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Built environment, urban vitality and social cohesion: Do vibrant neighborhoods foster strong communities?

Kostas Mouratidis[a,*], Wouter Poortinga[b,c]

[a] Department of Urban and Regional Planning, Norwegian University of Life Sciences, Ås, Norway
[b] Welsh School of Architecture, Cardiff University, Cardiff, Wales, UK
[c] School of Psychology, Cardiff University, Cardiff, Wales, UK

ABSTRACT

Urban vitality and social cohesion both provide multiple benefits in cities. While it has been argued that urban vitality – the liveliness of cities – may strengthen social cohesion, this has not been sufficiently examined by empirical research. This paper presents and tests a model in which urban vitality mediates the relationship between built environment characteristics and neighborhood social cohesion, using survey and geospatial data from the Oslo metropolitan area. We find that neighborhood density and land use mix are positive predictors of urban vitality, but are negatively associated with social cohesion. Green space is found to be associated with lower urban vitality, while public transport accessibility is associated with higher social cohesion. Results indicate seemingly contradictory relationships between the built environment, urban vitality and social cohesion. On the one hand, although compact urban form has higher levels of urban vitality, it has lower levels of social cohesion compared to low-density, single-use urban form. On the other hand, for similar urban form types, urban vitality is found to be positively associated with social cohesion, suggesting that local initiatives and interventions aiming to increase residents' walking and social activity within their neighborhood could also strengthen social cohesion.

1. Introduction

There has been a long tradition of research on the role of urban form in fostering social interactions and cohesion within diverse communities. This research is based on the idea that urban form has social implications, in that certain physical aspects of the built environment afford their use and as a result can facilitate or inhibit social interactions (Jacobs, 1961; Newman, 1972). This makes urban form a key aspect of what can be considered a vibrant, safe and healthy neighborhood. Over the past two decades a large number of empirical studies have been conducted that have explored links between the built environment and a wide range of social and health outcomes. This research has mainly focused on neighborhood social capital (Mazumdar, Learnihan, Cochrane, & Davey, 2018), neighborhood attachment (French et al., 2014; Poortinga et al., 2017), and physical and mental wellbeing (Renalds, Smith, & Hale, 2010).

In this paper, we will focus on the role of urban vitality in creating a socially cohesive neighborhood. Urban vitality is conceptualized and measured in this paper as "the extent to which a place feels alive or lively" (Montgomery, 1998). Urban vitality is a spatial quality "arising from a variety of unique commercial and entertainment opportunities, and a dense socially heterogeneous pedestrian population" (Maas, 1984). Vitality is therefore often associated with dense urban settings (Ye, Li, & Liu, 2018). As already argued by Jacobs in 1961, urban vitality is a prerequisite for a safe and successful city in terms of its street life. This paper explores the role of urban vitality in the development and maintenance of cohesive neighborhoods, as it provides opportunities for personal social interactions and thus may strengthen social ties at the community level (Brown & Lombard, 2014). It presents and tests a model in which urban vitality mediates the relationship between the built environment and social cohesion. Based on this model, the paper examines the different ways in which distinct built environment characteristics are linked to urban vitality and social cohesion.

The paper aims to address the following research questions: (1) *How is the built environment linked to urban vitality*; (2) *What is the relationship between the built environment and social cohesion*; and (3) *What is the role of urban vitality in the link between the built environment and social cohesion*? The paper will draw upon survey and geospatial data collected in Oslo metropolitan area. Data are analyzed with structural equation modeling (SEM). A theoretical model with urban vitality as a mediator between the built environment and social cohesion is developed, applied and assessed.

* Corresponding author.
E-mail addresses: konstantinos.mouratidis@nmbu.no (K. Mouratidis), PoortingaW@cardiff.ac.uk (W. Poortinga).

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2. Theoretical background

2.1. Built environment and urban vitality

In her seminal book on "The death and life of great American cities" (1961), Jane Jacobs argued that social interactions are the lifeblood of a vibrant city. Rather than building cities around a set of theoretical principles, planners should be sensitive to the complexities of human lives within the city to promote social and economic vitality. Jacobs (1961), and subsequently many other scholars (Buchanan, 1988; Gehl, 2011; Maas, 1984), maintain that successful places are dependent on street life and the social interactions they produce. Urban design is therefore not only about physical infrastructure, but also about the different social activities and events that occur within these places (Montgomery, 1998). Well-designed public spaces provide opportunities for a variety of casual social interactions; and it is these seemingly trivial interactions that form the social fabric of a vibrant urban life.

According to Jacobs' design theory (1961), urban vitality requires both street accessibility and building density. Maas (1984) suggested in his thesis that vitality at the neighborhood level comprises social, spatial, economic and experiential components. In particular, he considers urban vitality the synergism of relatively dense urban locales that provide a range of economic and 'gratuitous' opportunities, and a dense and heterogeneous population in terms of street life. The number and variety of amenities, including shops, cafes and restaurants, are therefore essential components in creating the conditions for attracting a population that uses the area continuously throughout the day. Low-density neighborhoods without adequate amenities may lack the footfall to provide the continuity in the presence of people and the accompanying casual social interactions needed to make a place vital. In line with Jacobs (1961) and Maas (1984), we therefore consider density a precondition for vitality and not part of the vitality measure itself. While denser neighborhoods are conducive to vitality, not all dense neighborhoods are vital.

