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Measuring urban social sustainability: Scale development and validation

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Abstract

Despite the significant role of social sustainability in the sustainable development agenda, there is a lack of research to clearly define and fully operationalise the concept of urban social sustainability. The aim of this study is to contribute to the existing literature by developing a comprehensive measurement scale to assess urban social sustainability (USS) at the neighbourhood level. We argue that urban social sustainability is a multidimensional concept that incorporates six main dimensions of social interaction, sense of place, social participation, safety, social equity, and neighbourhood satisfaction. Failure to consider each of these dimensions may lead to an incomplete picture of social sustainability. Validity, reliability and dimensionality of the USS scale are examined using factor analysis. We also illustrate the application of the USS scale by investigating the influence of quality of design, as one of the least studied factors of urban form, on different dimensions of social sustainability. The paper uses data collected from the household questionnaire survey in a sample of 251 respondents from five case study neighbourhoods of Dunedin city, New Zealand. This study provides new evidence on the significance of improving neighbourhood quality of design and its positive and significant relationship with different dimensions of social sustainability and the overall social sustainability.

Keywords

Urban social sustainability, quality of design, urban form, measurement scale, New Zealand, neighbourhood level

1. Introduction

Since the emergence of three-pillar sustainable development discourse in the 1980s – environmental, social and economic – social sustainability has always been the least defined and most vague pillar (Shirazi and Keivani, 2018). Instead of developing its own definition and sustaining its own right, social sustainability has frequently been framed as "added-on" in relation to economic sustainability (meeting basic human needs to reduce costs and increase productivity) or environmental sustainability (stewardship function of the society regarding natural resources) (Magis and Shinn, 2009). For years, the real challenge of social sustainability for researchers has been to present a clear theoretical formulation and operational definition of the concept (Dempsey et al., 2011). The cross-disciplinary and multifaceted nature of social sustainability has led to the identification of multiple, often conflicting, interpretations of the concept, including a wide range of practical, political and philosophical issues (Kyttä et al.,

2016). Review of the social sustainability literature reveals two main types of shortcomings. First, theoretical deficiencies regarding the definition and areas of coverage of the concept; and second, practical deficiencies associated with its operationalisation and incorporation into planning projects (Vallance et al., 2011).

The aim of this study is twofold. First, to address the lack of clear theoretical conceptualisation and operationalisation of social sustainability concept through developing, and empirically testing, a comprehensive and multidimensional scale for measuring urban social sustainability (USS) at the neighbourhood level. The validity and reliability of the proposed USS scale are tested through 261 household questionnaire surveys in five case study neighbourhoods in Dunedin, New Zealand. The second aim of this study is to investigate the application of the USS scale in an urban setting. Following calls for further investigation of the urban form factors that facilitate or hinder the achievement of social sustainability (Arundel and Ronald, 2017; Bramley and Power, 2009), we examine the impact of people's perception of quality of design in their neighbourhood on their perceived level of social sustainability. Quality of design is selected for the purpose of this study, as it is argued to be a critical but overlooked factor of urban form (Dave, 2011; Rani, 2012). This part of the analysis demonstrates how different dimensions of social sustainability may be promoted or weakened by the design quality of urban form in the neighbourhoods. In doing so, the possible influence of personal (socio-demographic) factors on the level of social sustainability is also controlled for.

The main contribution of this study is to develop and empirically test a multidimensional USS scale that integrates various aspects of this concept into one comprehensive model. The proposed scale can assist planners and policy makers in assessing different dimensions of social sustainability at the neighbourhood level and take action accordingly. This study also sheds light on social sustainability discourse by investigating the impact of quality of design on different dimensions of urban social sustainability that can inform the development of more liveable and sustainable environments.

The paper begins by reviewing the existing literature on social sustainability and debates about the relationship between quality of design and social sustainability. It then presents the proposed USS scale, followed by the data collection and data analysis process. This is followed by the presentation of the findings and discussion. Finally, the paper concludes by outlining some of the possible practical and theoretical implications.

2. Urban social sustainability

2.1 Fragmented conceptualisation of social sustainability

In recent years, social sustainability has gained increased attention as a fundamental component of sustainable development. However, despite the overall consensus about the significance of social sustainability in the sustainable development agenda, a common agreement on the definition and operationalisation of this concept is still missing (Vallance et al., 2011). Also,

there is still no agreement on which criteria should be considered when assessing social sustainability concept (Shirazi and Keivani, 2017; Dempsey et al., 2011).

Apart from a lack of clear definition of social sustainability, there seems to be no consensus on the perspectives and criteria that should be adopted for conceptualisation and measurement of this concept. It seems that scholars from different disciplines have conceptualised social sustainability in various ways. For instance, Sachs (1999) argues that social sustainability is grounded in three dimensions of social justice, democracy, and equality, whereas Chan and Lee (2008) suggest that social sustainability encompasses six dimensions of social infrastructure, availability of job opportunities, accessibility, townscape design, preservation of local characteristics, and ability to fulfil psychological needs. Masnavi (2007) defines social sustainability through two main dimensions of social interaction and neighbourhood satisfaction, while Thin et al. (2002) consider participation, social justice, security and solidarity as the dimensions of social sustainability.

One of the most comprehensive research in the field of urban social sustainability is the "CityForm" research project conducted by Bramley et al. (2006) in the context of British cities. Bramley et al. (2006: 16) defined urban social sustainability as "the continuous ability of a city to function as a viable, long-term setting for cultural development, human interaction and communication". Their analysis of urban social sustainability emphasises two overarching dimensions of "social equity" and "sustainability of community". Most recently, building on the "CityForm" research project, Hemani et al. (2017: 172) developed a social sustainability framework and defined social sustainability as "a combined top-down and bottom-up process for creating urban spatial forms that nurtures the 4'S', social capital, social cohesion, social inclusion and social equity".

