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Sustainable building renovation in residential buildings: barriers and potential motivations in Norwegian culture

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ABSTRACT

Retrofit of existing housing increases the possibility of meeting Sustainable Development Goals. Improving quality of life, minimising energy consumption and increasing productivity in buildings process with the aim of affordable housing (social, environmental, and economic sustainability) set new demands for renovation amongst residential housing in Norway. Most studies to date emphasised on mitigation of CO_2 emissions in building sector through building renovations. However, recent studies started evaluating why such renovation plans may not be considered by property owners. This study investigates potential barriers and motivations for Sustainable Building Renovations (SBR) from house-owners' perspective and discusses the role of urban Facility Management (FM) in promoting SBR. Results from a questionnaire survey with 341 citizens in Trondheim city, Norway, confirm economic issues as the main barrier for SBR with respondents suggesting different forms of financial support to resolve these barriers. Social engagement of citizens with public/private partners and neighbours illustrates the collective motivation for SBR. This requires an intermediary role like urban FM engaging citizens to co-create their needs in urban areas with public/private sectors. The output of this study helps to promote urban FM engaging with SBR targets through renovation of neighbourhoods.

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Sustainable building renovation; urban facility management; social engagement; neighbourhood; energy wastage

Introduction

Sustainable Building Renovation (SBR) has gained increasing focus in recent years as the considerable waste of energy in the existing buildings has been highlighted. The building sector is shown to be responsible for more than 40% of energy consumption and one-third of the global harmful emissions (Pearce *et al*. 2018). This entails increasing attention on sustainable construction and refurbishment in the building sector (Nielsen *et al*. 2016). Such huge energy consumption has attracted attention in European countries, which has led to regulatory actions to reduce energy use and related emissions in construction and the built environment (OJEU 2006, European-Committee 2010, Ramírez-Villegas and Eriksson 2016). Sustainable Development Goals (SDGs) "provides a shared blueprint for peace and prosperity for people and the planet, now and into the future" with a diverse set of goals ranging from eliminating poverty, climate action to building sustainable cities and communities (UN Economic and Social Council 2020). The Strategic Plan for Horizon Europe, particularly under Pillar II cluster of Culture, creativity and inclusive society is relevant for developing bottom-up partnerships that will impact local community context in meeting their needs and creating social value. Within this cluster, the transition to a low carbon economy and demographic developments, as well as technological advancements, pose multidimensional social, economic, ethical, cultural and political challenges. Broad thinking is required in order to address the energy wastage that comes from buildings that are not being maintained and require renovation. Sustainable Goal 7, Affordable and Clean energy, (target 7.1) aims to ensure universal access to affordable, reliable and modern energy. When energy consumption is considered in terms of existing buildings that have high-energy leakage, these buildings then reduce the affordability (Dubois and Meier 2016) and

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consequently affect the SDG 7 dealing with affordability. Given the SDG 11 focussed on Sustainable Cities and Communities, (target 11.3), by 2030, there will be an enhanced inclusive and sustainable urbanisation and capacity for participatory integrated and sustainable human settlement planning and management in all countries. This implies that thinking on the individual level is not enough for sustainable cities and communities. The EU emphasises the involvement of citizens in the generation of renewable energy, which can increase social acceptance and thus enable the low carbon energy transition (Fruhmann and Knittel 2016, Hauge *et al*. 2019). Considering the neighbourhood context, where activities reflect a diversity of interests and needs, there is no coordinating body to link activities. In the bigger picture, the consequences of this lack of coordination is reflected in the UN Emissions Gap Report (European-Committee, UN Environment 2018). It was highlighted that the role of non-state and subnational actors such as cities, states, regions, companies, investors, foundations, civil society and cooperative initiatives, had some positive outcomes. However, their diversification and lack of coordination of data creates problems in coordinating measurements of where and how improvements are occurring. In this way, taking a neighbourhood-level perspective to sustainable renovation can help meet the targets laid out in SDG 7 and SDG 11. However, it is assumed that neighbourhoods will come together and cooperate and do so without motivation or clear tangible benefits. This is problematic when it comes to SBR which are often viewed by citizen as expensive and highly technical (Lindkvist *et al*. 2014, Xue *et al*. 2020). The SDG goals indicate a need to cooperate. This work uses a survey to examine what type of cooperation is needed for SBR and further illustrates how the role of Urban FM can be a key intermediator between public and private bodies in cooperation with citizen at the neighbourhood level.

