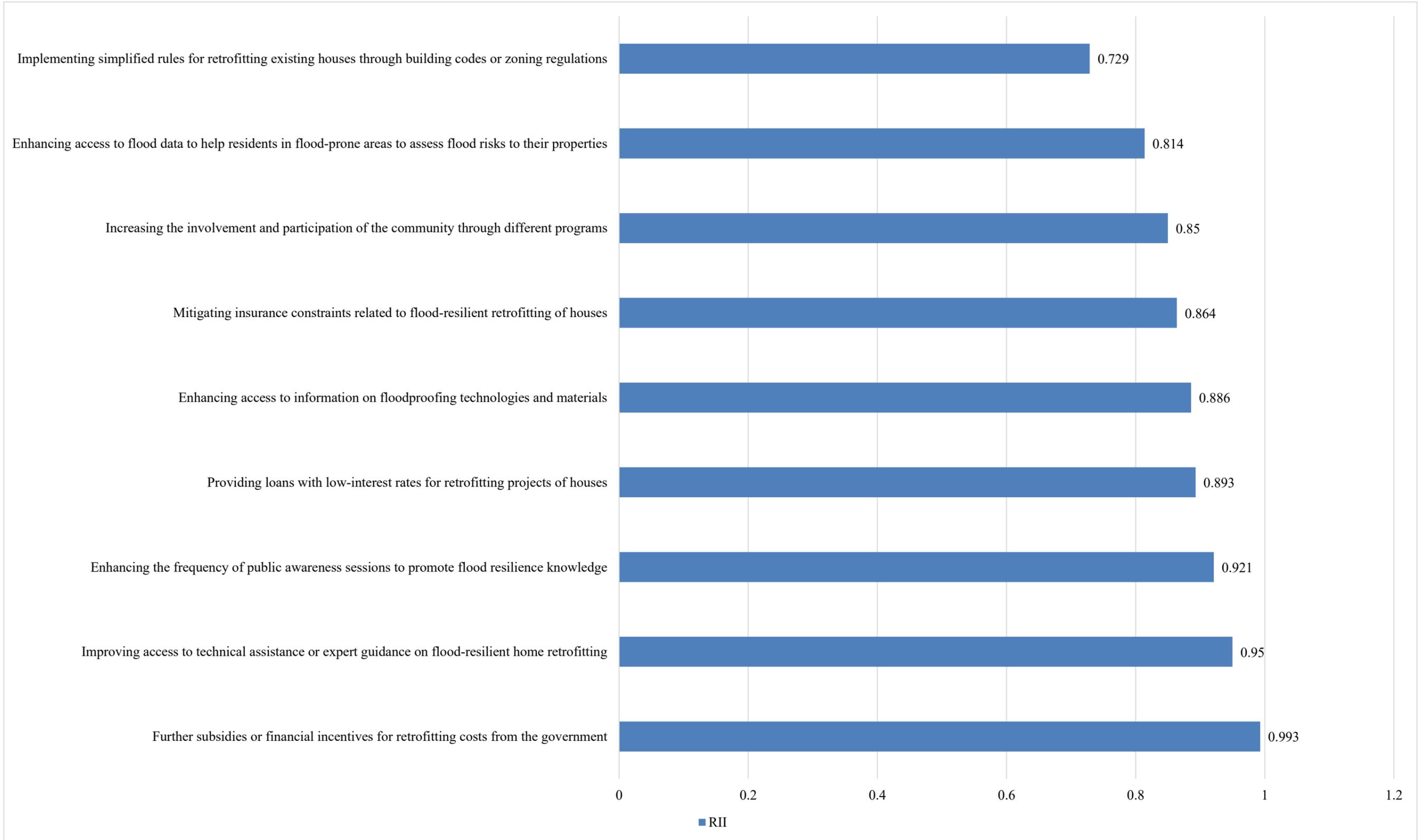
1. Further subsidies or financial incentives for retrofitting costs from the government (RII = 0.993)
2. Improving access to technical assistance or expert guidance on flood-resilient home retrofitting (RII = 0.950)
3. Enhancing the frequency of public awareness sessions to promote flood resilience knowledge (RII = 0.921)
4. Providing loans with low-interest rates for retrofitting projects of houses (RII = 0.893)
5. Enhancing access to information on flood-proofing technologies and materials (RII = 0.886)

The least important strategies were:

1. Implementing simplified rules for retrofitting existing houses through building codes or zoning regulations (RII = 0.729)
2. Enhancing access to flood data to help residents in flood-prone areas to assess flood risks to their properties (RII = 0.814)
3. Increasing the involvement and participation of the community through different programs (RII = 0.850)
4. Mitigating insurance constraints related to FRR of houses (RII = 0.864)

These figures emphatically show that financial and information support are the most important strategies from the household perspective. Insurance reform and regulatory ease were also favoured, although by fewer RII values.