In recent years, analysing urban social sustainability at the neighbourhood level has gained increasing attention. Chronological analysis of the dimensions of social sustainability shows there has been a shift in the level of the research (Shirazi and Keivani, 2017). While previous studies have focused more on the macro levels (region and city) (e.g. Yiftachel and Hedgcock, 1993; Burton, 2000), recent studies have mainly targeted the micro levels (community and neighbourhood) (e.g. Dempsey et al., 2012). Such chronological analysis also reveals how traditional "hard" social sustainability dimensions, such as employment and poverty reduction, are being complemented or substituted by more "soft" and intangible dimensions, such as social participation, happiness, sense of place or identity (Colantonio, 2009). Although this shift in social sustainability dimensions adds complexity to the measurement and interpretation of the concept, it reflects the changes in social needs and expectations of individuals and communities.

2.2 A working definition and conceptualisation of urban social sustainability

The body of knowledge on social sustainability is scattered in different disciplines such as economics, environmental studies, social studies and political science. Despite opacity in definition and conceptualisation, researchers from different disciplines have identified some

dimensions and variables for analysing and measuring social sustainability. In this study, our focus is on identifying the social sustainability dimensions related to the built environment. Moreover, as the definition of social sustainability dimensions depends on the level of analysis, for the purpose of this study, we narrowed down the identified dimensions to those that could be measured at the neighbourhood level. This is in line with the growing significance of neighbourhood level in the urban social sustainability studies (Shirazi and Keivani, 2017; Hamiduddin, 2015).

While, at first, social sustainability may appear to be a "concept in chaos" (Vallance et al., 2011: 342), some common themes can be found between the identified dimensions in the literature. For example, most of the researchers have identified social equity as one of the main dimensions of social sustainability (e.g. Dave, 2011; Dempsey et al., 2011). Table A1 in the online appendix shows the support that each dimension of social sustainability receives from the leading researchers in this area.

Building on an extensive review of the literature and after a thematic analysis of the identified dimensions, this study has developed a comprehensive and multidimensional measure of the most commonly stated dimensions of urban social sustainability and their associated variables. Based on the above, the following hypothesis is developed:

Hypothesis 1: Urban social sustainability is a second-order concept, comprised of seven main dimensions of social equity, housing satisfaction, social interaction, safety and security, social participation, sense of place, and neighbourhood satisfaction.

In this study, we define a socially sustainable neighbourhood as the one that provides residents with equitable access to facilities, services, and affordable housing; creates a viable and safe environment for interaction and participation in community activities; and promotes sense of satisfaction and pride in the neighbourhood in a way that people would like to live in there now and in the future. Each of the seven dimensions of social sustainability is briefly explained below:

"Social participation" is considered as a fundamental element of social sustainability associated with social cohesion and social network (Murphy, 2012). Being involved in a community, such as using recreational facilities (i.e., community centre, parks and sports fields) or being a member of a community group (i.e., church group and sport team), helps people to consider themselves as a part of that community, and therefore encourage them to have more interaction with other members of the community (Davidson, 2010).

"Safety and security" is considered as an essential prerequisite for all the positive social activities taking place in the neighbourhood (Eizenberg and Jabareen, 2017). Safety is defined as the extent to which people feel safe to enjoy moving around their environment and using facilities and amenities in their neighbourhood (Burton and Mitchell, 2006). Both actual crime rate and perceived feeling of crime can have destructive influences on achieving social sustainability in neighbourhoods (Larimian et al., 2013).

At the neighbourhood level, "social equity" is defined as an equitable access to a variety of facilities and services for people from different socioeconomic backgrounds (Dempsey et al., 2011). People, regardless of their age or physical condition, should be able to live, work and participate in cultural and leisure activities without the need for travelling too far (Smith, 2011).

"Neighbourhood satisfaction", which refers to residents' overall evaluation of their neighbourhood environment, is centred on the difference between an individual's desired and actual quality of their built environment (Grzeskowiak et al., 2003). Neighbourhood satisfaction may come under different umbrella terms such as subjective well-being, quality of life, good life, and life satisfaction (e.g. Sedaghatnia et al., 2013; Larimian, 2015).

"Social interaction" is described as the glue that holds the society together (Hirschfield and Bowers, 1997) and acts as a "social support system" (Pierson, 2016). In the absence of social interaction, residents of a community can only be described as a group of people who live their separate lives, with little or no sense of pride or attachment to their community (Dempsey, 2009). People need to live and work together and interact with each other in order for society to be considered as socially sustainable (Grillo et al., 2010).

"Sense of place" is defined as an amalgam of shared emotional contact through a sense of membership and place attachment, and feelings of having a "right to belong" (Talen, 1999: 1370). Sense of place is considered as "an integral component of people's enjoyment of their built environment" that is related to civic culture and common norms in a community (Hemani et al., 2017: 173). The premise is that if people are proud of where they live, they have stronger ties to their community and therefore are more likely to want to stay living in the neighbourhood and being involved in its continued development (Bramley and Power, 2009).

"Housing satisfaction" is defined as a balance between people's housing preferences (desires) and the actual situation of their house (Smith, 2011). Gifford (2007: 241) argues that "if the difference between your preference and your choice is great, you may be unsatisfied with your residence and it may never develop into a home". For most people, satisfaction with housing, as the largest "investment item of their lifetime", is considered a determinative part of the quality of life that can act as a "mediator" of people's feeling of well-being or happiness (Vera-Toscano and Ateca-Amestoy, 2008).

