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Neighbourhood Social Resilience (NSR): Definition, Conceptualisation, and Measurement Scale Development

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Received: 1 July 2020; Accepted: 31 July 2020; Published: 7 August 2020



Abstract: The literature on social resilience lacks a precise definition of this concept and a clear guideline on how to measure it. Particularly, social resilience at the neighbourhood scale has received remarkably little scholarly attention. This study contributes toward filling these gaps in the literature by developing and empirically testing the neighbourhood social resilience (NSR) model as a robust and reliable measurement instrument that integrates various aspects of this complex concept into one coherent and fine-grained psychometric model. The reliability and validity of the NSR model are empirically tested using questionnaire data collected from 234 respondents in five neighbourhoods of Dunedin city, New Zealand. Furthermore, a more nuanced definition for neighbourhood social resilience is provided. Results indicate that social resilience is a second-order and multidimensional concept incorporating eight dimensions. Each of these dimensions captures a distinct piece in the jigsaw of social resilience; therefore, failure to incorporate all dimensions may provide an incomplete picture of this complex phenomenon. Our research bridges the gap between top-down approach of stakeholders and policymakers and bottom-up perceptions and expectations of residents about social resilience of their urban neighbourhood.

Keywords: social resilience; neighbourhood scale; social network; adaptive capacity; measurement model

1. Introduction

Resilience, as an umbrella term, has been studied in different disciplines and contexts and has continued to spark the interest of academics and policymakers alike. More recently, the debates around resilience have moved beyond the dominant focus on environmental and economic resilience and involve areas such as social resilience [1]. A review of the literature suggests that, despite the theoretical and practical significance of social resilience, it has remained one of the least understood and most under-researched domains of resilience [2,3].

Research into social resilience is confined by several shortcomings. First, previous studies have not converged upon a common ground for defining social resilience, and it has remained an embryonic concept [4,5]. Current definitions of social resilience are rather fuzzy and confusing, mostly disaster-focused, and conceptually blurred with the concept of community resilience. Second, the literature is scattered and confined by lack of uniformly implemented and widely accepted approach for measuring social resilience concept [6]. The existing conceptualisations and operationalisations of social resilience lack consistency in dimensions and indicators and can lead to mixed and conflicting results [7], which potentially undermine their usefulness. Part of the difficulty is attributed to

social resilience being a multi-dimensional concept [8]. There is currently little consensus on what characteristics to measure and, as in the case of disaster resilience [7], this can lead to uncoordinated measurement methods and conflicting assessments.

Third, with a few exceptions (e.g., [2]), prior studies have mainly focused on social resilience at the urban [3,9] and regional [10,11] scales or on the person or household level [12,13]. Notably, the intermediate local or neighbourhood scale has been largely understudied and some important questions about the spatial dimensions of social resilience remain unanswered [14]. There is a need for empirical evidence to explore the interdependencies between social resilience and built environment at the local level. Recent studies confirm the gap and potential contribution of geographically defined empirical assessments of locally based resilience [1,15].

Fourth, there is a disconnect between top-down scientific knowledge and bottom-up local knowledge [16]. Top-down assessment models largely neglect the role of residents' judgments in defining and measuring social resilience. Despite the plethora of resilience measurement models and tools that are promoted and used by built environment disciplines, very few have emerged from participatory and integrative approaches [17]; an even smaller number of participatory measurement models refer specifically to social resilience at the neighbourhood scale.

Finally, with a few exceptions [18,19], there has been little effort to explore the potential contribution of a robust yet flexible quantitative participatory method, such as psychometric approach for measuring social resilience. Lack of attention to quantitative psychometric studies limits the potential for large-scale participation in policymaking for social resilience. Existing models that consider the views of residents in assessing social resilience are primarily qualitative [1] or rely on descriptive statistics [20]; thus, rigorous statistical reliability and validity tests have remained out of their scope. The development of a robust and uniformly accepted psychometric measurement model for social resilience can make a strong contribution to the literature in this area and address challenges in comparing and contrasting empirical findings. Quantitative assessment is not proposed here to replace in-depth qualitative input, which is typically delivered via the workshop dialogue method [16]. Instead, quantitative input can complement and expand stakeholder participation and inclusivity whilst utilising quantitative semantics, which remain the preferred language of policymaking [21]. This is particularly relevant in countries where technocratic risk management is the established approach over informal participation [22].