In the Norwegian context, the policy in the form of the "Green Shift" embeds Sustainable Development Goals (SDGs) to reduce emissions in the building and construction sector (Judson and Maller 2014). On the neighbourhood level for renovation, the focus is not just about emissions in the physical aspect, but also social value needs amongst neighbourhoods which influence carbon emissions. Such social value needs are often unclear on how to manage (Turcu 2013) or are simply forgotten as urban plans become implemented (Nielsen *et al*. 2019). To reduce carbon emissions and meet targets, the focus is often placed on the technical aspects of the built environment and the non-technical dimensions (social, architectural value and economic) tend to be disruptive (Lindkvist and Wyckmans 2017). These social values are often assumed to be included but are often lost or forgotten as there is no active continuity to link these values to municipal plans (Lindkvist *et al*. 2019). This indicates a gap in identifying how these social aspects can be worked on to build collectives (Skjølsvold and Lindkvist 2015). Projects that meet the technical requirements but ignore the liveability parameters focus on where only acceptable voices are included in project development (Skjølsvold and Lindkvist 2015). According to Leach *et al*. (2016), sustainable and liveable cities mean low-carbon, resource-secure cities in which societal wellbeing is prioritised, while changes in population, urbanisation, demography, climate, security of energy/other resources, and a plethora of historical legacies, provide the context. The liveability issues consider more focus on enhancing the community and individual wellbeing and ensuring equity. The reduced focus on liveability issues for communities' disregards that in order to create social value, human activity needs to be considered as the centre (Temeljotov Salaj, Hjelmbrekke, and Bjørberg 2018). Municipalities are in a prime position to act as an intermediator role to ensure community social values can be ascertained and acted on in an active collective way.

Studies on the role of municipalities is expanded to address concerns on energy and environment from national policy makers resulting in an influencing role in municipalities (or local authorities) to challenge or transform existing patterns of energy decision-making and practices (Fudge *et al*. 2016). Kivimaa and Martiskainen (2018) found that in many countries the building sector consists of a multitude of actors and requires structural coordinated activities by the municipality. Coordination and collaboration are difficult when partners have diverse interests, goals and motivations but a way to overcome this challenge is through shared understanding and mutuality. Howells (2006, p. 721) defines intermediaries broadly as "organizations that provide a supportive role for collaboration between two or more parties during various stages of the innovation process" but at the same time acknowledges that intermediaries are also individual actors. The role of intermediation is required for coordination of knowledge from planning to implementation, however, such roles are often not formalised and ill-defined and actors who perform the intermediator role often arise from projects rather than actively found (Lindkvist *et al*. 2019). The role of

intermediator requires social interaction in order for knowledge and understanding to build when diverse sectors do not share the same perspective of a development or project (Lindkvist *et al*. 2019, Javernick-Will and Levitt 2010). Urban FM is an intermediator role that can interact on different levels across public and private sectors as well as citizen engagement (Lindkvist *et al*. 2021). However, this role or approach is not fully formalised as an intermediator role that can facilitate urban areas and municipalities in meeting sustainable targets (Fudge *et al*. 2016, Kivimaa and Martiskainen 2018, Howells 2006).

In this context, understanding the connectivity between communities and services in a city scale and effective cooperation among nations is required to meet the CO_2 emission mitigations (United Nations 2017). The purpose of the survey is to find out how city-scale management of services can support social aspects. This is not widely understood within the city scale where management of services often focuses on meeting basic needs and infrastructure needs in a neighbourhood while neglecting services that support social aspects of a neighbourhood which is where Urban Facilities management comes to the fore (Lindkvist *et al*. 2021). In this study, we examine what are the barriers and potential solutions that residents view for sustainable renovation. We also discuss where Urban Facilities management can be an intermediator in making the connection embedded within municipality goals for meeting SDGs.

Sustainable building renovation of residential housing

Sustainable building renovation (SBR) projects aim for buildings to be more sustainable after the renovation than before. SBR can be defined as an upgrading, or refurbishment of a building in order to meet the social needs and requirements of the user in a cost effective and resource optimised way (Shah 2012, Nordic Innovation, 2015). In Norway, housing represents 67% of the building stock, which reinforces the importance of addressing sustainability in this sector (Bjørberg and Temeljotov Salaj, 2020). According to a report from the Energy Analysis of the Norwegian Dwelling Stock approximately 47% of the existing residential buildings are more than 50 years old in Norway (Thyholt *et al*. 2009). Other studies confirm that the cost of renovation is persistent for individual residential dwellings in Norway as buildings normally need frequent checks and renovations over time (Lindkvist *et al*. 2014, Xue *et al*. 2020).

The motivation for upgrading dwellings often varies among the homeowners; some are interested in the social and development of their community rather than just their own residence, while others only consider the benefit of redecorating and renovating their own dwelling (Temeljotov Salaj *et al*. 2020). Ownership plays a big role in decision-making. Residents who rent their property are reluctant or unable to undertake sustainability retrofits because their lease may prevent them from doing work on the property and they may not be able to afford the measures as the payback period can exceed the duration of their lease (Astmarsson *et al*. 2013). Zavadskas *et al*. (2004) categorised the factors affecting renovation/refurbishment decisions as micro level and macro level. The macro level includes environmental, social and economic factors, whereas indoor environmental quality, deterioration in buildings and lower fuel charges, as well as health benefits, are considered on the micro level. Energy saving measures are rarely the only motivation for renovating a residence but come when there is a need for updating and modernising other functions. According to Risholt and Berker (2013) every year new statistics show a considerable rate of home improvement among Norwegians. Upgrades include redecorations such as new floors/wall coverings, aesthetical upgrades, as well as renovations including repairs and replacement of components and improvement of the qualities of the dwelling (Risholt and Berker 2013). Such measures do not have direct energy saving potentials; however, they may indirectly influence the building energy use (Risholt and Berker 2013). For instance, incremental renovation such as improvements of the building envelope can lead to 37% of the stabilisation of the energy consumption in Norwegian household since the1990 (Hille *et al*. 2011).