Figure 5: RII analysis of strategies.



Government subsidies/financial incentives for the retrofitting costs are the top-ranked strategy important for FRR adoption. Low-interest loans are also highly ranked, showing their greater importance for the adoption of FRR (rank 4th). Both results mirror the ranking of barriers and indicate a strong household preference for direct affordability levers. Therefore, the integration of grants and low-interest loans is the most apparent way of bridging cost barriers and releasing residential retrofits. Increased access to technical support/specialist advice is ranked the second highest. Availability of information on flood-proofing technologies and products is also ranked high (5th). This highlights the critical role of sound, practical "how-to" advice in conjunction with finance for the adoption of FRR in existing housing. Therefore, providing on-call technical advice and clear product/measure guidance that translates willingness into practical, quality-assured FRR upgrades should be provided for households.

More public awareness sessions are the third highest on average. More community participation/involvement is of relatively high importance (rank 7th), which means households recognise a place for regular outreach to build salience and normalise retrofitting. Therefore, frequent, locally organised outreach and involvement programs keep risk in perspective and make retrofitting a routine option. Implementing simplified rules for retrofitting existing houses through building is categorised with a moderate RII value than financial/technical strategies (rank 9th), suggesting permits are significant but not considered to be the primary lever for many families. As such, pre-approved retrofit packages and permit packages remove process friction without requiring an across-the-board regulatory overhaul. Decreasing insurance limitations related to FRR is categorised with a higher RII value (rank 6th). Expanding availability of flood-risk information is also categorised with a relatively higher RII value (rank 8th). Both are ranked as positive, but less tangible than explicit funding and hands-on guidance. As such, open premium discounts for certified retrofits and easy-to-use property-level flood maps bolster the case to act, along with financing and advice.

5. DISCUSSION

These RII outcomes provide a straightforward ranking: insufficient financial incentives and high initial cost are the most restrictive factors combined, closely followed by insurance limits and knowledge/awareness gaps; income restrictions are also significant, but institutional/social are lower down on average (though not insignificant) for Shepparton families. Financial constraints were the most significant barrier to emerge, supporting findings from existing research (Barendrecht et al. 2020; Hartmann et al. 2019; Kousky and Kunreuther 2018; Price and Dupont 2023; Silvis et al. 2024). The very high RII for lack of incentives, cost of retrofitting, and low income/poverty shows a policy imbalance and ground-level unaffordability. The median weekly household income for 2021 is AU\$1369 (Greater Shepparton City Council 2024), and the unemployment rate is 4.9% as per the 2021 census (Greater Shepparton City Council 2025a). These figures confirm the ranking of cost barriers, as they are not financially capable enough to adopt FRR. This also depicts the absence of special funding mechanisms for the adoption of FRR in existing housing in regional suburbs like Shepparton. This lends strength to the argument that financial levers are critical in the adoption, especially in older, low-value housing areas built before strict flood regulations or codes. This demonstrates that citizens highly prefer government-triggered support. Interestingly, families then identify direct subsidies, technical support, awareness-raising, and low-interest credit as the most critical strategies, exactly the levers that address near-term cost salience and implementation risk. According to Athauda et al. (2025), the programmatic argument: concessional, targeted public incentives, grants and vouchers have successfully steered overseas private capital at the scale of property, instead of depending on big-scale defences.

Households identified insurance constraints as one of the highest barriers. Without easy, verifiable premium credits and easy verification for demonstrated FRR, the financial capability is too weak to encourage investment, particularly where payback is in doubt. The literature refers to insurance's ability to promote mitigation where program rules are clear and consistent (e.g., community rating systems, risk reduction grants) (Athauda et al. 2025). Moreover, insurance coverage has the ability to significantly increase community resilience, conduct adaptation, and provide incentives for the adoption of flood protection and loss-reducing measures (Priest et al. 2016). Therefore, it is essential to identify necessary insurance reforms for Shepparton households to reduce insurance constraints and promote FRR adoption.