Empirical research has shown some support for Jacob's design theory at the residential neighborhood level (Sung & Lee, 2015), in that built environment factors that can be seen to operationalize Jacobs's conditions for urban vitality are associated with pedestrian activity and other indicators of vibrancy in urban areas (Delclòs-Alió, Gutiérrez, & Miralles-Guasch, 2019; Lu, Huang, Shi, & Yang, 2019; Sung, Go, & Choi, 2013; Sung & Lee, 2015; Wu, Ta, Song, Lin, & Chai, 2018; Xia, Yeh, & Zhang, 2020; Zumelzu & Barrientos-Trinanes, 2019). Results consistently show that levels of walking activity are higher in dense and mixed neighborhoods that are close to the city center with a good public transport infrastructure (e.g. Durand, Andalib, Dunton, Wolch, & Pentz, 2011; Sallis et al., 2016); with the same built environment factors being associated with urban vitality (e.g. Wu et al., 2018). Researchers have further investigated the impacts of measures and policies that aimed to increase urban vitality. Gehl has argued that urban vitality can be promoted through pedestrianization, reduced traffic, reduced car parking and the provision of cycle lanes (Gehl, 2013). These measures will help to reclaim the streets and public spaces for the use of people rather than traffic (Pere, 2017). Some factors that determine the level of use of public space, according to Carmona (2014), are: levels of transient use; presence of local amenities; elements such as fountains, public art and public furniture; presence of grass to sit on; and microclimate. Smaller-scale community-led initiatives can also increase urban vitality and sense of community at a local level (Anderson, Ruggeri, Steemers, & Huppert, 2017).

2.2. Built environment and social cohesion

Social cohesion can be defined as the "extent of connectedness and solidarity among groups in society" (Kawachi & Berkman, 2000, p. 175); and is closely connected to the concept of social capital (Forrest & Kearns, 2001), which refers to "features of social organization, such as trust, norms, and networks, that can improve the efficacy of society by facilitating coordinated action" (Putnam, Leonardi, & Nanetti, 1993, p. 167). Social cohesion and social capital have important implications for the health and well-being of those living in cities (Kawachi & Berkman, 2000; Poortinga, 2006). Social cohesion is often measured and examined at the neighborhood level (Guest & Wierzbicki, 1999). Although neighborhood social ties seem to have become less important for highly-mobile, specialized and educated groups of people (Popenoe, 2005), they are still important for community well-being (Kawachi & Subramanian, 2007) – in particular for vulnerable groups such as older adults and economically deprived individuals (Cramm, van Dijk, & Nieboer, 2012; Miao, Wu, & Sun, 2019).

The built environment has been shown to play a role in the development and maintenance of social ties among residents (Boessen, Hipp, Butts, Nagle, & Smith, 2018). A recent literature review identified a number of consistent relationships between specific features of the built environment and social cohesion (Mazumdar et al., 2018). The study showed that access to destinations and walkability are associated with increased neighborhood social cohesion (Mazumdar et al., 2018), supporting previous relevant findings (Kwon, Lee, & Xiao, 2017; Leyden, 2003; Rogers & Sukolratanametee, 2009; Talen & Koschinsky, 2014; Wood, Frank, & Giles-Corti, 2010). The links between density and social ties are more mixed. Boessen et al. (2018) found that people living in blocks with higher population density are more likely to interact with others who live nearby. However, others showed that neighborhood density is associated with lower levels of social cohesion (Brueckner & Largey, 2008; French et al., 2014; Skjaeveland & Garling, 1997). Although urban form density may lead to more impersonal social ties at the local neighborhood level, it facilitates more frequent overall social interaction and larger overall social networks as it reduces distances between different areas of the city and increases opportunities for socializing at the city level (Mouratidis, 2018). The later finding supports Putnam's idea that urban sprawl, which brings people further apart, may decrease social activity (Putnam, 2001). The relationship of social cohesion with other attributes of the built environment such as land use mix and local amenities, urban green space and public transport has been explored less. Mixed land uses that include numerous "third places" could potentially provide space for local social interaction (Carmona, 2019; Gehl, 2013; Oldenburg, 1999). Green space may also encourage social activity and thus strengthen social cohesion according to some studies (Hartig, Mitchell, Vries, & Frumkin, 2014). Public transport is typically accompanied by walking activity of residents in their neighborhood for accessing public transport stops. This walking activity might lead to higher local social interaction and foster local social relationships, as argued by Jacobs (1961).

2.3. Urban vitality and social cohesion

One of Jane Jacobs' central claims is that more vibrant neighborhoods, i.e. those with higher urban vitality, increase casual social interaction; and it is those seemingly trivial interactions that may afford a sense of local community and social cohesion (Jacobs, 1961). While many of Jacobs' ideas on vitality have been supported by empirical research (Delclòs-Alió et al., 2019; Lu et al., 2019; Sung et al., 2013; Sung & Lee, 2015; Wu et al., 2018; Zumelzu & Barrientos-Trinanes, 2019), the suggestion that urban vitality helps improve social cohesion has not been sufficiently investigated yet. And as shown above, the links between features of the built environment on the one hand and urban vitality and social cohesion on the other appear inconsistent.