Gohardani *et al*. (2015) discuss several decision-making tools concerning refurbishment and explains how renovation projects can be turned into energy saving opportunities. Considering a wide range of conflicting interests, including social and economic related issues and the involvement of several stakeholders in decision making processes (Ferreira *et al*. 2013), researchers suggest different involvement models engage residents to overcome barriers to SBR (Jensen and Maslesa 2015, Kovacic *et al*. 2015, Galiotto *et al*. 2016, Paiho *et al*. 2019). As agreed in several studies, the motivation of being involved in SBR requires consciousness and special, personal beliefs, situational aspects, social engagement, the facilitation and access to expertise (Ferreira *et al*. 2013, Baumhof *et al*. 2018, Paiho *et al*. 2019, Støre-Valen and Buser 2019).

The absence of motivation for SBR is often linked to its high cost (Bruce *et al*. 2015, Shah 2012, Miller and Buys 2008), long-term payback period (Shari and Soebarto 2014, Bruce *et al*. 2015), lack of information about its economic and social benefits, knowledge of how to engage and get involved as well as personal benefits, in terms of better indoor quality or reduced energy costs (Gohardani *et al*. 2015, Baumhof *et al*. 2018, Paiho *et al*. 2019, Temeljotov Salaj and Lindkvist 2021). Thus, involving expertise and giving best practice examples to the residents in order to communicate the benefits of sustainable renovation projects is recommended by Baumhof *et al*. (2018). Paiho *et al*. (2019) introduce a district-scale procedure for involving individuals at the neighbourhood level to ease feeding information, dynamic calculation capacities and support to decision and policy makers (Paiho *et al*. 2019). Trachte and Salvesen (2014) suggest that such actions facilitate taking account of local particularities and allow for appropriation of choices that have become collective, which ensures multiple solutions and points of view.

Financially incentivising communities in existing neighbourhoods is also shown to be beneficial for meeting the ambitious targets laid out at EU and Norwegian levels (Lindkvist and Wyckmans 2017). Different financial schemes can stimulate neighbourhoods to agree on refurbishment actions (Paiho *et al*. 2019). Paiho *et al*. (2019) conclude that refurbishment actions in a neighbourhood have economic benefits when done in an area rather than done at an individual level. In support of this perspective is a study by Ferreira *et al*. (2013) on comparing some district refurbishment scenarios by means of operational costs, energy usage and CO_2 emissions. They pinpoint that focussing on energy-efficient refurbishment of buildings, is more cost efficient at a district scale than on an individual building scale. While the established role of Facilities Management (FM) practitioners can enable processes to be sustainable for engaging house owners in SBR related issues, both at a single building and neighbourhood level (Støre-Valen and Buser 2019), Urban Facilities Management has the potential to SBR at a neighbourhood level in less formally established organisations through partnerships.

The role of urban facility management in promoting SBR

Urban FM can fill the gap in expanding the FM discipline from singular organisation context to the complex urban context facilitating new partnerships and addressing community neighbourhood needs (Temeljotov Salaj, Gohari, *et al*. 2020). Urban FM as a strong actor takes social responsibility in urban areas to increase the sustainability development of existing neighbourhood's for facilitating liveable areas with the focus on health and well-being (Alexander and Brown 2006, Larsen *et al*. 2011, Temeljotov Salaj and Lindkvist 2021). FM as a network of relationships, can create perceived value amongst key stakeholders (Jensen and Maslesa 2015), so being in close relationship with citizens, it can improve citizens' sense of attachment, commitment, trust, inclusion and integration (Temeljotov Salaj *et al*. 2018). Building on FM established characteristics, Urban FM makes links between communities, municipalities and engagement of private partnership that are currently very tentative. There are increasing studies considering the partnerships required to consider persistent problems that are reducing the sustainability of cities. Urban FM can be an intermediator to interact across multiple sectors of public, private and citizen (Lindkvist *et al*. 2021) on different levels of multisector participation that range from informing, consulting, involving, collaborating and empowering (Xue *et al*. 2020). Indeed, such partnerships are viewed as essential for renovation business models in order to gain knowledge from economic options and technical aspects, as well as including social liveability aspects (Xue *et al*. 2020).

To date, the reduced focus on liveability issues for communities' disregards that in order to create social value human activity needs to be central (Lindkvist *et al*. 2019), and Urban FM is a role that can actively focus on liveability. The deterioration of physical place is connected with the absence of self-organisation of neighbourhood residents (Kuijlenburg 2020), thus ensuring inclusivity of communities in design and management of services in the urban environment through a value-driven approach. Such approaches could lead to developing solutions that meet community needs, sustainable goals and business opportunities (Lindkvist *et al*. 2019). This would aid in the ability of Urban FM to focus on liveability for SBR.