This study aims to address the aforementioned gaps and extend the evolving literature on social resilience in a number of ways. First, this study examines the conceptual domain of social resilience at the neighbourhood scale and contributes to a better understanding of the main constituent elements of this complex phenomenon. We argue that social resilience is a multifaceted gestalt-like construct comprising interdependent dimensions. Each dimension may have unique implications; therefore, social resilience cannot be fully captured using any single dimension or indicator. Thus, this study acknowledges the multidimensionality of social resilience and empirically unpacks this construct. Second, we advance the literature by developing a comprehensive and psychometrically sound measure of social resilience and empirically test its validity and reliability. Third, this study is among the first few to focus on social resilience at the neighbourhood scale (as opposed to urban or regional scale), and defines, conceptualises, and develops a measurement model with respect to the particular requirements and characteristics of neighbourhood scale. Fourth, this study contributes to the literature by proposing a beneficiary-centred approach for measuring social resilience at the neighbourhood scale. This study adopts a bottom-up approach grounded in the perceptions of local residents and explicitly incorporates residents' views into conceptualisation and measurement. Finally, this study contributes to the literature by introducing a new dimension of social resilience at the neighbourhood scale that was not acknowledged in previous studies. This important new dimension that emerged from our study relates to the tolerance and acceptance of residents to diversity and their flexibility and adaptability to changes; accordingly, we labelled this dimension as "neighbourhood tolerance and adaptive capacity".

The remainder of the article is organised as follows: we begin with a review of the literature on social resilience to identify attributes of significance at the neighbourhood scale. The literature review formulates the basis for a hypothesised model for social resilience at the neighbourhood scale. The next section articulates the research design and explains the steps undertaken to use the perceptions of neighbourhood residents to transform the initial generic model into a contextually refined model—a robust and reliable measurement instrument that is empirically tested and integrates aspects of this complex concept into one coherent and fine-grained psychometric model. We then discuss the results as a prelude to the potential of the NRS model to inform built environment researchers and practitioners about the nuances of perceived social resilience in different urban settings. Finally, further contributions and limitations of the findings are considered to identify recommendations for theory and practice, as well as potential avenues for future research.

2. Literature Review

2.1. Perceived Social Resilience at the Neighbourhood Scale

Amongst the literature, studies that explore the role of empirical context in shaping people's resilience are centred primarily around the notions of community resilience (as a proxy for scale) and social resilience (as a dimension of community resilience). While theoretical debate has extensively dwelled—with no consensus—on interpretations and assessments of community resilience [23,24], social resilience has received little attention. Key definitions noted in the literature are generic and appear to have emerged in response to disaster-related risks (Table 1).

Table 1. Definitions of social resilience in key literature.

Author	Definition of Social Resilience
Adger (2000, p. 347) [25]	"the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change".
Bruneau (2003, p. 735) [26]	"the ability of social units (e.g., organizations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future earthquakes".
Kofinas (2003) (CARRI, 2013, p. 6) [24]	"Two types of social resilience: (1) a social system's capacity to facilitate human efforts to deduce the trends of change, reduce vulnerabilities, and facilitate adaptation; and (2) the capacity of a [social-ecological system] to sustain preferred modes of economic activity".
Maguire and Hagan (2007, p. 16) [27]	"Social resilience is the capacity of social groups and communities to recover from, or respond positively to, crises".
Cuthill et al. (2008, 146); Maclean et al. (2014, p. 146) [5]	"the way in which individuals, communities and societies adapt, transform, and potentially become stronger when faced with environmental, social, economic or political challenges".
Marshall et al. (2009, p. 904) [28]	"comprises four key characteristics: (1) the perception of risk associated with change; (2) the ability to plan, learn and reorganise; (3) the proximity to the thresholds of coping; and (4) the level of interest in change".
Obrist et al. (2010, p. 289) [8]	"the capacity of actors to access capitals in order to—not only cope with and adjust to adverse conditions (that is, reactive capacity)—but also search for and create options (that is, proactive capacity), and thus develop increased competence (that is, positive outcomes) in dealing with a threat".
Ross et al. (2010, p. 1) [29]	"how individuals, communities and societies adapt, transform, and potentially become stronger when faced with environmental, social, economic or political challenges".