2.3 Quality of design and social sustainability

There seems to be an overall consensus on the influence of quality of design, as a key determinant of urban form, on social sustainability (Karuppannan and Sivam, 2011; Dempsey, 2009). The attractiveness of a neighbourhood is not only related to its cleanliness, but also incorporates other aspects such as design and quality of urban furniture, proper lighting, and maintenance of buildings and open spaces (Ghahramanpouri et al., 2015; Smith, 2011).

A well-designed and maintained urban environment provides a friendly and healthy atmosphere that encourages residents to come out into their environment and use their public spaces and facilities (Choguill, 2008). People feel more attached to their environment when

building configurations are properly designed and the visual appearance is good (Chan and Lee, 2008). In this regard, Arbury (2005: 90) states that "good design is required to create a sense of place, identity and community within an area, which greatly contributes to more liveable communities". Social participation has also been shown to be positively related to the quality of design. People living in neighbourhoods with a comfortable and enjoyable environment, tend to be more willing to participate in community activities within their neighbourhood (Choguill, 2008).

Urban design factors of a neighbourhood, such as the aesthetic appeal of the townscape, maintenance, and design quality of housing, contribute to residents' perceived levels of safety and security (Cozens et al., 2015; Carmona, 2010). As Cozens et al. (2005: 337) argue, "promoting a positive image and routinely maintaining the built environment ensures that the physical environment continues to function effectively and transmits positive signals to all users". More specifically, the presence of physical signs of decay and social disorder, such as litter, vandalism, or graffiti, may decrease people's feeling of constant control and surveillance over the environment (Armitage, 2017; Lewicka, 2010). This study empirically examines the relationship between quality of design and each dimension of social sustainability and the overall social sustainability. Accordingly, the following hypothesis is proposed:

Hypothesis 2: there is a significant and positive relationship between quality of design and social sustainability in residential neighbourhoods.

3. Research design

3.1 Data collection

For the purpose of this research, we designed a household questionnaire survey entitled "your neighbourhood living experience" and used it as the primary source of information for measuring social sustainability and quality of design. We argue that the best judges of the quality of a neighbourhood, are those who live in that environment themselves. Individuals' interpretations about the quality of their built environment are "issues of subjective judgement made by the perceiver", and therefore, the values placed on these factors may vary from person to person (Dave 2011, 201). Such variation cannot be adequately reflected in secondary data. In addition, secondary data sources, such as public reports or census data, are often not available at the neighbourhood level.

To ensure the content validity of the measures, the initial version of the questionnaire was analysed by the academic experts who were familiar with the topic under investigation and revised based on their comments. Prior to data collection, a pilot study questionnaire was conducted in order to check for production mistakes with the survey and assess the survey's terminology, clarity of instructions, and response formats. The pilot study was run with 20 participants from one of the case study neighbourhoods, resulting in minor amendments to wording and survey design. In this study mailed questionnaire with the distribution method of

postage-paid reply envelope is used for data collection. A total number of 864 questionnaires were distributed to residents of the five case study neighbourhoods from Dunedin, a medium-sized city for New Zealand. In total, 260 questionnaires were returned which corresponds to a total response rate of 30.1%. Of the questionnaires received, nine had missing data, resulting in a usable response rate of 29.1% (251 questionnaires). The five case study neighbourhoods are Caversham, Opoho, Green Island, Concord and Maori Hill. These neighbourhoods are selected to reflect diverse urban neighbourhood forms in New Zealand's medium-sized cities and to include a variety of different housing types, residential density, occupancy types, and land uses. Moreover, since this study controls for the potential effects of personal factors, such as people's age and gender, on their perceived level of social sustainability, the neighbourhoods are selected from different socio-demographic backgrounds. Table A2 in the online appendix presents some general information about each case study neighbourhood.

3.2 Methodology

The data analysis of this study comprises two separate and yet related parts. The first part focuses on the development of the USS scale. We followed the standard procedures recommended for scale development in the literature (e.g. DeVellis, 2016; Hair et al., 2010). In this part of the analysis, both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) are applied to shape the USS scale and to test its validity, reliability and scale dimensionality. The scale development process is presented in Figure A1 in the online appendix. The second part of the data analysis focuses on the application of the proposed USS scale in the context of urban neighbourhoods. In this regard, the relationship between design quality of urban form and social sustainability is investigated using multiple regression analysis.

3.3 Measurements

3.3.1 Measuring social sustainability

Based on an extensive review of the literature, this study identifies seven dimensions for defining social sustainability including social interaction, safety and security, social equity, social participation, neighbourhood satisfaction, sense of place, and housing satisfaction. Each of the social sustainability dimensions is defined through selected variables and each variable is associated with one question in the household questionnaire survey. Questions use a 7-point Likert scale where respondents are asked to rank their responses to a statement using one of the seven categories, ranging from strongly disagree (rating of 1) to strongly agree (rating of 7). Each of the variables for social sustainability dimensions is derived from the extant literature and previously validated surveys (e.g. Cerin et al., 2008; Bacon et al., 2012; Smith, 2011; Bramley et al., 2009; Rani, 2012). This allows us to take advantage of already validated questions enabling wider benchmarking of the results. Table 1 shows a detailed overview of the hypothesised dimensions of social sustainability and their associated variables.