The scope of this study

In relation to sustainable development goals, SDG 7 and SDG 11, this study presents how singular thinking is problematic for addressing the needs of the renovation wave set by the European Green Deal. The study aims to investigate existing barriers hindering people from SBR from the citizens' point of view. The potential motivations to promote SBR in the scale of single

building and neighbourhood level in Norwegian culture is also discussed.

Trondheim is located in a fjord in the centre of Norway. The municipality has a plan to reduce Greenhouse Gas (GHG) emissions with ten objectives, five of which focus on *city development targets* and five on *municipality development targets/activities* (Kommune 2017). Some of the city development targets include:

1. making Trondheim robust to meet future climate change, by 2025;
2. providing stationary energy use in building and construction at the same level as in 2013 (about 3.5 TWh), which corresponds to a 20% reduction in consumption per person by 2030;
3. reducing direct greenhouse gas emissions by 80% compared to 1991 by 2030 (Kommune 2017).

Energy and climate targets fall under the *municipality's activities*:

1. Trondheim municipality will start phasing in climate-neutral vehicle park for heavier vehicles as soon as they are available;
2. energy consumption in own operations is reduced by 7% compared to 2017 by 2020;
3. indirect emission cuts, by rolling of the plan in 2020;
4. reducing the climate footprint for major investment projects in the municipality by 30%, in comparison with the reference building (assuming that life cycle costs do not significantly increase);
5. making the municipality of Trondheim a zero-emission business by 2030 (Kommune 2017).

The municipality drives these targets, however, to achieve these targets they require cooperation with citizens living in neighbourhoods and district in the city. Such city targets are direct contributions to meeting SDG 7 and SDG 11, but it is not always clear how citizen see their role in the cooperation in terms of SBR. Within the following survey, we examine how citizen is willing to change through SBR initiative which will inform how municipalities can facilitate meaningful cooperation with them.

Research methods

This study was carried out in June 2018 in Trondheim city. Trondheim with 197,501 population, is in Sor-Trondelag (63.4305° N, and 10.3951° E) in Norway. An existing neighbourhood in need of maintenance in the city was selected as a case study and an anonymous cross-sectional questionnaire survey was conducted on residents in that area. The fundamental objective of the questionnaire was to investigate the social needs of the citizens for sustainable refurbishment in the scale of a single building and neighbourhood. This method is applied in some similar studies in this field of research (Ali *et al*. 2008, Shah Ali *et al*. 2009, Knudsen *et al*. 2016).

The questionnaires were available online and via hard copy versions to participants of the study. The paper version was distributed among the Trondheim district of Illa, where residents who were opportunistically sought on the street in the case study neighbourhood. The online version was sent via email to a group of residents, who participated in the survey according to their consent. The questionnaire contained an "Introduction" part including the definition of some expressions (sustainable, renovation, refurbishment, etc.) and some questions on:

- Individual's background (e.g. age, occupation)
- Subjects' living conditions (e.g. building and neighbourhood quality, services)
- Technical issues at buildings (e.g. discomfort sources, potential reasons for renovation)
- Environmental interests (e.g. environmentally friendly behaviour, contributions to save environments)
- Social and financial supports for renovation plans (e.g. social engagement, funding)

The survey sample size was selected according to the recommended value in Israel's study (1992). Israel (1992) recommended the required sample size for subjective surveys on different populations and diverse precision levels using Cochran's method (Cochran 1977). As the whole population in the case study neighbourhood (Ila) is 6809, the recommended sample size by Israel (1992) for such population size and 5% precision is 375 ± 19. Overall, completed questionnaires received from 341 participants, which can be considered as acceptable for statistical data analysis, even though it is slightly lower than the recommended sample size by Israel (1992). Collected data was statistically analysed (using SPSS, statistical analysis package) and interpreted quantitatively and qualitatively.

A summary about the participants' background is provided in Table 1. Participants were mainly full-time (52%) and part time employees (25%) and a small

Table 1. A summary of the participants age group and occupation.

Age groups	Full-time employee (%)	Part-time employee (%)	Student (%)	Unemployed (%)	Retired (%)	Total in age group
Under 20	3	0	3	0	0	3
21–30	35	18	60	29	28	39
31–40	21	13	9	14	18	16
41–50	13	13	11	38	7	14
51–60	14	35	11	14	18	15
61–70	9	17	3	0	18	8
Above 70	5	4	3	5	11	5
Total in occupation	52	25	7	9	7	100

Table 2. Ownership status of the participants.

Ownership status	Percentage (%)
Owner	61
Tenant	4
Shared place (partly owner/tenant)	35

proportion were unemployed, students or retirees. Regarding their age, they tend to be between 21 and 30 (39%) and between 31 and 60 (» 45%), with some small groups of people above 61 years old. The participants under 40 years old are mainly fulltime employees or students, whereas the highest proportion of participants above 40 is part-time employees, unemployed or retired. A detailed look at the table shows that 28% of the participant in 21−30 age group are classified as retired, which can be due to a disability to work, or misunderstanding of the questionnaire by this group of subjects.