Table 1. Cont.

Author	Definition of Social Resilience
Lyon (2014, p. 1010); Keck and Sakdapolrak (2013, p. 14) [6,30]	“the persistence of a social system, whereby the system is able to resist stresses (e.g. the loss of an industry or resource base) without altering its basic functioning or its development path”.
Kwok, Doyle, Becker, Johnston and Paton (2016, p. 198) [1]	“The resilience of the social environment—social resilience—refers to a social unit or a group to collectively cope with or respond to external stresses and disturbances resulting from social, political, and environmental changes [Adger, 2000]. By adapting Cutter’s [Cutter, 2016] framework on resilience, social resilience can be conceptualised as a process of capacity building (e.g., disaster planning), as a post-disaster outcome (e.g., rate of population retention after an earthquake), or as both a process and an outcome”.

The table excludes definitions of community resilience.

In addition, social resilience has been the focus of resilience assessments only indirectly—typically integrated in community resilience measurement models. However, to understand social resilience in relation to built environment characteristics, scale and spatiality play an important role. In this line of interrogation, the term community becomes problematic because it can represent both spatial and transpatial social systems and solidarities [31]. Moreover, the term is associated in planning discourse with difficulties in inclusive stakeholder representation, e.g., of those most vulnerable or marginalised [32]. Instead, to enable socio-spatial relevance, the physical setting of neighbourhood can be adopted.

Neighbourhoods maintain references to qualities and nuances of social groupings, as well as administrative convenience for governance and policymaking. Resilience of urban neighbourhoods play a critical role in the overall resilience of New Zealand cities, as the country is highly urbanised with 86.6% of the population living in cities [33]. A review of the literature shows that neighbourhood is an amorphous concept which has been applied to “entire suburbs, to walkable areas or, most often, to an undefined spatial area” [34], p. 59. Therefore, it is difficult to define neighbourhoods based on a set number of dwellings or spatial size, as boundary and size of neighbourhoods are context dependent and can differ from society to society. Furthermore, in some cases, neighbourhood boundaries are defined by local residents themselves [34]. Similarly, due to the dynamic nature of neighbourhoods, defining them based on pre-determined activities and functions is also problematic. Not only neighbourhood functions and activities may vary over time, but they also depend on unique contextually embedded socioeconomic, cultural, and geographical characteristics of each neighbourhood. For the purpose of this study, we follow the definition of neighbourhoods proposed by [35], p. 5: “[Neighbourhood is] the connecting spaces between individual dwellings, other structures and to the wider city system and are arenas of casual interaction as well as being a key site of the routines of everyday life”.

Although not tied to a spatial scale, research in community resilience has largely encouraged place-based considerations in the study of people’s responses to stresses and change [36,37]. Through in-depth examination of cultural and cognitive norms of communities, phenomenological concepts such as sense of place and place attachment have surfaced as contributing factors to community resilience [38]. Embedded in phenomenological and cultural studies is the consideration that alongside tangible or institutionalised realities exist subjective socio-cultural interpretations of perceived realities [39]. Physical aspects of the built environment such as spatial layout and materiality of urban form play an important role in not only reflecting cultural meaning but also shaping everyday life and social encounter in the past and present [40,41]. While there is increasing research interest in transdisciplinary understanding of “spatial cultures” and the spatiality of social life [42], current practice in production, regulation, and management of space remains largely engineering driven. By adopting approaches that focus solely on physical infrastructure, urban resilience policy and practice has largely neglected the relationship between built environment and the people and communities who inhabit it [43]. Instead, ethnographic insight can reveal the agency of space through affective, embodied, and

symbolic mediation of cultural and social meaning [44]. As Brumann et al. put it, “The way we make space calls for scrutiny, then, and not just within the confines of a specialised discipline but in all kinds of social and cultural analysis.” [45], p. 2.