Table 1. Social sustainability dimensions and measurement variables

Dimensions	Variables as asked in the questionnaire
Neighbourhood Satisfaction	NS1: This neighbourhood is a good place in which to live NS2: This neighbourhood is a good place for children to grow up in NS3: The quality of life in this neighbourhood is high NS4: People should be happy to say they live in this neighbourhood NS5: Living in this neighbourhood is good for my mental and physical health
Sense of Place	SOP1: I miss this neighbourhood when I'm away from it for too long SOP2: I feel like I belong to this neighbourhood SOP3: Living in this neighbourhood gives me a sense of community SOP4: I like to think of myself as similar to the people who live in this neighbourhood SOP5: I am willing to remain resident of this neighbourhood for a number of years
Safety and Security	SS1: I feel safe when out and about in the neighbourhood during the day SS2: I feel safe to walk alone in the neighbourhood after dark SS3: I don't worry about crime in my neighbourhood SS4: I am not aware of crimes committed in the neighbourhood within last 12 months
Social Equity	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)
Social Interaction	SI1: I know the first names of my next door neighbours SI2: I am satisfied with the level of contact I have with my neighbours SI3: I visit my neighbours in their homes SI4: I believe my neighbours would help me in an emergency SI5: I borrow things and exchange favours with my neighbours SI6: I regularly stop and talk with people in my neighbourhood SI7:The friendships and associations I have with my neighbours mean a lot to me
Housing Satisfaction	HS1: Housing in my neighbourhood is affordable HS2: I am satisfied with the size and condition of my house
Social Participation	SP1: I am willing to work together with others on something to improve my neighbourhood SP2: I participate in activities in a social group in my neighbourhood (e.g. golf, church etc.) SP3: I have done some volunteer work in my neighbourhood within the last 12 months SP4: We have a strong and active community in our neighbourhood SP5: I want to be a part of things going on in my neighbourhood

3.3.2 Measuring quality of design

Building on previous studies, we measure the quality of design of a neighbourhood based on the respondents' perceptions of five selected variables in their particular built environment. The measurement variables of quality of design include: satisfaction with attractiveness of neighbourhood (e.g. landscaping, views); satisfaction with maintenance of homes and yards; satisfaction with cleanliness of neighbourhood; satisfaction with the street lighting in the

neighbourhood; and perception of vandalism, graffiti, and deliberate damage to public spaces and facilities (Rani, 2012; Smith, 2011; Clifton et al., 2008; Arundel and Ronald, 2017). Each of these variables is linked to one question in the household questionnaire and respondents are asked to rank their responses in a 7-point Likert scale. We validate our measure using factor analysis. The variables load on one factor with a high eigenvalue and high explained variance ($R^2 = 0.57$). Results indicate that the factor loadings for all variables are significant (ranged from 0.73 to 0.80). Construct reliability is examined using Cronbach's alpha which exceeds the 0.7 threshold value (α=0.81) (Hair et al., 2010), demonstrating high inter-item consistency reliability.

4. Results

4.1 Modelling urban social sustainability

4.1.1 Exploratory Factor Analysis (EFA)

In this study, an exploratory factor analysis is conducted to examine the hypothesised social sustainability factorial structure (Figure 2) and uncover the number and nature of underlying dimensions associated with the observed variables (Hair et al., 2010). Following the procedure recommended by Hair et al. (2010) and DeVellis (2016), we assessed the dimensionality of the USS scale and refined the item pool. The variables that either display a low factor loading (< 0.5) or substantial cross-loading (with factor loading > 0.32 in more than one dimension) are sequentially removed to ensure a stronger measurement scale. As a result of this procedure, five variables with low factor loadings are eliminated as they deem to be poor measures of their underlying dimension. Also, three variables are eliminated from the scale due to unacceptable cross-loading.

Table 2 presents the EFA factor loadings, percentage of variance explained, and factor reliabilities (i.e., Cronbach's alpha values) for the refined scale. As can be seen, the loadings of all the variables are acceptable, with none of the loadings being bellow 0.5 (Hair et al., 2010). Factor loading shows the importance of each variable in explaining its underlying dimension. The higher the factor loading for a particular variable, the more reliable that variable in explaining its associated dimension. The results of reliability analysis indicate that all the dimensions have Cronbach's alphas higher than the accepted threshold of 0.7, except for the dimension of sense of place with Cronbach's alphas of 0.69 which is close enough to the threshold to be acceptable (Hair et al., 2010).

Table 2. Results of exploratory factor analysis (N = 251)

Factors and items	Factor loading range	Eigenvalues	% variance explained	Cronbach's Alpha
1. Social Interaction *(Items: SI1, SI2, SI3, SI5, SI6, SI7)*	0.65 - 0.81	5.69	23.74	0.85

2. Neighbourhood Satisfaction *(Items: NS1, NS2, NS3, NS5, HS2)*	0.64 - 0.82	3.05	12.70	0.83
3. Social Participation *(Items: SP1, SP2, SP3)*	0.70 - 0.92	2.15	8.97	0.82
4. Safety and Security *(Items: SS2, SS3, SS4)*	0.74 - 0.82	1.64	6.84	0.76
5. Social Equity *(Items: SE1, SE3, SE4, HS1)*	0.56 - 0.85	1.50	6.25	0.71
6. Sense of Place *(Items: SOP2, SOP3, SOP6)*	0.71 - 0.77	1.28	5.36	0.69

Note. Extraction method: principal component analysis; Rotation method: Promax with Kaiser Normalisation
KMO = 0.801; Bartlett spherical test = 2508.615; significance = 0.000