Results

The ownership status of the participants is presented in Table 2. Around 61% of the participants are homeowners, 35% are partly owner or sharing a place as tenants and only 4% of the subjects are tenants in this survey. This confirms that the following results can be mainly considered from the homeowners or partially homeowners of the residential buildings.

The relation between the building types and the ownership status is presented in Figure 1. Detached houses and townhouses are shown to be the first and second priority of the buyers, respectively. Whereas apartments and semi-detached buildings are more common among the tenants and those who prefer to live in collective residence. However, as the participants are mainly young (between 20 and 40), their preferences for the building type and living environment can be a matter of affordability, social outlook and their occupations.

The participants were asked about the sources of dissatisfaction with their dwellings and the potential measures that can make their homes more energy efficient. Table 3 shows the results of the top three voted measures in relation to the reported dissatisfaction

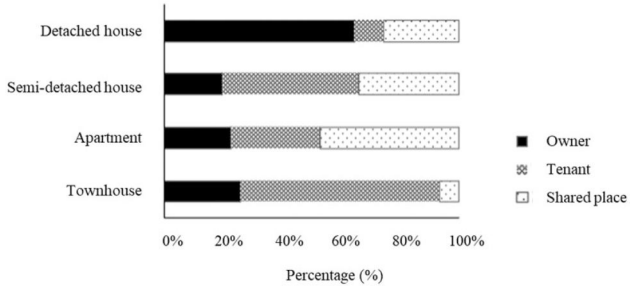

Figure 1. Ownership status in relation to building types.

sources (i.e. three dots indicate the highest and one dot refers to the lowest number of the votes). Applying better insulation, renovation of the heating systems, installing the better glazed and more operable windows are the top three priorities voted by the participants. Considering the solutions reported by the participants for each dissatisfaction source shows that they have some basic knowledge on the technical issues in buildings.

Results on the relocation and moving plans show that 50% of the participants are going to move out from their current living environments (Figure 2). Among this group, approximately 53% of the subjects reported "poor building conditions" (heat loss, draughts, damp, etc.) as the main reason for their relocation. The others voted for "small space" (30%), location (28%) and other reasons including changing their occupations, aesthetics and private motivations (32%).

Figure 3 presents the potential motivation for renovation among the participants. Approximately 32% of the subjects voted for aesthetic aspects as their main renovation motivation. This was followed by improving comfort in their dwellings (29%), reducing electricity cost (23%), and finally saving the environment (16%). Such findings are confirmed by Knudsen *et al.* (2016) presenting house owners interest in saving energy for the sake of the environment and their own economy. Given aesthetic and comfort upgrades as the first and second placed motivations for renovation agrees with the findings in Risholt and Berker's (2013) study, which concluded that the highest motivation

Table 3. Voted actions to make dwellings more energy efficient in relation to the dissatisfaction sources.

	Actions to make buildings more energy efficient				
Dissatisfaction sources	Applying better insulation	Renovation of heating systems	Installing better glazed/ operable windows	Lowering cost of electricity/renewable energy sources	Controlling ventilation
Thermal discomfort	λλλ	λλ	λ		
Moisture level/ damp	λλλ	λλλ	λλ		λ
Draughts	λλλ	λ		λλ	
Inappropriate air quality	λλ	λλλ	λ		

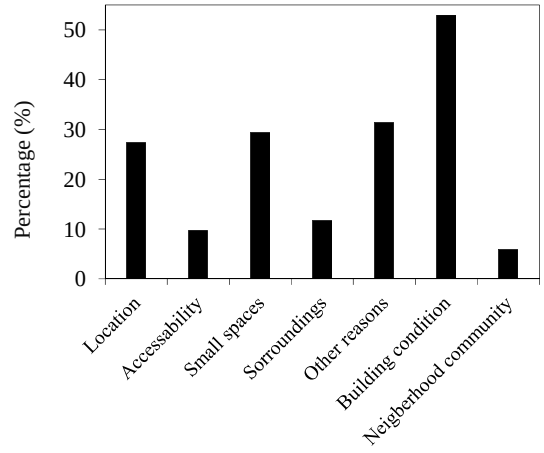

Figure 2. Reasons behind plans to move out from the living environment.

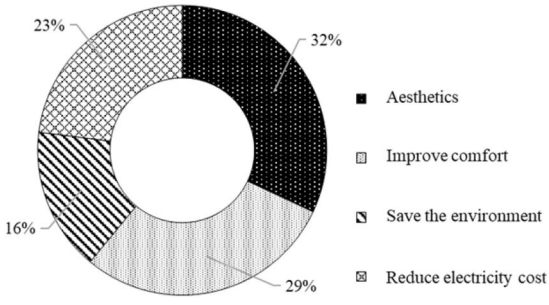

Figure 3. Participants' potential motivation for renovation.

for renovation/refurbishment tend to be redecoration, modernisation, improving the aesthetics and quality of dwellings. Such motivations are also classified in micro level according to Zavadskas *et al*. (2004).