To bridge this gap, Kwok et al. provide a helpful generalised framework for the distinction between *structural* and *cognitive* indicators for social resilience of communities [1]. Structural indicators refer to discrete characteristics of social groups (e.g., demographic and income structure, access to resources) while cognitive indicators include cultural and perceptual attitudes, values, and beliefs of social groups and individuals. Both structural and cognitive social resilience can be assessed top-down from the outside (e.g., by researchers, institutions, etc.) or bottom-up from the inside (e.g., residents and other involved stakeholders). In addition, the built environment can also be understood as the product of top-down “authored” planning and decision-making and bottom-up “non-authored” craft and building practice [46]. Resilience-building efforts need to acknowledge the “spatial plurality” of social environments to understand longer-term urban development processes and the ways in which the built environment can support social resilience and sustainability [47].

Bottom up knowledge and practice can inform conceptualisation of how long-term multi-generational resilience and neighbourhood life can be enabled by physical space, linking resilience to social sustainability [48]. For example, Arkaraprasertkul’s study of *lilong* houses in Shanghai uncovers “neighbourhood sense” as the most fundamental concept of the resilient traditional urban housing typology [49]. Additionally, recent studies looking at the physical and social aspects of the built environment as perceived by residents confirm the effects of urban form on social sustainability [50,51]. Bottom-up narratives are equally relevant in resilience studies due to the subjective ways in which people respond to risk and adapt to shock or change [52]. Insights from people’s experiences and needs to manage risk and recovery from adverse effects have been found to challenge assumptions about resilience as process, outcome, or strategy [53]. There are growing calls for top-down resilience planning to consider more actively residents’ views on their strengths and needs to create stronger alliances between state and civil responsibility—however, integration remains a challenge [22]. In this respect, it is interesting to explore residents’ and stakeholders’ perceptions of social resilience in relation to different types of built environment settings, e.g., neighbourhoods having different built form characteristics and infrastructural provision.

The next section reviews assessment methods and indicators that have been adopted by research and practice and highlights how these are complemented by the methods developed in this paper.

2.2. Assessment Methods and Dimensions Associated with Social Resilience

In their evaluation of resilience measurements, Gaillard and Jigyasu discuss the epistemological origins, strengths, and shortcomings of three main methods—quantitative, qualitative, and participatory assessment [21]. Due to their *modus operandi*, quantitative assessments are associated with top-down evaluations of resilience outcomes, while qualitative and participatory assessments are considered bottom-up evaluations of resilience-building processes. Gaillard and Jigyasu point out that each approach operates in a silo and ultimately suggest that hybrid methods, such as QPM (also known as participatory numbers or participatory statistics) [54] can help to bridge epistemological barriers in research and operational barriers in practice.

Perceived resilience has largely been the inquiry of qualitative, in-depth research, with only modest contributions from quantitative or psychometric studies [20]. Nevertheless, research by Béné et al. is an excellent example of how rigorous quantitative interrogation of psychometric data (e.g., residents’ self-reporting via Likert scale) can reveal new insights about resilience as a social construct [18]. Their research examines perceptions at the household level across four countries. It reveals the usefulness of comparative study and overturns assumptions; for example, it confirms the role of wealth in the recovery process but questions the universality of social capital as a positive factor. Although classified as primarily quantitative, this type of work contributes in bridging the state–local knowledge gap; it can also be applied as a more rigorous tool for QPM, if conceptualised by or in

collaboration with those working and living in the areas studied (see for example Hung et al., 2016). In this paper, the potential of quantitative psychometric studies is explored, focusing on dimensions of social resilience related to the built environment and using the neighbourhood as our scale of analysis.