4.1.2 Confirmatory Factor Analysis (CFA)

In this study CFA analysis is conducted to assess the factorial validity of the six-dimension model with 24 variables identified in the EFA process. In doing so, the principal component estimation procedure is conducted in AMOS software (Arbuckle, 2006). The path diagram of the factorial structure of the finalised USS measurement scale is represented in Figure A2 in the online appendix. Several indices of overall model adequacy (goodness-of-fit) exhibit a good fit of the USS scale to the data: $\chi^2 = 344.89, df = 234, p < 0.001$, NNFI=0.69, CFI=0.76, RMSEA= 0.04. All of these indices are within the accepted threshold (Hair et al., 2010) reinforcing the findings that the six-dimension social sustainability measurement scale fits the data very well. The composite reliability (CR) of each dimension is also tested in the CFA analysis. The CR of dimensions range from 0.87 to 0.62 which are all above the 0.60 threshold and further verify the reliability and high internal consistency for all the six dimensions (Bagozzi and Yi, 1988). In addition, the large and significant standardised loadings of each variable on its intended dimension provides support for unidimensionality of the model.

In addition, we performed convergent, content, and discriminant validity tests to evaluate the validity of the USS scale and to ensure that the variables are relevant and the operationalised dimensions actually measure what they are supposed to. Content validity can be ensured if the measurement model is being built based on a comprehensive review of the relevant literature (Hair et al., 2010). All of the variables and dimensions in the USS scale have been constructed from the extensive review of the literature. The pilot test, which was carried out before the actual data collection, also supports the content validity of the developed scale.

Convergent validity is evidenced by the strong and significant standardised loadings of each variable on its intended dimension. Convergent validity is accepted when factor loadings are higher than 0.5, and t coefficients are significant, i.e. higher than 1.96 (Hair et al., 2010). As can be seen in Table 2, all the variables load significantly and positively on their respective dimensions, demonstrating strong convergent validity. Finally, the discriminant validity assesses the extent to which a dimension and its variables are differentiable from another dimension and its variables (Bagozzi and Yi, 1988). Discriminant validity is approved as the factor loadings of the individual variables on their respective dimensions are above 0.50 (Hair et al., 2010) and are

larger than with other dimensions in the measurement scale. In addition, we applied the average variance extracted (AVE) test recommended by Bagozzi and Yi (1988). For all the variables, the square root of AVE for their respective dimension is greater than the correlation coefficient with any other factor which confirms discriminant validity. Overall, results indicate that the loadings of variables in the USS scale are strong and the six dimensions explain over 63.86% of the total variance, indicating a strong model fit.

4.2. The relationship between quality of design and social sustainability

The social sustainability model developed at the previous stage of analysis provides useful inputs for exploring the effects of quality of design on social sustainability. Ordinary least squares (OLS) regression modelling is applied for this part of the analysis because it is considered to be a suitable technique for providing empirical evidence on the nature and direction of the relationship between quality of design and social sustainability. In total, seven separate sets of multiple regression analyses are conducted using SPSS (version 18) to investigate the relationship between quality of design and each dimension of social sustainability and overall social sustainability. The possible effects of the personal factors, such as income category and home ownership, on each dimension of social sustainability, are also investigated. Descriptive statistics and ordinary least squares regression results are shown in Table A3 in the online appendix.

5. Discussion

This study has developed and validated a comprehensive and multidimensional measure of social sustainability at the neighbourhood scale called the USS scale. We operationalised social sustainability as a second-order concept, comprising of six dimensions of social equity, sense of place, social interaction, neighbourhood satisfaction, safety and security, and social participation. As reported above, the goodness of fit results indicates that the model fits the data well and demonstrates that six dimensions accurately represent the social sustainability concept. This result contradicts hypothesis 1 that suggested seven dimensions for social sustainability. Our results show that housing satisfaction was not strong enough to emerge as a separate and independent dimension. One of the variables of housing satisfaction, "housing in my neighbourhood is affordable" loaded under the social equity dimension. Review of the literature shows that some researchers define social equity as not just limited to access to facilities and services but also including affordable housing (e.g. Semenza and March, 2009; James, 2008). This group of researchers believe that high housing costs have a destructive influence on the overall social sustainability as it may lead to problems such as high rents, overcrowding, and poor housing stock. Therefore, loading this variable under the social equity dimension can be supported by the literature.

The other variable of housing satisfaction, "I am satisfied with the size and condition of my house", loaded under neighbourhood satisfaction dimension. This is an interesting result, as it

shows that people's satisfaction with their neighbourhood is also dependent on their satisfaction with their home. Although some studies such as Grzeskowiak et al. (2003) and Smith (2011) identify housing satisfaction and neighbourhood satisfaction as two separate dimensions of social sustainability, a group of researchers (e.g. Grillo et al., 2010; Rani, 2012; Karuppannan and Sivam, 2011) consider satisfaction with home as an indispensable part of neighbourhood satisfaction as a bigger picture. Therefore, it can be said that it is not surprising that housing satisfaction did not come up as an independent dimension, but its variables were combined with both neighbourhood satisfaction and social equity.

In addition, this study has assessed the implication of the proposed USS scale by examining the impact of quality of design on different dimensions of social sustainability and the overall social sustainability. According to the results, quality of design is significantly related to social sustainability, confirming hypothesis 2. Findings indicate that quality of design is a significant determinant of people's sense of place and neighbourhood satisfaction. This implies that people feel more satisfied with and attached to their environment when the visual appearance is good and building configurations are properly designed. This result concurs with previous literature that indicates poor townscape design practices weakens the sense of place among the residents through destroying the uniqueness of places (Chan and Lee, 2008; Bramley et al., 2009; Ghahramanpouri et al., 2015).