Potential barriers for SBR

Figure 4 shows a summary of the reasons for the participants' limited interest in SBR. Approximately half of the participants indicated that high cost is the main hinderance of renovation plans in their homes. Similar results are also shown in some previous studies in Australia (Bruce *et al*. 2015), Finland (Shah 2012) and the UK (Miller and Buys 2008), all of which confirm the high cost as the most considerable barrier for SBR. It is followed by the other reasons including plan to move shortly (19%), no interest in the environment (1%), producing noise, dust and environmental emissions (13%) and requiring another place during the refurbishment process (12%). The two latter reasons also refer to the economic issues coming from the high cost of renting a place for the families to stay away during the renovation processes. The findings here are in line with the results of Lindkvist *et al*. (2014) and Xue *et al*. (2020) studies confirming the high cost of renovation as a reason of limited interest in SBR. The positive point here is that only 1% of the participants voted for no interest in the environment. This reinforces the trend that more citizens are being concerned about the environment (Figure 3).

The socio-economic contribution of building renovation

The respondents expressed their expectation for receiving financial support as a key driver to renovate their neighbourhood (Figure 5(a)). They were also asked about their desired financial support for SBR. As presented in Figure 5(b), among 39% of the participants voted for financial support, 12%, 10% and 7% voted for financing for renovation of the neighbourhoods, lowering the cost of electricity and renewable energy sources, and tax cut, respectively, as the top three desired supports.

When they were asked about the services they need in close distance from their living environments, grocery store was voted by 45% of the subjects. This was followed by gym by 20% and parks or social meeting areas by 35% of the citizens as the second and third place, respectively (Figure 6). Their votes for parks/social meeting areas in the third place, reinforces the findings on citizens interests in their neighbourhoods, which can imply to the Norwegian culture (Figure 5). Also, this might partly refer to the residents' desire for social involvements in the neighbourhood level, but this is quite low and more work needs to be done to engage the other 65% of residents to engage in social meeting areas.

Figure 7 shows the participants preferences to interact with other neighbours to share knowledge on SBR. Around half of the subjects showed interest in

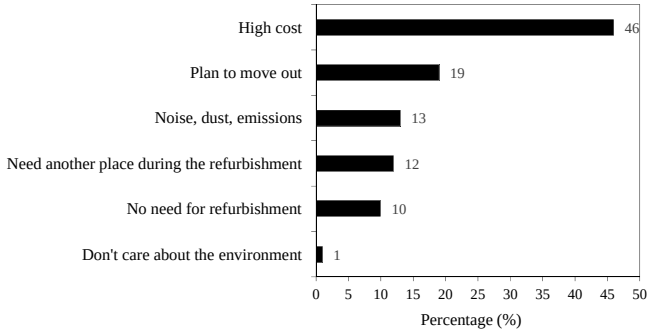

Figure 4. The reasons behind no-interest in SBR, reported from participants.

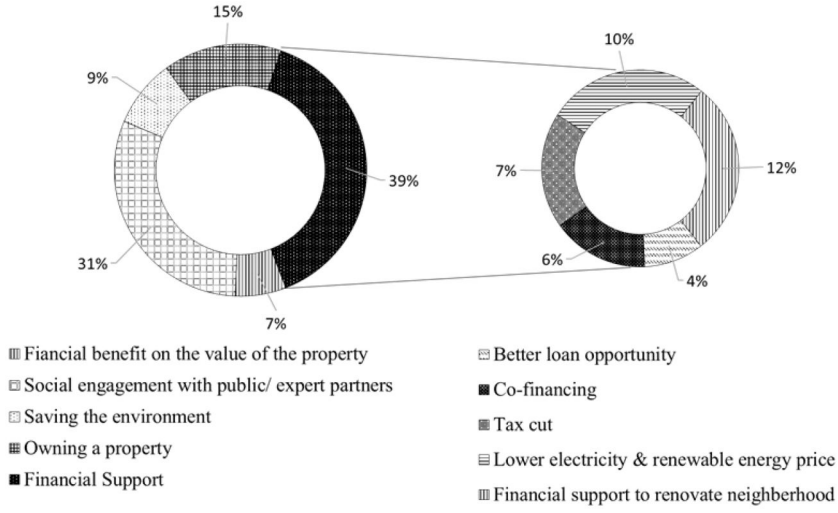

Figure 5. The voted motivations for SBR (a) and the potential forms of financial supports (b).

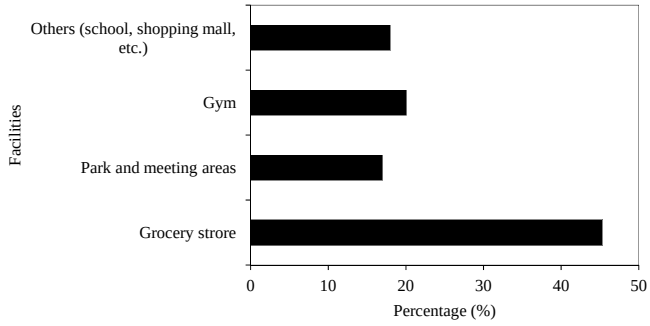

Figure 6. Participants vote on the facilities needed in their neighbourhoods.