Following an extensive review of the literature on social and community resilience (see Table A1), in this study social resilience is conceptualised with seven dimensions, namely sense of belonging and place attachment; participation and influence; social network, trust, and reciprocity; residential stability; local community support; social equity; and safety and security. Each dimension is associated with a set of indicators which relate to the neighbourhood built environment and the livelihood that it enables.

Sense of belonging and place attachment are concepts that reflect affective bonding that individuals or groups develop with a built, or generally biophysical, setting [44,55]. Affective bonds relate both to functional dependency as well as emotional connection and are key determinants of people's sense of place [56] which eventually influences place-related behaviour [38] and emplacement processes which unite people and place [57]. Place attachment is also enhanced by sensory properties of the built environment which are mediated by materiality and experienced through movement. Kinaesthetic perception and visual experience are qualities of the built environment which are strongly related to physical character and urban heritage and support long-term social sustainability [58].

Participation and influence refers to people's engagement, participation, and interaction in community activities and the degree to which residents feel that they can influence outcomes [59]. It has been acknowledged that participation and involvement can strengthen the social cohesion and social network within the community [60] and encourage collective action and adaptation to change [61]. Neighbourhood space can encourage participation in multifarious ways by supporting quotidian activities, embodying social memory, and enabling processional and mass participation activity in a shared material context [62].

Social network, trust, and reciprocity are fundamental elements for the formation of social capital that, in turn, has been found to support community resilience [63] and post-disaster recovery [64]. Social trust develops when social groups embrace norms of reciprocity, shared values, and participate in formal and informal networks [65]; and it is found to facilitate recovery [66]. The role of spatial cultures in supporting the formation of social networks is extensively researched from diverse disciplinary perspectives, e.g., in archaeology, anthropology, urban history, urban morphology, and space syntax [42]. Social network evolves from behavioural acts and is formed when residents "share common cognitive attributes, such as norms and trust that help them to organise and prioritise their relationships with others" [2], p. 21. At the neighbourhood scale, social network can be measured by indicators such as knowing neighbours, frequency of visiting them in their homes, trusting neighbours and exchanging favours with them, and mutual assistance and concern for neighbours [67–69]. Social network, trust and interaction among the residents is strongly linked to higher sense of belonging and residential satisfaction and lower crime and fear of crime in the neighbourhood [2,20]. Furthermore, review of the literature reveals that urban form factors of high density and land-use mix can strengthen people's social networks in their neighbourhood due to various reasons such as providing opportunities for residents to interact and develop social bonds as a result of less dependence on cars and more pedestrian activities [67,70]. It is also believed that socio-demographic factors such as homeownership and length of residence in the neighbourhood can positively influence people's social networks and interactions with each other [20,51].

Residential stability is an interesting dimension as it has been argued to have both positive and negative connotations for residents' psychological well-being depending on the economic profile of neighbourhoods. For example, residential stability may enable social cohesion [71], but it can also lead to social isolation and a feeling of entrapment in disadvantaged neighbourhoods [72].

Local community support is a form of social support, and, as such, it generally refers to material, informational and psychological resources that an individual can receive from their local network that increases their ability to cope with stress [73]. It is an important factor associated with resilience,

either received (enacted) or perceived (expected) [74] and can help individuals during the recovery process from a shock or disaster [75].

Social equity has been predominately interpreted as the equitable distribution of goods, amenities, infrastructure, and basic services [67]. Distributional equity is indirectly linked to social resilience because it facilitates social interaction and the creation of social ties [60]; as well as directly linked to resilience-building through provision or omission of resilience planning [76]. Nevertheless, equally important are recognitional (i.e., acknowledgement of injustice, diversity, and respect of different groups) and procedural (i.e., inclusivity in decision-making processes) dimensions of social equity which are found to be largely neglected by resilience strategies and policies [77].

