From Green to Sustainable Urban Development:

Analysis of Sustainability Performance in Swedish housing

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Master Thesis Series in Environmental Studies and Sustainability Science,
No 2013:023

A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science (30hp/credits)

LUCSUS

Lund University Centre for Sustainability Studies

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Submitted May 18, 2013

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ABSTRACT

The idea of energy efficient, healthy buildings has existed since 1970s. However, a one-dimensional approach for many housing issues does not assure sustainability. Therefore, near the end of the 20th century, the built environment became a focus of attention within the environmental movement with wider focus on building certification schemes and sustainability issues such as interrelationships between social, environmental and economic dimensions. This thesis argues that the unsustainability of current housing practices is ingrained from different occupants' perceptions and levels of residential satisfaction. Therefore, understanding and bridging the gaps of housing practices based on occupants' perceptions and satisfaction levels allows achieving transition from green buildings to sustainable urban environment which include three-strands of sustainability. The data presented in this work are mainly derived from survey results based on the two cases: 1) certified (LEED and Miljöbyggnad) buildings, and 2) uncertified buildings in the Southern Sweden.

Case studies of housing projects are compared to investigate the gaps and areas of improvements based on a framework of sustainability and theoretical underpinnings from residential satisfaction theory. The results showed that due to different social, environmental and economic conditions in each site the elements from sustainability framework varied slightly. However, the two cases proved that perceptions about housing and levels of satisfaction are context dependent. This means that solutions for improvements of housing conditions may not be transferable to other localities and should be developed from the start based on three-dimensional sustainability approach. Furthermore, despite the framework's dependency on the setting, with some criteria adjustments it can be used as guidelines for sustainable housing projects in other contexts. In addition, the outcome and final recommendations of this thesis may serve as a basis for constructors', architects' and designers' teams, also as for clients and environmentalists striving for more sustainable urban environment.

Keywords: *sustainability, green buildings, certification schemes, residential satisfaction, Sweden*

Word count: 14110* (*excluding titles and headings)

ACKNOWLEDGEMENTS

Most importantly I would like to thank for Mr. Jan Hammarström and Ms.Viveka Lidström for giving me an idea and opportunity to conduct a project in Ramböll Sverige.

Much gratitude to my thesis supervisor Sara Brogaard who encouraged me and gave valuable insights during the thesis process. Also Henner Busch for a helping hand in the March despair.

I would especially like to thank to my parents, for the opportunity to obtain international education, constant support and being patient with my "ups" and "downs" during the thesis writing period.

To save the best for the last, thanks to my LUMES friends, especially Olga, Mervi, Marina, Oliver, Nadia, Dana and Bekki for the help with proofreading, translating, "tearing apart my perfectly looking" thesis sections and unforgettable times spent together during two-year experience.

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ABBREVIATIONS, CONCEPTS and USEFUL LINKS

BREEAM	Building Research Establishment Environmental Assessment Method (UK, 1991)
CASBEE	Comprehensive Assessment System for Building Environment Efficiency (Japan, 2002)
GB Tool	Green Building Tool (Canada, 2002)
HQE	High Quality Environmental standard for green building based on the principles of sustainable development (FR, 1992)
IDIOSYNCRACY	A characteristic identifying what is peculiar or distinctive (e.g. local climate conditions)
LEED-NC	Leadership in Energy and Environment Design for New Construction and Major Renovations (U.S., 2000)
MILJÖBYGGNAD	Swedish Environmentally Classified Buildings certification scheme (SE, 2009)
OFEE	Office of the Federal Environmental Executive
SGBC	Swedish Green Building Council
USGBC	United States Green Building Council
Carbon footprint	According to the UN (2009), it is the impact of people's activities on the environment through the amount of greenhouse gases they produce, that measures the carbon footprint. Units are measured in carbon dioxide (CO2).
Green building	According to U.S Environmental Protection Agency (2013): *"A green building is an environmentally sustainable building, designed, constructed and operated to minimize the total environmental impacts".*

Links for the research and information

http://www.fastighetsagarna.com/	*Property Owners* is a trade and industry organization working for well-functioning property market
http://www.hyresgastforeningen.se/Sidor/default.aspx	The association working for everyone's right to have a right to good housing at a reasonable price, with safe environment and opportunities for society to evolve.
http://www.std.se/	*Svensk Teknik och Design* - an organization for the Swedish architectural firms and consultancy engineers in the construction and industrial sectors