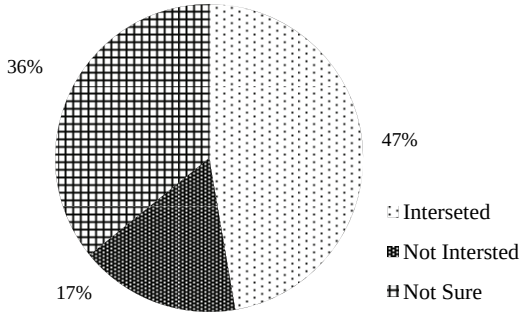

Figure 7. People votes on interest in working with others towards SBR.

working with other owners to share knowledge and technical information about SBR. However, 16% of them were not attracted in such events and 35% were not sure about such interactions, which could come from lack of enough information.

Discussion

Findings on the participants' interest in SBR show the high cost required for building renovation and financial issues as the main reason for limited interest in

SBR plans among homeowners. They tend to know about the sources of dissatisfaction and some basic knowledge on the energy efficient measures to fix these dissatisfaction sources. However, due to high cost of renovation and long-term payback periods, residents of this study mainly prefer to relocate from their current place instead of considering SBR plans. This is problematic as there is no way of knowing when and if these housing will be renovated in the near future while at the same time increasing carbon emissions through energy leakage. However, similar to some previous investigations (Risholt and Berker 2013, Temeljotov Salaj and Lindkvist 2021), this study confirms higher motivation for modernising properties and upgrading the comfort and aesthetical features in dwellings than for energy-saving reasons. This shows that even if people can financially support their renovation plans, they prefer to upgrade the aesthetic aspects in buildings with more considerations on liveability compared to energy aspects. A reason for this can be due to their lack of information on the social, economic and liveability benefits of SBR (Gohardani *et al*. 2015, Baumhof *et al*. 2018, Paiho *et al*. 2019, Temeljotov Salaj and Lindkvist 2021) and environmentally friendly measures, which can indirectly reduce the buildings energy costs and financial benefits (Risholt and Berker 2013, Gohardani *et al*. 2015). In light of this SDG 7.1 target for affordable energy seems to not be a high target in this neighbourhood. It illustrates that further focus within the Norwegian context is to not just be about the expense of renewable energy solutions but in developing better understanding on how to invest in these solutions that also support concerns about aesthetics and comfort. In addition, half the neighbourhood illustrated a reluctance of uncertainty to cooperate with each other, which is a challenge in housing associations in Norway that requires the majority of tenants to agree on major changes in the neighbourhood. This is a key finding for municipalities in that cooperation cannot be assumed amongst citizens. It requires direct intermediary processes to understand the values in the neighbourhood and bring about better cooperation processes to motivate citizens to cooperate with each other.

Regarding the socio-economic engagement of the citizens in SBR plans, the findings of indicating some positive citizens' interest in social activities, interactions with the other groups of people and collaborations with experts and public partners. However, it also illustrates uncertainty among residents of this neighbourhood to cooperate socially. The finding found a willingness to cooperate for financial support joint initiatives in funding renovation at the neighbourhood scale. In this way, cooperation at the neighbourhood level is reliant on tangible mutual benefit, and while social interaction is of interest to some, it is not a priority for most. This reinforces their interest to promote their neighbourhood and more social engagement with neighbours in line with the Norwegian culture. Such interest has already been suggested by researchers as a driver to overcome the barriers of SBR (Jensen and Maslesa 2015, Kovacic *et al*. 2015, Galiotto *et al*. 2016, Paiho *et al*. 2019, Temeljotov Salaj and Lindkvist 2021). However, only 35% appeared interested in meeting places. This indicates that relying on social initiatives being primarily bottom-up is risky as if they are not formally organised in neighbourhoods, these social activities require further municipal intervention in order to develop cooperative initiative for SBR. Such intervention could be filled through the role of Urban FM.

The role of Urban FM is not established in Norwegian municipalities to link social needs and services to the needs of developing a neighbourhood. At the same time municipalities are viewed as a key intermediator for structuring required coordinating activities in the complex multitude of actors in the building sector (Kivimaa and Martiskainen 2018). Urban FM in translating the knowledge from this sector into the neighbourhood level and at the same time facilitate social needs and activities that can aid cooperation in neighbourhoods (Lindkvist *et al*. 2021). It Municipalities and neighbourhood need to work together for mutual benefit and in order to open up neighbourhoods to commercial interests where municipal financing are unable to supplement. The role of Urban FM can aid in gaining support among citizens for SBR developments, particularly as financing is a key concern among citizens to invest in SBR as illustrated int eh survey. The Urban FM approach as the scope to intermediate between private companies, public organisation and citizen leading to cooperation that opens up the possibility for mutual interests to align and invest in SBR (Xue *et al*. 2020). Such facilitation can be done by working with residents, housing associations and municipality to engage citizen living in poorly maintained areas for collective consideration of the social value of the area. For instance, by organising events that bring neighbourhoods together, but such events require a tangible mutual benefit as illustrated within the survey. Similar activities were seen as successful within the Kuijlenburg (2020) work in engaging neighbourhoods. Furthermore, as shown in