Safety and security in the context of neighbourhoods relate to people's perception that they can live and socialise safely in their immediate environment and are protected from threats to their security [78]. The argument for security is central to urban resilience narratives in relation to multifarious threats—to society, economy, and the environment [79]. Furthermore, lack of trust and feeling of fear are considered as the two main causes of insecure social relations among citizens [80]. Social trust is defined as a risk judgement based on cultural values, rather than on notions of competency [81].

3. Methodology: Scale Development

The objective of this research is to bridge the gap in the literature by developing a psychometrically valid measurement model for neighbourhood social resilience that captures the multidimensional and integrated nature of the construct. The data for this study were collected using a household survey that was designed to capture the opinion of residents regarding various factors related to their neighbourhood. To ensure the validity of the measures, a standard multiple-step protocol was followed as recommended in the scale development literature [82,83]. Details of the five phases of scale development are discussed below.

3.1. Phase 1—Domain Specification and Item Generation

In this first phase, an initial pool of potential indicators was developed from the literature and supplemented them with additional items that emerged from focus group discussions with residents. From these, the conceptual domain of each of the seven dimensions of neighbourhood social resilience was defined along with a large pool of indicators to assess the dimensions.

3.2. Phase 2—Pilot Test and Scale Purification

The second phase of the study aimed to assess the quality of indicators and to purify the initial scale. Based on the initially identified indicators, a draft of the questionnaire was developed with a 7-point Likert scale ranging from 7 (strongly agree) to 1 (strongly disagree). The questionnaire's content and design were examined by six senior academics who were familiar with the subject area to assess the content and face validity. According to the received feedback, some overlapping and double-barrelling indicators were deleted, and the wording of some questions was modified to enhance their clarity and specificity.

Subsequently, after applying the suggested modifications, a pilot study was conducted using the revised draft of the survey with 20 participants from one of the case study neighbourhoods and asked the respondents to complete the survey and provide feedback on the design and wording. Based on the pilot study, some minor amendments were applied to improve the clarity and readability of questions, and the survey was finalised. Table 2 shows a detailed overview of the hypothesised seven-factor model that emerged from Phase 1 and 2 as well as the 46 indicators used for measuring these dimensions.

Table 2. Hypothesised Model for Neighbourhood Social Resilience.