There might be a conflict between urban vitality and neighborhood social cohesion. Urban vitality tends to be higher in denser urban areas (Durand et al., 2011; Lu et al., 2019; Sung & Lee, 2015). High urban density reduces distances enabling larger overall social networks, more frequent overall social interaction and stronger support from close relationships (Mouratidis, 2018). However, these interactions may not be with people from the same neighborhood; and also more frequent

interactions do not necessarily lead to strong ties at the neighborhood level (cf. Granovetter, 1973). Denser neighborhoods may involve more impersonal interactions with a wider variety of contacts and thus be linked to lower levels of social cohesion (Brueckner & Largey, 2008; French et al., 2014; Skjaeveland & Garling, 1997; Wirth, 1938). It is therefore possible that vibrant neighborhoods may foster overall social interaction but are less socially cohesive at the neighborhood level. This is in line with work from urban sociology that argues that urbanity, while conducive to vitality, leads to impersonal social relationships and as a result lower social cohesion. Early urban sociologists claimed that urbanity and heterogeneity generates lower levels of trust, negative behaviors, impersonal social interactions and superficial relationships between residents (Simmel, 1903; Tönnies, 2002; Wirth, 1938). More recently, Sennett argued that modern vibrant urban spaces remove social contact between their users: "spaces full of people in the modern city are either spaces limited to and carefully orchestrating consumption, like the shopping mall, or spaces limited to and carefully orchestrating the experience of tourism" (Sennett, 1992). Valentine concluded that "proximity does not equate with meaningful contact" and that meaningful social interactions in cities require that issues of inequality and diversity are addressed by urban politics (Valentine, 2008).

The aim of the current paper is to provide empirical evidence on and develop a better understanding of the relationships between features of the built environment, urban vitality and social cohesion. In particular, it will examine how built environment characteristics that are conducive to urban vitality may hinder or promote social cohesion and whether and how urban vitality is linked to social cohesion. The paper will investigate these relationships by using urban vitality as a possible mediator between the built environment and social cohesion, as seen in Fig. 1. Three relationships will be examined, i.e. (a) built environment – urban vitality, (b) built environment – social cohesion, and (c) urban vitality – social cohesion, to address the three research questions listed in the introduction above.

3. Data and methods

3.1. Data sources

The study uses a population-based survey and geospatial data collected in Oslo metropolitan area. In 2019, the population of Oslo metropolitan area was around 1.5 million inhabitants; while the population of the continuous urban area of Oslo was around 1 million inhabitants. Oslo comprises a wide range of built environment characteristics and has a high diversity in urban vitality levels, thus, it is a good case for this study. Different types of neighborhood co-exist in Oslo, including low-density, single-use suburbs; medium-density neighborhoods; and high-density, mixed-use, inner-city neighborhoods.

A population-based survey with residents of neighborhoods across Oslo metropolitan area was conducted in May-June 2016. The survey was sent to residents of 45 neighborhoods that cover various locations (Fig. 2) and different urban form types (low, medium and high density). The range of built environment characteristics and urban vitality levels captured by the present study reduces concerns about omitted-variable bias (see Appendix A). The sample consists of 1344 residents aged 19–94. The target population was adult residents of all ages living in the 45 neighborhoods. A list of all the residential addresses within the postal zones corresponding to the selected neighborhoods was obtained from municipal registers. An invitation letter to fill out an online survey was sent by post to a random sample of addresses selected for each postal zone. The invitation letter as well as the online survey were written in both Norwegian and English to enable the participation of immigrants who do not speak the Norwegian language. A maximum of one member per household was allowed to take part in the study. The response rate in the survey was 13.8%, so non-response bias may be present. As seen in Table A3 in Appendix A, most of the survey sample's socio-demographic characteristics are relatively similar to those of the population, while there are certain differences in terms of level of education, immigrant status and cohabitation status. Yet, in this study, we do not investigate urban vitality or social cohesion with univariate analysis to necessitate a perfectly representative sample, but we aim to explore relationships between the built environment, urban vitality and social cohesion with structural equation models that account for socio-demographic variables. Therefore, we expect that the sample's deviations from the population will not affect the outcomes of the study in a meaningful way (Hough, Cao, & Handy, 2008). The study has been registered with the Norwegian Center for Research Data (NSD).

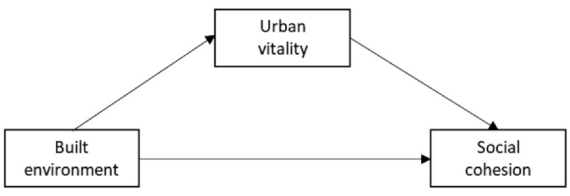

Fig. 1. Conceptual model.

3.2. Variable descriptions

Descriptive statistics for the variables of the study are presented in Table 1. Built environment characteristics were captured with geospatial data. The built environment characteristics examined in the study are: distance to city center, neighborhood density, local amenities, public transport and green space. *Distance to city center* assesses the location of the neighborhood in relation to the city center. It was measured in kilometers as the distance from the centroid of each neighborhood to the city center along pedestrian routes. *Neighborhood density* was calculated in persons per hectare as the number of inhabitants of each neighborhood divided by the area coverage. *Local amenities* were calculated as the aggregate number of cafés, restaurants, community centers, bars and pubs within a buffer of 1000 m from the centroid of each neighborhood. *Public transport* accessibility was measured using a public transport index: the total number of departures per hour from all public transport stops at peak hours within a 500 m buffer from the centroid of each neighborhood. *Green space* was assessed as the mean percentage of green space within 250 m, 500 m and 1000 m buffers from the centroid of each neighborhood. Data from Hansen et al. (2013) were used. The final analysis uses data from the 1000 m buffer measurements of green space, as these gave the optimal fit for the structural equation model.