Results reveal that the design elements of an urban area have significant positive associations with the feeling of safety and security among residents. Previous studies have also proven that variables such as cleanliness, the absence of graffiti, and maintenance and upkeep have a positive influence on crime and fear of crime (Cozens et al., 2015; Carmona, 2010; Larimian et al., 2013). Findings also suggest that quality of design has a significant positive relationship with both social interaction and social participation. This implies that those residents who are more satisfied with the design elements of their neighbourhood, have more willingness to interact with others and participate in community activities. This finding supports previous studies (e.g. Lewicka, 2010; Choguill, 2008), suggesting that well-designed open spaces and high-quality housing are more socially and visually appealing and provide residents with more opportunities to engage with others and strengthen their social ties.

Of the six dimensions of social sustainability, social equity is the only dimension that has no significant relationship with quality of design. This insignificant relationship may be explained by the fact that social equity is more related to other urban form factors such as density and land use mix rather than being influenced by the design quality of urban form (Bramley et al., 2009; Rani, 2012). Finally, we found a significant positive relationship between quality of design and the overall social sustainability. Results of this study reinforce the prominent role of strategies to improve the quality of design in promoting social sustainability and creating neighbourhoods that people would like to live in now and in the future.

6. Conclusion

Social sustainability, as a key component of sustainable development, has been studied in various contexts and disciplines. However, the review of the literature reveals that a clear definition, conceptualisation, and operationalisation of urban social sustainability is still missing (Shirazi and Keivani, 2018; Colantonio, 2016). This study contributes toward filling this gap in the literature by operationalising the USS scale as a comprehensive measurement model for analysing social sustainability at the neighbourhood level and testing its reliability and validity using a systematic and rigorous statistical approach. In addition, this study explores the application of the proposed USS scale in an urban setting. Following calls for further empirical exploration of the impact of urban form on social sustainability (Rani, 2012; Dempsey et al., 2010), we investigated the influence of quality of design, as one of the least studied urban form factors, on social sustainability.

This paper extends our understanding of social sustainability and offers several contributions to the extant literature. From a theoretical perspective, the proposed USS scale has the potential to advance and unify the fragmented conceptualisation of social sustainability and integrate its scattered dimensions into a coherent framework. Although most of the dimensions and variables in the USS scale have been studied separately in previous studies, they have not been studied collectively. We argue that failure to consider each of these dimensions may yield an incomplete picture of social sustainability as a multifaceted and complex phenomenon. This study also addresses the lack of robustness in social sustainability measures used in previous studies, as they have rarely undertaken meticulous validity, reliability and dimensionality analyses. Future studies can use the USS scale to investigate the determinants and outcomes of social sustainability at the neighbourhood level. Such studies, to date, have received little attention and need clarification.

In addition, this study has a practical implication in that it provides a more holistic and fine-grained view of different aspects of social sustainability at the neighbourhood level. Practitioners could use the USS scale to map out the strengths and weaknesses of each neighbourhood across different dimensions of social sustainability.

One of the notable findings of this study is that, of the six USS scale dimensions, social interaction has the highest predictive power in defining urban social sustainability (23.74% variance explained) (see Table 2). This finding underscores the importance of prioritising the strategies related to increasing people's social interaction, such as empowering local neighbourhood communities and organising social events, in order to enhance the overall social sustainability in residential neighbourhoods.

This study also highlights the critical role of quality of design in promoting social sustainability of residential neighbourhoods, with having positive and significant associations with four dimensions of social sustainability as well as the overall social sustainability. These findings are particularly important as they promote the assertion that "urban form beyond density

does matter" (Arundel and Ronald, 2017: 47). It seems that previous studies have mainly focused on density and land-use mix, as dominant measures of urban form (e.g. Dave, 2011; Rani, 2012; Bramley et al., 2006), and therefore overlooked the influence of other potentially important urban form factors on social sustainability. Unlike density and land use mix strategies that are more difficult and costly to implement in existing built environments, quality of design can be improved with a limited budget and in relatively short time, while having a considerable impact on social sustainability.

As with any study, this paper has some limitations that provide opportunities for future research. First, a possible limitation of this study is that the data collection of household survey was restricted to the New Zealand context, which could limit the generalisability of the model to countries with similar urban context. Since urban social sustainability is influenced by cultural, social, and environmental factors, replicating this study in the context of other countries is warranted to test the generalisability of the findings.

Second, this is one of the first attempts to develop and test a measurement scale for urban social sustainability. Although we cannot claim to have fully captured all the dimensions of social sustainability, the effort has been made to develop a comprehensive scale that integrates and categorises the most commonly used dimensions in the literature under a common umbrella. In order to continue refining and improving the USS scale, we encourage researchers to undertake interviews or focus group discussions to uncover other potentially important variables that might have been overlooked in this study.

Third, as explained earlier, our review of the literature demonstrates that social sustainability is essentially a dynamic phenomenon that has evolved from traditional hard dimensions to more soft and intangible dimensions over time (Shirazi and Keivani, 2018; Colantonio, 2009). In this light, we argue that a static and cross-sectional research design may not fully capture the complexities of social sustainability concept and its comprising dimensions. Therefore, the current study can be extended by adopting a longitudinal study approach to explore the dynamism and the trajectory of evolutions in social sustainability over time.