CHAPTER I

1.1. Introduction

The idea of energy efficient, healthy buildings has existed since the energy crisis of 1970s (OFEE, 2010). Near the end of the 20th century, around the world the built environment became a focus of attention within the environmental movement with wider focus on building certification schemes and sustainability issues, such as "greening" of the city, revitalization of urban areas, creative spaces, educational/research role demand (Barton, 2000). In Sweden the continuous research on environmental impacts of housing sector revealed that housing and commercial premises account for roughly 30 % of Swedish end use energy and for about 7 % of its total emissions of greenhouse gases (Toller et al., 2011). Electricity accounts for nearly half the sector's energy use, followed by 30 % for district heating and 10 % for biofuels (Bergström & Save-Öfverholm, 2011).

Building construction in Sweden is expected to increase in the future, further exacerbating these impacts. Although Sweden early on established a considerably high level of housing standards, the challenge for the need of improved housing still remains. Therefore, sustainable urban development incorporating green building certification schemes was developed alongside an awareness of the ecological impacts. However, the underlying tension between the associated aspects of sustainability – environmental, social, and economic – as well as the wide interpretation of the concept, has led to a variety of urban development projects being described as 'sustainable' (Dempsey et al., 2011).

Despite the focus of the definition of sustainability, the majority of architectural expressions show that many projects were (and are) rarely referred as sustainable. Instead they are often accredited to as environmental, ecological, low-energy, green or bioclimatic (Knudstrup et al., 2009), and since building performance assessment methods are based on water and energy efficiency, energy performance in the buildings, materials selection, resource consumption and loadings, assessing the quantifiable criteria and omitting the non-quantifiable ones (Ding, 2005). Also it is important to add that the term *green building* and *sustainable building* are often used interchangeably, but these definitions should be used with a caution as they have different meanings. The main attributes of the green buildings are based on "*the practices of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle*" (OFEE, 2010). The main message, therefore, is essentially to improve conventional design and construction practices and standards, and reduce the overall impact of buildings to the environment (Cryer & Corbet, 2006), so that the buildings we build today will last longer, will be more efficient, cost less to operate, increase productivity, and contribute to healthier living and working environments for their occupants (Kubba, 2012). Also, since there is no uniform

definition of *green*, it is essential that every "*green*" term be specifically defined and agreed-to objective standards of performance in a contract (Kubba, 2012). Debates about sustainable housing most-often consider sustainability as an only environmental concern, and do not incorporate economic and social dimensions (Dempsey et al., 2011), despite that this sphere has been widely agreed upon in literature (Vale & Vale, 1991). Therefore, for my research I will use a *sustainable building's* definition which brings these aspects into focus and expands the green building concept. Accordingly, *sustainable construction* is based on the best practices which emphasize long term affordability, quality and efficiency and at the same time increases comfort and quality of life (Isover, n.a.). Moreover, I will complement a sustainable construction concept with Williamson et al. (2004) approach. He argues that building is the system which creates/structures the knowledge of a building in terms of its sustainability and in relation to satisfying the socio-economic needs such as urban quality, green spaces, reduced costs and others. Thus, to achieve sustainability in the built environment and satisfy the needs of different stakeholders, a building system's model should encompass the subsystems (Williamson et al., 2004) as shown in the *Figure 1.1*.

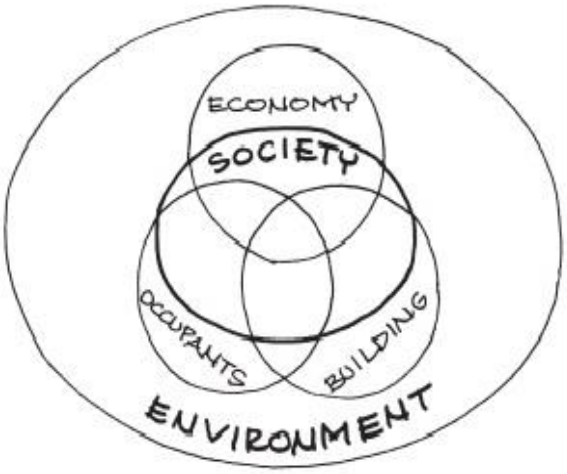

Figure 1.1 *Systems/subsystems view encompassing economy, society, environment, occupants and the actual buildings (drawn by Deborah White)*

Further by "*imposing various criteria for more or less distinguishable body of knowledge*" (e.g. economy, society, etc.) we will be able to construct a complete building-centered system model and analyze the relationships between those subsystems and emphasize areas of success or future improvements (Williamson et al., 2004).