The *urban vitality*, *social cohesion*, *socio-demographic* and *life satisfaction* variables were measured via the population-based survey (see Data Sources section above). *Urban vitality* was measured via survey respondents' evaluations of the level of liveliness in their neighborhood. This is in line with the definition of urban vitality as "the extent to which a place feels alive or lively" (Montgomery, 1998). Urban vitality was measured by asking survey participants to evaluate the following attributes of their neighborhood "liveliness", "interesting things happening" and "opportunities for entertainment" on a scale from "very low" (1) to "very high" (5). An urban vitality scale was formed based on these three items. The urban vitality scale has a Cronbach's alpha of 0.904, indicating excellent internal reliability. The *social cohesion* questions were based on the definition of social cohesion as the "extent of connectedness and solidarity among groups in society" (Kawachi & Berkman, 2000, p. 175), and measured at the neighborhood level using questions similar to previous relevant studies (Cramm et al., 2012; Fone et al., 2007; Sampson, Raudenbush, & Earls, 1997). Survey respondents evaluated "to what extent they feel that their neighbors help one another" and "to what extent they feel close to their neighbors" on a rating scale from "not at all" (1) to "a great deal" (5). A social cohesion scale was formed based on these two items. The social cohesion scale has a Cronbach's alpha of 0.896, indicating excellent internal

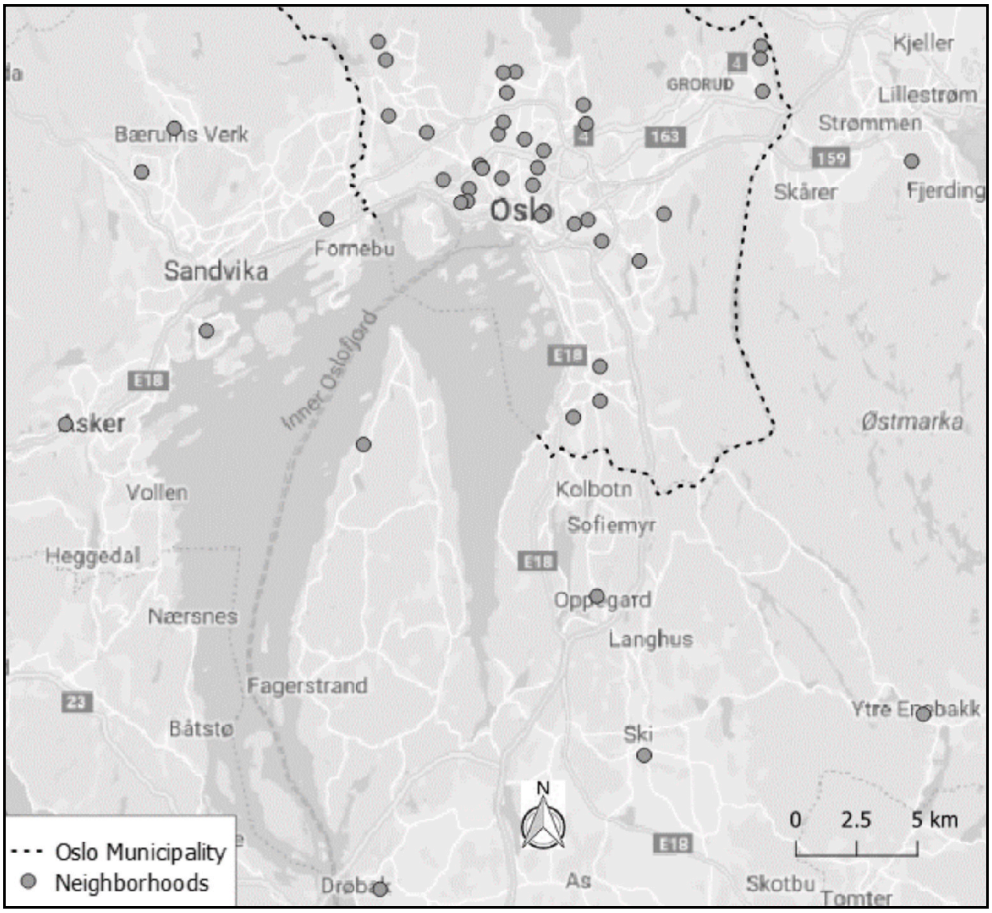

Fig. 2. Oslo metropolitan area and the neighborhoods of the study.

Table 1
Descriptive statistics.

Variables	N	Min/Max	Mean	s.d.
Social cohesion				
SC1: Feel that neighbors help one another	1,296	1/5	3.25	(1.09)
SC2: Feel close to neighbors	1,329	1/5	2.99	(1.18)
Urban vitality				
UV1: Liveliness	1,307	1/5	3.69	(1.08)
UV2: Interesting things happening	1,305	1/5	3.28	(1.10)
UV3: Opportunities for entertainment	1,309	1/5	3.24	(1.21)
Built environment				
Distance to city center (km)	1,344	0.7/46.2	10.22	(10.84)
Neighborhood density (persons/ha)	1,341	14/306	112.93	(88.04)
Local amenities	1,341	0/272	68.97	(79.98)
Public transport	1,341	0/279	115.23	(91.46)
Green space (%)	1,339	9.6/73.0	25.85	(15.04)
Personal characteristics				
Female	1,331	0/1	0.53	(0.50)
Age	1,344	19/94	50.16	(15.71)
Living with partner/spouse	1,329	0/1	0.61	(0.49)
Non-Norwegian	1,342	0/1	0.09	(0.28)
Adjusted household income (1000 s NOK)[1]	1,259	35/4330	642.2	(321.08)
College degree or higher	1,341	0/1	0.79	(0.41)
Household with children	1,334	0/1	0.32	(0.47)
Unemployed	1,339	0/1	0.03	(0.16)
Time living in dwelling	1,335	1/5	3.74	(1.33)
Additional covariate				
Life satisfaction	1,340	0/10	7.88	(1.71)