Though less severely ranked than fiscal issues, barriers such as lack of technical details on FRR of houses and technical implementation issues reflect a higher systemic deficiency in institutional support. Even in flood-risk neighbourhoods with a known risk history, residents remain unaware of retrofitting practices, funding streams, or qualified contractors. This is in line with current studies on disaster readiness that highlight the

impact of intermediaries (Barendrecht et al. 2020; Laska 1986). Galvin and Sunikka-Blank (2014) argued that if technical details about FRR were sufficiently explained to the households, more homeowners might help with flood mitigation efforts by modifying and flood-proofing their properties. Therefore, the state governments should provide greater technical assistance to local governments so they can generate flood details, evaluate risk and support the communities to identify the necessary retrofitting measures to floodproof their homes (Wenger 2013).

Though most of the social barriers were weaker in the RII, qualitative returns from participants have subtle nuances. Older homebuyers were slow to commit based on physical barriers and adverse perceptions of long-term returns. Voluntary participation and engagement towards FRR of houses and racial disparities in flood mitigation and retrofitting efforts are also identified by Shepparton residents as barriers for FRR adoption, which are also highlighted in the existing literature (Gordon and Yiannakoulis 2020; Messenger et al. 2021; Zinda et al. 2023). Even if "age/language/miscommunication" are overall lower, the mix of older residents and migrant families in country towns requires culturally attuned provision: translated documents, home-visit advisory service, and simplified grant application forms. The trends suggest that though money is valuable, it must be supplemented by socially based delivery mechanisms, presumably involving local councils, multicultural outreach services, and champions within the community. Successful campaigns should be locally context-dependent and delivered via trusted intermediaries (councils, community organisations, multicultural organisations), rather than mass messages.

Communication barriers ranked low to moderate. Lack of actionable, localised information ranks above miscommunication between stakeholders. In practice, households should be provided with clear property-type-specific guidance that converts their interest into a FRR adoption plan. Wenger (2013) elaborated that in order to assess their risk and make the best retrofitting choices, homeowners must have access to precise, fine-scale data regarding floods. These communications should be conducted through trusted channels, such as councils, community organisations, and multicultural associations and in multiple languages. Unpredictable climate patterns feature a relatively high rank barrier. To demonstrate how the climate is changing, government organisations should make sure that more thorough flood maps are available and that updates are released more frequently (Kousky and Kunreuther 2018; Wenger 2015). Therefore, governments should design the FRR adoption initiatives with a focus on changing climate requirements. Regulatory barriers are ranked from lower to moderate. Although households perceive misaligned or inconsistent regulations and approval uncertainty, they do not see them as the primary barriers compared to affordability. However, to remove regulatory obstacles to flood-proofing homes, local governments must implement more vigorous enforcement of building rules and land-use restrictions (Kousky and Kunreuther 2018). Wenger (2013) also argued that in locations that are vulnerable to flooding, state and territorial governments had to think about using more conservative planning techniques when it comes to higher floor levels, building materials, and design.

6. CONCLUSION AND RECOMMENDATIONS

This study explored why FRR remains rare in a highly exposed regional setting and what households assert would enable adoption. In the face of universal exposure to floods and non-negligible knowledge about FRR, there is low take-up, a striking knowledge-to-action gap. The rankings show a clear ordering of frictions: affordability first (lack of financial incentives and high upfront cost), followed by enabling signals and execution risk (insurance frictions and low know-how/awareness), with most institutional frictions and social/demographic factors relatively lesser drivers. Households, on their part, value a pragmatic sequence of interventions: direct subsidies, concessional finance, hands-on technical guidance, and persistent awareness, followed by supportive actions on regulatory streamlining, risk-data availability, and insurance alignment.

Currently, FRR awareness is insufficient, and a coherent household-centred program is required to make these FRR activities financially viable, procedurally straightforward, and socially attractive. Specifically, we suggest (1) low-interest, property-backed loans combined with targeted grants to overcome cost hurdles; (2) upskilling related experts to overcome the technical and regulatory barriers and provide quality; (3) pre-approved packages of retrofit and permits to reduce process drag; (4) highlight insurance credits with light-touch authentication; and (5) place-based outreach (including culturally responsive delivery) to make risk and options salient and fair. Better discoverability and validation of FRR will assist valuers and purchasers in identifying enhancements in resilience, reduced perceived payback, and facilitate a virtuous cycle of FRR adoption. Although the research sample is purposively local and discovery-driven, the ordering rationale is policy-ready and transferable to other similar flood-at-risk communities worldwide. Follow-up studies must

pilot the suggested stack through field trials (grants and guidance), monitor insurance and value impacts, measure co-benefits (e.g. reduced downtime), and assess expert-capacity programs. Without it, legacy housing will be a liability during climate-magnified floods; with it, families can transition from awareness to resilience at scale.

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