1.2. Aim and Objectives of this study

The primary aim of my research is to critically assess the residents' perceptions about multiple factors in the housing setting that reflect a shift from green buildings to sustainable urban environment.

In order to achieve the research aim and have more complete picture of the built environment – buildings system, research objectives will be developed.

The first objective is to document and evaluate the knowledge about sustainable buildings and certification schemes and how this knowledge has been used in Sweden. That means that my study's boundaries cover just Swedish context and the main certification schemes for residential buildings, such as LEED-NC and MILJÖBYGGNAD. The third certification scheme – BREEAM is also popular in Sweden, however, the first residential area certified as BRREAM Communities was announce just in February 2013 and it is at the initial stage to start constructions.

The second objective is to develop a sustainability criteria framework for conducting the assessment of the Swedish housing quality via residential satisfaction as a determinant. Meaning that if residents perceive that some criteria from a set of sustainability already exist and it is enough to achieve satisfaction, then there is no need for improvements in the built environment.

Further, this paper argues that the unsustainability of today's housing practices is rooted in different perceptions about sustainable housing by the different stakeholders involved – designers, producers, and users (Huong & Soebarto, 2003). Therefore, by comparing certified and non-certified building residents' perceptions I will examine how far beyond "green" (or not) are the current construction development projects.

Moreover, the research suggests that understanding and addressing the multiple factors of sustainability, namely environmental, social and economic aspects, and emphasizing on areas of sustainability variables improvements will help to create an integrated perspective of sustainable building and its environment, and increase the quality of the certification schemes.

Finally, this study could serve as a basis for or be replicable in future research on sustainability factors in built environment with adjustments according to geographical contexts to provide a holistic and comprehensive framework for analyzing housing issues.

1.3. Justification of the project

My interest in green buildings was sparked when I moved to study in Sweden since the field and research on how built environment relates to us and a variety of sustainable incentives has been growing more rapidly here, with new technical knowledge, literature, and products, rather than anywhere else in Europe. Having taken a good inventory of what has been going in the field there came out to the light that current certification schemes mostly looking at the performance

of individual housing elements rather than the building's holistic performance during its full life-cycle (Wolf & Boyano, 2012). In addition, while planners discuss the meaning and theories that should be applied for sustainable development, there is a parallel debate is on the concept of green buildings (Retzlaff, 2008). Many builders, architects and developers have suggested that certification schemes for buildings, primarily focusing on the environmental performance, should change to consider broader sustainability issues, including social and economic dimensions (Cole, 2001). As Rebecca Retzlaff (2008) argues in her paper, "[…] *to change the goal to sustainability, building assessment systems will have to be reframed to focus on outcomes, rather than on inputs to buildings. Sustainability cannot be achieved solely by comparing buildings to benchmarks or to other buildings* […]".Therefore a big picture of perspectives on certification schemes and built environment from professionals and green building users, and identification of the major determinants to create more sustainable built environment and move further from green building paradigm – evaluating solely on one criterion, usually environmental performance - to sustainable built environment is needed. Recognition and application of a holistic approach for the underlying attitudes, opportunities and barriers within the built environment, additional to already existing values, such as reduced operating costs, better indoor air climate, higher sale prices or strong signal value, may improve multi-dimensional sustainability of the buildings and quality of certification schemes (MT Højgaard, n.a.).

1.4. Research Questions

There is one overriding question and three follow-up questions that drive this research which aims to grasp better the multiple dimensions of sustainability, addresses the core factors missing from the urban sustainable development process, and stimulate the formulation of criteria set capable of more effectively assessing the overall sustainability performance.

RQ.1. What are the residents' attitudes that reflect a shift from "green" buildings to sustainable urban environment?