Note: [1]Annual household income divided by the square root of the size of the household.

reliability. *Personal characteristics* of the participants (socio-demographic variables) included gender, age, cohabitation status (living with partner or spouse), citizenship, household income, level of education, presence of children in the household, employment status and time living in the present dwelling. Time living in the present dwelling, which may be associated with neighborhood social cohesion (Sampson, 1988), was measured on a scale from "less than a year" to "more than ten years". *Life satisfaction* was used as an additional covariate in the analysis. Life satisfaction was measured following the guidelines of OECD (2013), asking participants "All things considered, how satisfied are you with your life as a whole nowadays?" on a scale from "extremely dissatisfied" (0) to "extremely satisfied" (10).

3.3. Statistical analysis

The study uses SEM to test the conceptual model of the research, employing AMOS (version 25) software package. AMOS is an add-on module for IBM SPSS. SEM allows detailed statistical modeling of complex relationships between variables, and is thereby used to examine pathways between the built environment, urban vitality and social cohesion. SEM can estimate direct, indirect and total effects based on conceptual models which are linked to quantitative datasets (Byrne, 2016). A structural equation model comprising both latent variables and path analysis is employed. To estimate the significance levels of the statistical effects, bootstrapping of 1000 replications is used. Cases with missing values were removed to perform bootstrapping. Therefore, sample sizes are reduced in SEM results.

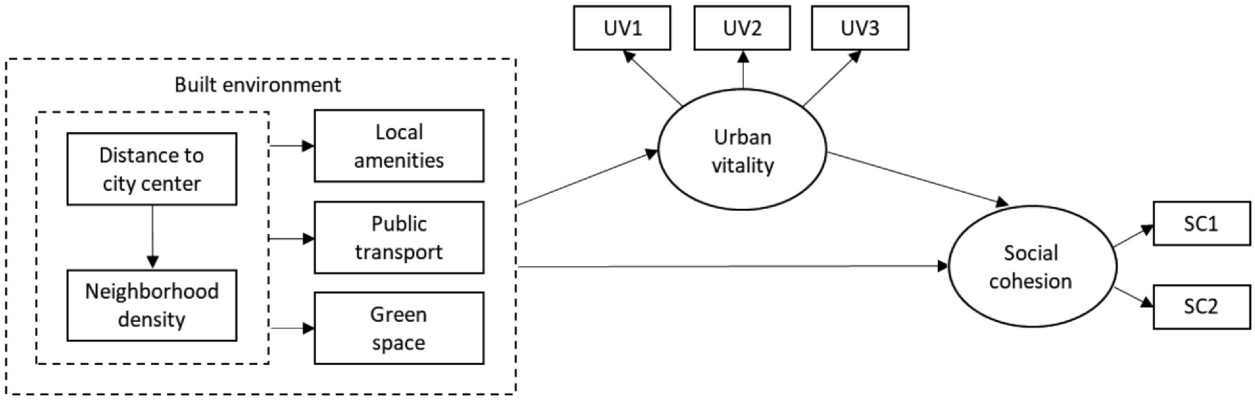

Fig. 3. Structural equation model.

3.4. Structural equation model

Fig. 3 presents the full structural equation model, examining the relationships between the built environment, urban vitality and social cohesion. The model is based on the theoretical background and the conceptual model (Fig. 1) presented in Section 2 above. Personal characteristics are also included in the model as covariates (exogenous variables) linked to the three main elements of the study: built environment characteristics, urban vitality and social cohesion, but are not shown in Fig. 3 for simplicity. The built environment characteristics that are examined in the study are: distance to city center, neighborhood density, local amenities, public transport and green space.

The placement of built environment characteristics in our model derives from previous conceptual models and empirical studies from Oslo (Næss, Strand, Wolday, & Stefansdottir, 2019; Stefansdottir, Næss, & Ihlebæk, 2019). In monocentric cities such as Oslo, distance to city center can influence neighborhood density, local amenities, public transport and green space and is therefore considered exogenous to these variables. Denser neighborhoods tend to be located closer to the city center, and denser neighborhoods tend to have more local amenities and more frequent public transport due to higher demand but less green space coverage due to reduced open space and differences in dwelling typologies (apartments versus houses with gardens). These trends are clearly observed in the neighborhoods of the study (see Tables A1 and A2 in the Appendix). Due to these trends, built environment characteristics are not all considered fully exogenous in the model. Treating all built environment variables as exogenous potentially underestimates the indirect effects of distance to city center and neighborhood density. For example, high density is a prerequisite for numerous local amenities, but not the other way around. This is why the model treats local amenities as endogenous to density. Similarly, proximity to city center (geographical centrality) facilitates access to goods, and this is why central areas tend to have more local amenities than more peripheral areas. By treating the local amenities variable at the same level as density and distance to city center (all exogenous), the model would not capture such effects. For comparative purposes, an alternative structural equation model that treats all built environment characteristics as exogenous variables is presented in Appendix B. As can be seen in Appendix B, results are comparable to the ones presented for the main model in the section that follows, with the exception of the statistical effects of distance to city center and neighborhood density, since the model in Appendix B does not capture their indirect effects via other built environment variables as does the main model of Fig. 3.