Finally, in assessing the relationship between quality of design and social sustainability, we encourage future research to apply a mixed-methods approach. Adopting a qualitative research along with quantitative data analysis provides further insights into why, how, and under what conditions quality of design may enhance people's perceived levels of social sustainability and their quality of life. This provides urban planners and policy-makers with a better understanding of people's perceptions and expectations of the design quality of their built environments and helps them to address these needs more effectively and efficiently in the future plans of socially sustainable neighbourhoods.

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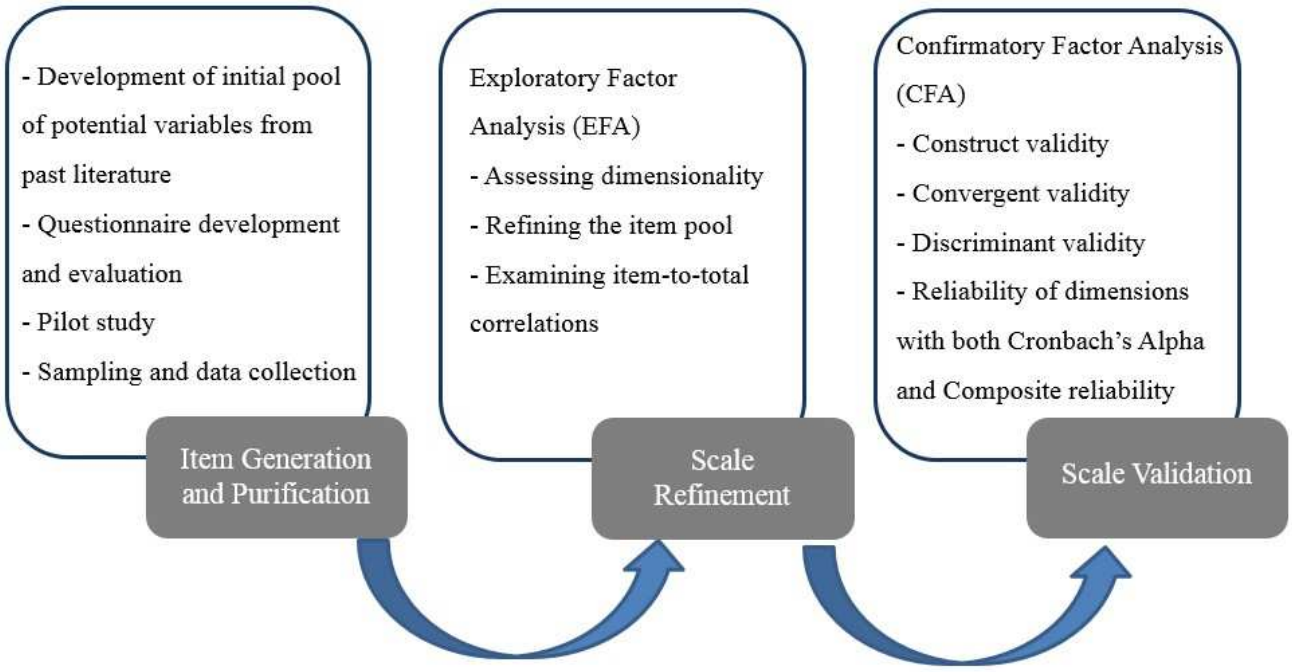