this study the participants may have some basic information in construction area from both technical and sustainability point of view (Table 3). Therefore, gatherings among the neighbours not only lead to social benefits, and sense of attachment to the neighbourhood, but a mutual benefit of shared knowledge and even encourage owners who may not be familiar enough with SBR, to find out more about it. These social activities are key for sharing knowledge across different perspectives (Javernick-Will and Levitt 2010). Such activities are in line with SDG 11 in developing Smart Sustainable Cities. As discussed by Trachte and Salvesen (2014), such actions facilitate taking account of local particularities and allow for appropriation of choices that have become collective, which ensures multiple solutions and points of view.

The insufficient awareness of residential building owners regarding the benefits of SBR and its processes is introduced in the existing literature as one of the most common barriers against SBR (Shah 2012, Shari and Soebarto 2014, Bruce *et al*. 2015). Thus, involving experts in this context, who can give the best practice examples to the residents and communicate the benefits of sustainable renovation projects, can also work to encourage citizens for SBR. However, citizen often does not know how to access such knowledge or what type of knowledge they need to access (Lindkvist *et al*. 2014). In this way, having a one point of contact such as that under the Urban FM approach would be knowledge on how to access services for building renovation from the expert/construction companies would be easier, more cost- and energy-efficient compared to providing such facilities for each single building (Ferreira *et al*. 2013, Paiho *et al*. 2019). The urban facility manager practitioners can also contribute to finding appropriate financial solutions to SBR on the neighbourhood level.

Conclusion

This study investigates the barriers hindering Sustainable Building Renovation (SBR) in dwellings from the citizens' points of view, and where municipalities can intermediate through an Urban FM approach to facilitate collaborative processes. The study was conducted in an existing developing neighbourhood in Trondheim Norway in 2018. Through a questionnaire survey on 341 subjects, the social needs of the citizens for building renovations, the reasons for limited interest in SBR and the potential motivations to promote SBR in Trondheim were studied.

The findings regarding the SBR barriers show that economic issues and high cost of SBR tend to be the first and the most common reason for limited interest in SBR among the citizens. At the same time, the study illustrates how the neighbourhood was potentially interested in examining collective financial ways to improve the neighbourhood. Only 35% were interested in social activities in the area which was reflected in another questions on interactions where 35% appeared uninterested in such interactions.

The neighbourhood citizen was more interested in obtaining tangible knowledge from interactions such as experts and public partners who have technical knowledge on SBR. If Trondheim municipality is to meet goals through cooperation, getting neighbourhoods to cooperate and interact appears as an important factor that is often assumed but not acted on. The study illustrates tangible benefit appear as an important catalyst for cooperation. They desire better social areas and opportunities to work with other neighbours towards SBR plans. Also, the majority of the participants show interest in the environment and only 1% reported no interest in saving the environment.

As a solution to promote SBR, receiving financial supports in form of lowering the cost of renewable energy sources, better loan opportunities, tax cut, co-financing and funding for renovating the neighbourhoods were suggested by the citizens. In addition, some people reported social engagement with the public and expert partners as a motivation encouraging them to consider SBR.

While the SDG 7 deals with affordability and SDG 11 Sustainable Cities and Communities are to be met, there needs to be more work done via municipalities to engage neighbourhoods and motivate community building. Illustrating the mutual benefits for the surrounding area by developing social activities requires intermediation via the Urban FM approach between public, private and people partnerships. The development of social activities at the neighbourhood scale has the potential to provide citizens with the opportunity of interaction and sharing knowledge regarding the SBR that can mutually benefit the quality of life in the neighbourhood. Such gatherings among the neighbours can also make them more satisfied and improve their sense of attachment to their living area. Furthermore, if the neighbours work together towards there is a stronger foundation for making Trondheim robust to meet future climate change, by 2025 (Kommune 2017). The study indicates that renovation at the neighbourhood level is being considered in this study at the financial level, but agreements to

renovate at the neighbourhood level require trust and that requires increased social activities for residents in neighbourhoods to get to know each other. In this way the services and materials can be provided in the neighbourhood scale rather than the individual buildings, which make the renovation process faster and more cost effective.

The limitation of this study is that it focuses on one neighbourhood in Trondheim. However, it is recommended for future studies to conduct the survey in some more neighbourhoods in the city, which can better represent the Trondheim citizens requirements in Norwegian culture. Also, further investigation on the role of urban facility management in the promotion of SBR and social engagement of people in this regard is recommended.

The findings from this study have the potential to be extended to other European countries. However, given the diverse social facilities and housing situation in different countries, it is recommended to repeat this type of study in the context of different European countries to get more reliable results.

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