4. Results

Table 2 presents the results of confirmatory factor analysis for the urban vitality and social cohesion factors that form part of the conceptual model of the study. The standardized coefficients for the two latent variables are all > 0.8, indicating highly reliable estimates.

Table 2
Confirmatory Factor Analysis results from model in Fig. 3.

Variables	Standardized coefficient
Urban vitality	
UV1: Liveliness	0.828
UV2: Interesting things happening	0.909
UV3: Opportunities for entertainment	0.903
Social cohesion	
SC1: Feel that neighbors help one another	0.840
SC2: Feel close to neighbors	0.963

Table 3 presents the direct, indirect and total statistical effects of the path analysis for the model in Fig. 3. The values of the fit indices are CFI = 0.961 and RMSEA = 0.066, indicating good model fit. The results can be summarized as follows. The built environment factors are all interrelated, with a range of direct and indirect effects. Distance to city has a strong negative association with neighborhood density, as denser neighborhoods tend to be located closer to the city center. Both shorter distance to city center and higher neighborhood density have strong positive effects on public transport and local amenities, and strong negative effects on green space. Denser, inner-city neighborhoods tend to have more local amenities, better access to public transport, but also lower green space cover. The direct effects of distance to city center on the other built environment factors (i.e. local amenities, public transport and green space) are smaller than the indirect effects via neighborhood density.

The built environment factors are strongly associated with urban vitality. Table 3 shows that distance to city center has a strong negative association with urban vitality, while neighborhood density and local amenities both have strong positive associations with urban vitality. Green space has a negative association with urban vitality. The association between public transport and urban vitality is non-significant. The direct effects of neighborhood density and proximity to the city center on urban vitality are weaker, than the indirect effects via local amenities, public transport and green space; suggesting that an important part of the effects can be explained by the amenities available in the different neighborhoods.

Table 3 further shows that high neighborhood density and, to a lesser degree, short distance to city center are negatively associated with social cohesion. While the built environment factors of local amenities and green space are negatively associated with social cohesion, the factor of public transport is positively associated with social cohesion. Neighborhood density is both directly and indirectly associated with neighborhood social cohesion, with the direct effects being stronger than the indirect effects. For distance to city center, the total

Table 3
SEM results: standardized direct, indirect and total effects.

	Endogenous variables					
	Neighborhood density	Local amenities	Public transport	Green space	Urban vitality	Social cohesion
Direct effects						
Built environment						
Distance to city center	−0.654**	−0.109**	−0.187**	0.270**	0.076*	0.014
Neighborhood density		0.694**	0.779**	−0.504**	0.174**	−0.253***
Local amenities					0.467**	−0.248**
Public transport					−0.105	0.190*
Green space					−0.248**	−0.010
Urban vitality						
Urban vitality						0.297**
Indirect effects						
Built environment						
Distance to city center		−0.454**	−0.509**	0.330**	−0.452**	0.055[a]
Neighborhood density					0.367**	0.142**
Local amenities						0.139**
Public transport						−0.031
Green space						−0.074***
Total effects						
Built environment						
Distance to city center	−0.654**	−0.562**	−0.696**	0.600**	−0.376**	0.069*
Neighborhood density		0.694**	0.779**	−0.504**	0.542**	−0.112**
Local amenities					0.467**	−0.110*
Public transport					−0.105	0.159*
Green space					−0.248**	−0.084[a]
Urban vitality						
Urban vitality						0.297**
Summary statistics						
Squared Multiple Correlation (SMC)	0.428	0.592	0.831	0.506	0.446	0.197

Notes: [a] p < .10, * p < .05, **p < .01, ***p < .001. Levels of significance for direct, indirect and total effects are calculated with bootstrapping. Sample size N = 1110. Bootstrap replications = 1000.
X^2 = 493.860, df = 95, p = 0.000; Root Mean Squared Error of Approximation (RMSEA) = 0.062 < 0.08; Comparative Fit Index (CFI) = 0.961 > 0.93.
The model also includes personal characteristics as covariates (gender, age, cohabitation status, citizenship, level of education, household income, employment status, presence of children in household and time living in dwelling).

effect is significant, while its indirect effect is marginally significant.

The results further suggest that built environment characteristics that mainly shape vibrant neighborhoods have a negative association with social cohesion. High neighborhood densities, high presence of local amenities (high land use mix) and short distances to city center are the main contributors to high urban vitality, but at the same time they are all associated with lower social cohesion. Nevertheless, when accounting for built environment characteristics, urban vitality has a strong positive association with social cohesion, as can be seen in Table 3. Therefore, although more vibrant neighborhoods generally have lower social cohesion, for similar built environment characteristics social cohesion is higher in neighborhoods that have higher levels of urban vitality.

The model has been tested for robustness by controlling for life satisfaction. SEM results in Table 4 show that life satisfaction is positively associated with urban vitality and social cohesion; but all results remain substantially the same after controlling for life satisfaction. The standardized total effect of urban vitality on social cohesion when accounting for life satisfaction, built environment characteristics and socio-demographic variables is 0.248 (bootstrap p = 0.002), indicating that a strong positive association persists even when accounting for life satisfaction. As an additional check, the models have been tested using multi-level modelling, controlling for neighborhood deprivation (Tables C1 and C2 in Appendix C). Neighborhood deprivation was found to be non-significantly associated with both urban vitality and social cohesion and was therefore not included in the SEM model.