Figure A1. Different stages of using factor analysis

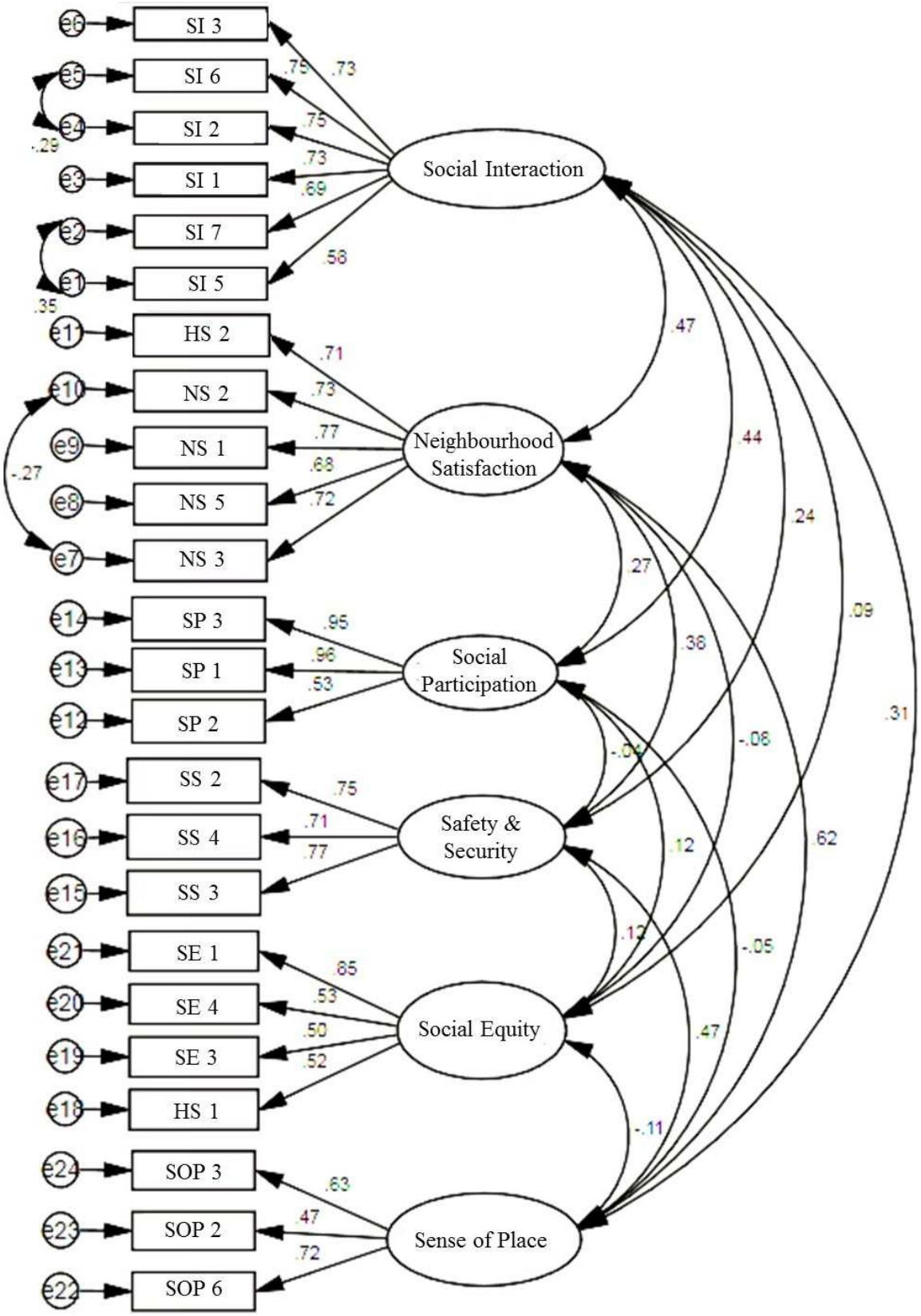

Figure A2. Factorial structure of the urban social sustainability measurement scale

Table A1. Key researchers and their viewpoints about the dimensions of social sustainability

	Social Interaction	Safety & Security	Housing satisfaction	Social Equity	Social Participation	Neighbourhood Satisfaction	Sense of place
Yiftachel and Hedgcock (1993)	✓				✓		✓
Forrest and Kearns (2001)		✓	✓	✓		✓	
Burton et al. (2003)				✓		✓	
Littig and Griessler (2005)		✓			✓		✓
Bramley et al. (2006)	✓	✓		✓	✓	✓	✓
Chan and Lee (2008)	✓	✓					✓
(Karuppannan and Sivam, 2011)	✓		✓	✓		✓	
Ghahramanpouri et al. (2015)	✓	✓	✓	✓	✓	✓	
Colantonio (2016)	✓	✓		✓	✓	✓	
Eizenberg and Jabareen (2017)	✓	✓		✓	✓		

Table A2. Socio-economic and demographic information about each case study neighbourhood

Data source	Neighbourhood	Opoho	Caversham	Green Island	Maori hill	Concord
Statistics New Zealand	Location within the city	Inner area	Middle area	Outer area	Inner area	Outer area
	Population	1,212	4,851	2,580	1,878	1,938
	Socioeconomic deprivation	3	8	6	2	6
	Number of occupied dwellings counted	480	2,094	1,065	750	744
	Unemployment rate in total population aged 15 years and over	5.8%	11.3%	5.8%	4.7%	7.2%
	Median income of total population aged 15 years and over (per person)	$30,500	$24,500	$27,800	$35,600	$28,500
Household questionnaire	Number of respondents	49	53	50	48	51
	Median age of respondents	38.3	31.6	43.8	50.2	37.3
	Home-ownership rate	67.9%	54.7%	73.7%	84.3%	76.5%

* Source: Statistics New Zealand and household questionnaire survey

Table A3. Descriptive statistics and ordinary least squares regression results (N=251)

	Mean	Std. Deviation	Social interaction	Neighbourhood satisfaction	Social participation	Safety & security	Social equity	Sense of place	Overall social sustainability
(Constant)			-0.196	-0.800*	0.856†	-0.170	0.024	-1.041*	-0.596
			(0.486)	(0.373)	(0.460)	(0.556)	(0.588)	(0.520)	(0.387)
Age group	4.23	1.72	0.100**	0.021	0.036	0.042	-0.015	0.168***	0.117***
			(0.034)	(0.026)	(0.032)	(0.039)	(0.041)	(0.036)	(0.027)
Gender	1.68	0.47	-0.041	-0.021	-0.015	-0.141	-0.078	-0.163	-0.116
			(0.114)	(0.088)	(0.108)	(0.131)	(0.138)	(0.122)	(0.091)
Income	5.53	2.28	-0.003	0.050**	-0.054*	0.107***	-0.044	0.038	0.043*
			(0.023)	(0.018)	(0.022)	(0.027)	(0.028)	(0.025)	(0.019)
Length of residence	3.21	0.87	0.086	0.070	0.198**	-0.052	0.104	0.077	0.113*
			(0.069)	(0.053)	(0.065)	(0.079)	(0.083)	(0.074)	(0.055)
Home Ownership	1.21	0.41	-0.342*	0.201†	-1.090***	-0.161	0.064	0.122	-0.252*
			(0.149)	(0.115)	(0.142)	(0.171)	(0.181)	(0.160)	(0.119)
Quality of design	0.00	1.00	0.427***	0.740***	0.163**	0.193**	-0.003	0.302***	0.604***
			(0.056)	(0.043)	(0.054)	(0.065)	(0.068)	(0.060)	(0.045)
R^2			0.331	0.605	0.399	0.122	0.018	0.233	0.576
F			20.085	62.247	26.971	5.645	0.753	12.340	55.212

Notes: Standard errors are in parentheses. Coefficients are unstandardized. † p < 0.1; ∗ p < .05; ∗∗ p < .01; ∗∗∗ p< .001.