Dimensions and Indicators
Dimension 1—Sense of Belonging and Place Attachment (SB)
SB1. I miss this neighbourhood when I'm away from it for too long
SB2. I feel like I belong to this neighbourhood ^{RE}
SB3. I feel comfortable living with people from different ethnic backgrounds in this neighbourhood
SB4. Living in this neighbourhood gives me a sense of community
SB5. I like to think of myself as similar to the people who live in this neighbourhood ^{RE}
SB6. People should be happy to say they live in this neighbourhood
SB7. I feel comfortable living with people with different religious backgrounds in this neighbourhood
SC8. Our neighbourhood has distinctive character that differentiates it from other neighbourhoods in this city
Dimension 2—Participation and Influence (PI)
PI1. I am willing to work together with others on something to improve my neighbourhood
PI2. I would like to be more involved in decisions that affect my local area ^{RE}
PI3. I have done some volunteer work in my neighbourhood within the last 12 months ^{RC}
PI4. I want to be a part of things going on in my neighbourhood
PI5. My voice and influence can play a role in shaping local decisions
PI6. I participate in social group activities in my neighbourhood (e.g., golf, church, etc.)
Dimension 3—Social Network, Trust, and Reciprocity (SN)
SN1. I know the first names of my next-door neighbours
SN2. I believe in the ability of the people in my neighbourhood to overcome a difficult situation together
SN3. I am satisfied with the level of contact I have with my neighbours
SN4. I visit my neighbours in their homes
SN5. I believe my neighbours would help me in an emergency
SN6. There is mutual assistance and concern for others in my neighbourhood
SN7. I believe this neighbourhood is a place where people from different backgrounds get on well together ^{RE}
SN8. I regularly stop and talk with people in my neighbourhood
SN9. The friendships and associations I have with my neighbours mean a lot to me
SN10. I borrow things and exchange favours with my neighbours
Dimension 4—Residential Stability (RS)
RS1. I am willing to remain a resident of this neighbourhood for a number of years
RS2. This neighbourhood is a good place for children to grow up in
RS3. Living in this neighbourhood is good for my mental and physical health
RS4. I think the future of this neighbourhood is promising
Dimension 5—Local Community Support (CS)
CS1. We have a strong and active community in our neighbourhood
CS2. I am interested in being involved in activities led by my local community group ^{RE}
CS3. My local community functions well and I have faith in their decision making
CS4. I am willing to accept changes in my neighbourhood that are likely to lead to an improvement in the quality of life (despite the risk of failure of such changes)
CS5. I am treated with dignity and respect in the community ^{RE}
CS6. When people in this neighbourhood get involved in the local community, they really can change the way that their neighbourhood is run
Dimension 6—Social Equity (SE)
SE1. Access to essential facilities (Supermarket, sundry shop/convenience store, post office, healthcare centre/doctor, bank/money machine, religious centre)
SE2. Access to recreational facilities (Sports field, park/public garden, indoor community facility, playground)
SE3. Access to educational facilities (early childhood education, primary school, secondary school)
SE4. Access to transportation facilities (public transport)
SE5. Access to socio-cultural facilities (e.g., community centre, Māori/Pacific centre kids centre, youth centre, old age centre) ^{RE}
SE6. In my neighbourhood, appropriate attention is given to people with special needs (e.g., elderly and people with disability)
SE7. Housing in my neighbourhood is affordable

Table 2. Cont.

Dimensions and Indicators
Dimension 7—Safety and Security (S)
S1. I feel safe when out and about in the neighbourhood during the day
S2. I feel safe to walk alone in the neighbourhood after dark
S3. I don't worry about crime in my neighbourhood
S4. I am not aware of crimes committed in the neighbourhood within the last 12 months
S5. I sometimes feel worried, afraid, or anxious in my daily life in this neighbourhood ^{RE}

RE: Removed during EFA. RC: Removed during CFA.

3.3. Phase 3—Sampling and Data Collection

In this phase, the revised questionnaire was used to collect data. For distribution of the questionnaire and collecting the data, the questionnaire was mailed along with a postage-paid reply envelope to 864 households located in five case study neighbourhoods in Dunedin, inviting them to participate in this study. Overall, 276 questionnaires were returned, resulting in a response rate of 31.9%. Of these, 234 questionnaires were used for further data analysis and formed the database for this study.

The five neighbourhoods selected as case studies in this research are Caversham, Opoho, Green Island, Concord, and Maori Hill. Detailed statistics about each neighbourhood, along with maps and pictures of neighbourhoods are presented in Table A2 and Table A3 in the Appendix A. The logic behind choosing these neighbourhoods is that they arguably represent the heterogeneity of urban forms in neighbourhoods in typical medium-sized cities in New Zealand. These neighbourhoods represent considerable variation in terms of urban form factors (such as housing types, residential density, occupancy types, quality of design, distance from the city centre, and land use mix) as well as socioeconomic factors (such as residents' income, unemployment rate, and homeownership). For the purpose of this research, we applied the official pre-defined boundaries of the case study neighbourhoods as identified by Dunedin City Council (Table A3).

3.4. Phase 4—Dimensionality Assessment Using EFA

The analysis performed for this study is comprised of two main phases. The analysis began by conducting exploratory factor analysis (EFA) to assess the hypothesised seven-factor model proposed for measuring neighbourhood social resilience. EFA was performed on the 46-item questionnaire, using the sample of 234 completed questionnaires. EFA does not assume any priori factorial structure and identifies the underlying relationships between measured indicators. Furthermore, EFA enables the identification and removal of items with poor reliability and psychometric properties. EFA was conducted with principal components analysis and varimax rotation in IBM SPSS Statistics 25 package and extracted the factors with eigenvalues greater than 1. EFA prompted the removal of eight indicators (identified in Table 2 with RE) due to low factor loadings or double loading, which led to a more interpretable and parsimonious solution.