The models presented in Tables 3 and 4 also include personal characteristics as covariates. These results are not presented in the SEM tables to reduce complexity. Age, higher education and presence of children in the household are found to be associated with higher evaluations of social cohesion. The presence of children in the household is also associated with higher evaluations of urban vitality. Foreign citizenship is associated with lower evaluations of urban vitality and

Table 4
SEM standardized total effects on urban vitality and social cohesion including life satisfaction as covariate.

	Endogenous variables	
	Urban vitality	Social cohesion
Total effects		
Built environment		
Distance to city center	−0.373**	0.074*
Neighborhood density	0.545**	−0.107**
Local amenities	0.456**	−0.124**
Public transport	−0.099	0.154*
Green space	−0.245**	−0.086[a]
Urban vitality		
Urban vitality		0.248**
Additional covariate		
Life satisfaction	0.158**	0.232***
Summary statistics		
Squared Multiple Correlation (SMC)	0.466	0.227

Notes: [a] p < .10, * p < .05, **p < .01, ***p < .001. Levels of significance are calculated with bootstrapping. Sample size N = 1107. Bootstrap replications = 1000.
X^2 = 505.954, df = 102, p = 0.000; Root Mean Squared Error of Approximation (RMSEA) = 0.060 < 0.08; Comparative Fit Index (CFI) = 0.961 > 0.93.
The model also includes personal characteristics as covariates (gender, age, cohabitation status, citizenship, level of education, household income, employment status, presence of children in household and time living in dwelling).

lower evaluations of social cohesion. For the model in Table 4, time living in the dwelling is found to be associated with higher evaluations of social cohesion. This indicates that local social ties (or at least how they are perceived) may strengthen over time residing in a neighborhood.

5. Discussion

5.1. Discussion of the results

This study provides new evidence on the relationship between urban vitality and social cohesion. It has examined (1) the role of the built environment in urban vitality, (2) the role of the built environment in social cohesion, and (3) the links between urban vitality and social cohesion. A structural equation model with urban vitality as a mediator between the built environment and social cohesion has been developed, applied and assessed.

Findings suggest that urban vitality is mainly shaped by neighborhood density, land use mix and neighborhood proximity to the city center. Higher neighborhood density, higher presence of local amenities (indicating a high mix of residential and commercial land uses) and neighborhood proximity to the city center are all strongly associated with higher urban vitality. On the other hand, urban green space is negatively associated with urban vitality. This suggests that larger green spaces may inhibit the sense of liveliness, which can be expected when people are diffused across a large public space. It can even be argued that the lack of vitality and social interactions are some of the reasons as to why green spaces are calming and restorative (Hartig et al., 2014). The finding that neighborhood density and mixed land uses contribute to urban vitality is in line with urban design theory (Gehl, 2013; Jacobs, 1961; Montgomery, 1998) and subsequent empirical studies (e.g. Sung & Lee, 2015; Wu et al., 2018). The present study also shows that proximity to the city center is an important contributor to urban vitality indirectly via its influence on neighborhood density and local amenities. This is especially the case for monocentric cities such as Oslo. For polycentric cities, the proximity to local centers may also be expected to be linked to urban vitality.

The results further show that social cohesion at the neighborhood level is negatively associated with neighborhood proximity to the city center, neighborhood density, local amenities and urban green space, while it is positively associated with public transport accessibility. The finding that denser neighborhoods have lower social cohesion is consistent with previous empirical studies (Brueckner & Largey, 2008; French et al., 2014; Skjaeveland & Garling, 1997) as well as the systematic review by Mazumdar et al. (2018). This finding is also in line with the views from urban sociology that urbanity may result in declining social cohesion (Sennett, 1992; Simmel, 1903; Tönnies, 2002; Wirth, 1938). The finding that the presence of local amenities and urban green space are negatively associated with social cohesion at the neighborhood level is in contrast with some previous studies that find that access to stores and green space are positively related to neighbor social ties (Lund, 2003). Our finding that high presence of local amenities (mixed land uses) may play a negative role in neighbor social ties is consistent with the findings by Wood et al. (2010) who suggest that the high presence of commercial uses may attract too many external visitors and thereby inhibit the formation of local social connections. The small negative role of urban green space in neighborhood social cohesion found in the present study could be due to increased physical distances between neighbors when green space is too large. The association between public transport and social cohesion has not been explored much by previous research. The potential positive influence of public transport accessibility on social cohesion might be explained by increased walking activity of residents in their neighborhood for accessing public transport stops. Increased walking of residents within their neighborhoods may lead to higher local social interaction and foster local social relationships.

This study's findings uncover a seemingly contradictory relationship between urban vitality and social cohesion. On the one hand, neighborhood density, mixed land uses and proximity to the city center are positively associated with urban vitality, but negatively associated with social cohesion. On the other hand, for similar built environment characteristics between neighborhoods, social cohesion is higher when urban vitality is higher as seen in Tables 3 and 4. When built environment characteristics are similar, the aforementioned potential influences of the built environment are not present, but, on the other hand, increased activity by residents in their local neighborhood may lead to more local social interaction and foster local social relationships. In that case only, urban vitality is positively linked to social cohesion.

It seems that residents of dense, mixed-use, inner-city neighborhoods form more impersonal neighbor ties resulting in lower social cohesion. There are several possible explanations for this phenomenon. First, while dense inner-city neighborhoods may afford the casual interaction that make these areas vibrant that does not necessary lead to strong social ties (cf. Granovetter, 1973). Housing typologies in denser neighborhoods (usually apartment blocks) are usually less conducive to such strong ties as compared to those in lower-density neighborhoods (detached houses, duplexes, row houses). In lower density neighborhoods, residents may have more control over whom they interact with at a regular basis (Baum & Valins, 1977). City centers tend to attract a large number of external visitors who will leave the area after their visit. While this may make the area more vibrant by providing the footfall needed, it does not directly contribute to social cohesion. Inner-city residents may have more opportunities to socialize using a wider variety of local amenities, but these local interactions may be of casual nature. In contrast, residents of lower density neighborhoods are more likely to interact frequently with a smaller number of neighbors, which is necessary to establish the trust needed for social cohesion. Furthermore, suburban residents tend to stay longer in the same dwelling and neighborhood, while inner-city residents are usually more mobile and more likely to move to a new neighborhood. This longer time living in low-density suburbs may help shape stronger local social ties, as suggested by Sampson (1988) and also by the results presented above. Lower social cohesion in dense inner-city neighborhoods, however, persists even after accounting for time living in the dwelling, as results of the present study suggest. Finally, because inner-city residents may be enabled to socialize more easily with residents of other neighborhoods due to geographical centrality, they might have lower needs for local social interaction and be less engaged in forming local social bonds compared to residents of low-density neighborhoods that are further away from the city center.

It should be noted that different residents may have differing needs and preferences. Needs and preferences are shaped by, among others, background and past experiences, socioeconomic status, life stage, personality, values, goals and attitudes. According to their needs and preferences, residents may choose to live in neighborhoods that fit their preferred lifestyle. Highly dense, mixed-use, vibrant neighborhoods may not be the most suitable option for all residents in a city. A variation in the levels of density and land use mix across different neighborhoods in a city contributes to covering diverse needs and preferences.

5.2. Limitations and future research

The study has certain limitations that could be addressed in future research work. First, the analysis is based on a cross-sectional dataset, so the results represent associations and not causal relationships. It is likely that there are two-way relationships between the main variables of the study. Urban vitality may be conducive to social cohesion, while more cohesive areas may generate more vitality through more social interactions. Future studies would benefit from longitudinal or quasi-experimental research designs to provide insights into the direction of

the examined relationships and offer support for causality. Testing with instrumental variables could also be an option for future studies aiming to address this issue. Second, the study does not account for residential self-selection. Residents may self-select in particular neighborhoods and therefore the statistical results may be biased if this is not accounted for. For example, individuals seeking strong neighbor ties may choose to reside in low-density suburbs, while individuals who prefer socializing on a wider geographical scale may choose to reside in the inner city. Including a wide range of socio-economic variables in the present study is expected to at least partially reduce biases from such a possible self-selection; however, future studies could include targeted self-selection variables. Third, the study does not control for personality traits and personal values which might also differ across neighborhoods and at the same time influence self-reported evaluations of neighborhood attributes or the tendency of individuals to form strong local social ties. Future research could address this issue by collecting relevant data and including them in statistical analyses. Fourth, the mechanism studied in the present paper is of vitality mediating the relationship between built environment characteristics and social cohesion. Conceptual foundations are based on theories from urban design and urban sociology, as discussed in the review of literature above. Another appropriate avenue for further research would be to test for moderation instead of mediation: for example, whether and how the relationship between built environment and social cohesion is moderated by urban vitality.

6. Conclusions

This study has provided new insights into the relationship between urban vitality and social cohesion. It is one of the first empirical investigations to explore how the built environment relates to both urban vitality and social cohesion and to shed light on whether urban vitality contributes to a socially cohesive neighborhood. Although there have been theoretical claims that urban vitality may foster social cohesion, this had not been sufficiently investigated by empirical research. Moreover, although there have been several studies independently examining links between the built environment and urban vitality or links between the built environment and social cohesion, limited evidence existed on the relationships between all these three together: built environment, urban vitality and social cohesion.

The present study has attempted to cover these gaps by addressing three main research questions. (1) Findings show that neighborhood density, local amenities and neighborhood proximity to the city center are associated with increased urban vitality, while green space is associated with lower urban vitality. (2) Built environment characteristics linked to increased urban vitality – neighborhood density, local amenities and neighborhood proximity to the city center – are associated with lower social cohesion. Public transport accessibility is found to be positively associated with social cohesion, while green space and social cohesion are found to have a weak negative association. (3) Urban vitality seems to play a positive role in social cohesion for similar types of urban form (in terms of density and land use).

These findings indicate that while urban policies aiming to increase urban vitality can do so by employing a dense, mixed-use urban form that includes numerous, diverse facilities and services, these measures might lead to lower neighborhood social cohesion. Since urban vitality and social cohesion are positively associated for similar urban form types, it is possible that small-scale initiatives and interventions that would improve urban vitality could also strengthen social cohesion. Ways to strengthen social cohesion via increasing urban vitality could be local community initiatives and small-scale design interventions related to walkability, public space design and housing design. Researchers, practitioners and policymakers should further look into such measures that would help to provide the important societal benefits of stronger social cohesion.

CRediT authorship contribution statement

Kostas Mouratidis: Conceptualization, Methodology, Formal analysis, Investigation, Visualization, Writing - original draft, Writing - review & editing. **Wouter Poortinga:** Conceptualization, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2020.103951.

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