Interestingly, the solution obtained by the EFA analysis revealed eight dimensions (as opposed to the hypothesised seven-factor structure) with eigenvalues greater than 1. The factor that emerged during this analysis encompassed five indicators (i.e., SB3, SB7, SN2, SN6, and CS4) related to neighbourhood tolerance for ethnic and religious diversity as well as the residents' ability to accept change and overcome a difficult situation together. Accordingly, the new dimension was labelled, "neighbourhood tolerance and adaptive capacity". Following the recommendation of [84], the reliability and validity of constructs were assessed based on Cronbach's alpha, eigenvalues, factor loadings, and the percentage of variances explained. Cronbach's alpha is a measure used to assess the composite reliability and internal consistency of the NSR measurement model. As can be seen in Table 3, the Cronbach's alpha coefficients of all eight dimensions are between 0.771 to 0.895, which exceed the

0.7 threshold value recommended by [85]. These results indicate a high degree of reliability of our composite measure and suggest good inter-item consistency. All indicators achieved a reasonably high factor loading ranging from 0.672 to 0.873 [84], and the eight-factor model explains 67.18% of the variance. Thus, the indicators measure their designated factors with an acceptable level of reliability.

Table 3. Results of exploratory factor analysis (N = 234).

	Factor Loading Range	Eigenvalues	% Variance Explained	Cronbach's Alpha
1—Social Equity (Items: SE1, SE2, SE3, SE4, SE6, SE7)	0.672–0.764	3.320	9.833	0.840
2—Social Network (Items: SN1, SN3, SN4, SN5, SN8, SN9, SN10)	0.705–0.835	7.944	11.078	0.881
3—Neighbourhood Tolerance and adaptive capacity (Items: SB3, SB7, SN6, CS4, SN2)	0.706–0.786	2.488	9.231	0.873
4—Participation and influence (Items: PI1, PI3, PI4, PI5, PI6)	0.694–0.822	2.107	7.978	0.828
5—Safety and Well-being (Items: S1, S2, S3, S4, RS3)	0.727–0.873	4.675	9.860	0.895
6—Sense of Belonging (Items: SB1, SB4, SB6, SB8)	0.740–0.841	2.007	7.527	0.874
7—Residential Stability (Items: RS1, RS2, RS4)	0.782–0.858	1.654	5.886	0.792
8—Community Support (Items: CS1, CS3, CS6)	0.775–0.835	1.336	5.789	0.771

Extraction method: principal component analysis; Rotation method: Varimax with Kaiser normalisation. KMO = 0.830; Bartlett sphericity test = 5224.007; significance = 0.000.

3.5. Phase 5—Construct Validity Assessment Using CFA

In the next step of scale development and validation procedure, confirmatory factor analysis (CFA) was performed to assess the goodness of fit of the eight-factor structure identified from EFA, as well as assess the convergent and discriminant validity. CFA analysis was conducted using the maximum likelihood estimation procedure in SPSS AMOS 25. One indicator (PI3) was excluded during CFA as it caused convergent validity issues (identified in Table 2 with RC). All the other indicators loaded significantly on the predicted dimensions. As can be seen in Table 4, the composite reliabilities (CR) range from 0.77 to 0.89, which further verify indicator reliability. A number of goodness-of-fit indices were used to assess the overall model adequacy: $\chi^2 = 950.312$, $p = 0.000$; $\chi^2/df = 1.611$, comparative fit index (CFI) = 0.924, PCLOSE = 0.365, root mean square error of approximation (RMSEA) = 0.051, Standardised Root Mean Square Residual (SRMR) = 0.060. Overall, these indices suggested that the eight-factor solution had a good fit with the data.