SubQ.1. Which sustainability aspects as perceived by certified ("green") and uncertified buildings' residents indicate a shift from "green" buildings to sustainable ones?

SubQ.2. Which opinions from industry professionals' have a potential to enhance sustainability in the built environment?

SubQ.3. How can the public opinion be sensitized in order to achieve a shift from green to sustainable urban environment?

1.5. Thesis Organization

The following chapters of the thesis will introduce the reader to the topic, results, analysis and conclusions. The introduction is followed by the second chapter introducing relevant background information introducing a variety of certification schemes in the European and the Swedish

contexts, and what implementation issues they raise. The third chapter explains the theory and sustainability criteria framework. The fourth – methodology applied in the research work. The next section represents survey results and the sixth chapter presents comparative analysis of the results and discusses current green and uncertified buildings' sustainability performance, residents' perceptions and areas of improvements. The last section provides the conclusions of the work and draws the recommendations for further research.

CHAPTER II

CERTIFICATION SCHEMES IN THE EUROPEAN AND SWEDISH CONTEXTS

2.1. Certification Schemes in the European Context

There is a plethora of building certification schemes that have been established worldwide aiming to assess various environmental performance indicators (McGraw Hill Construction, 2009). A certification system provides a certificate and performance report for buildings (SGBC, n.a.), which is in demand in Sweden and are seen as useful tools for the coordination of different parties involved in the process (Bergström & Save-Öfverholm, 2011). Rapid establishment and application of building certification schemes were accelerated by EU regulatory standards. These standards include *EU Energy Performance of Buildings Directive* (2010), which sets the basic principles, requirements and methodologies for the buildings energy consumption, and mandates that all new buildings are "near-zero energy" buildings from 2021; and *the European Commission's "Lead Market Initiative for Europe"* where construction sector was identified as a lead market with immense potential for environmental benefits (Nelson et al., 2010).

The main certification schemes comprise of BREEAM (Building Research Establishment Environmental Assessment Method, launched in UK, 1991), LEED (Leadership in Energy and Environment Design, launched in the U.S., 1998), MILJÖBYGGNAD (Swedish certification scheme launched in 2009) (SGBC, 2012), EU Green Building (2004), GB Tool (Green Building Tool, first launched in Canada, 2002), CASBEE (Comprehensive Assessment System for Building Environment Efficiency, launched in Japan, 2002) and others (Houlihan Wiberg, 2009).

Application of the certification schemes raises a variety of issues in different contexts. For instance, many newly developed building projects are highly dependent on different levels (Cole, 2001). At the international level, a green building would have different components, for instance in sunny Italy than it would have in rainy Sweden. Also, internationally, green building is often concerned with maintaining standards of living rather than paying attention to different community members' needs (Retzlaff, 2008). This translates into lack of emphasis to include the perspective of all stakeholders, including owners, tenants, and developers (Nelson et al., 2010). Some researchers suggest that countries should create their own - national - building assessment systems, because for instance, "*US-LEED and BREEAM remain ill-equipped to consider the idiosyncrasies of local climate conditions*"(Nelson et al., 2010). On one hand, many will not have enough resources for this and prefer better use already acknowledged and further developed international certification schemes (Retzlaff, 2008). On another hand, the co-existence of many certification schemes makes informed choices and evaluation of the state green buildings in the EU countries difficult (Nelson et al., 2010).

2.2. Certification Schemes in Sweden

During the last decade Sweden has experienced a fast and growing demand for eco-labeling of buildings. This can be illustrated with the *Figure 2.1* presented in an open ("SGBC-Syd" (South) members meeting in Malmö with the topic "*Sustainability Certifications of Neighbourhoods and Local Area Network"* (Andersson, 2012). Moreover, many companies within the Swedish construction and property sector, municipalities and governmental bodies have also started the activities which have concerned green buildings (Bergström & Save-Öfverholm, 2011). At the same "*SGBC-Syd*" members' meeting the progress of more and more members joining the Swedish Green Building Council was presented, that emphasized that in May 2010 there were just 4 main actors and by the end of June 2011 there were 36 actors with 120 people (Andersson, 2012). They all incorporated the concept of environmental sustainability which has been widely accepted and together with the whole Swedish society saw it as a voluntary commitment to apply in their everyday-life (Sand et al., 2012).

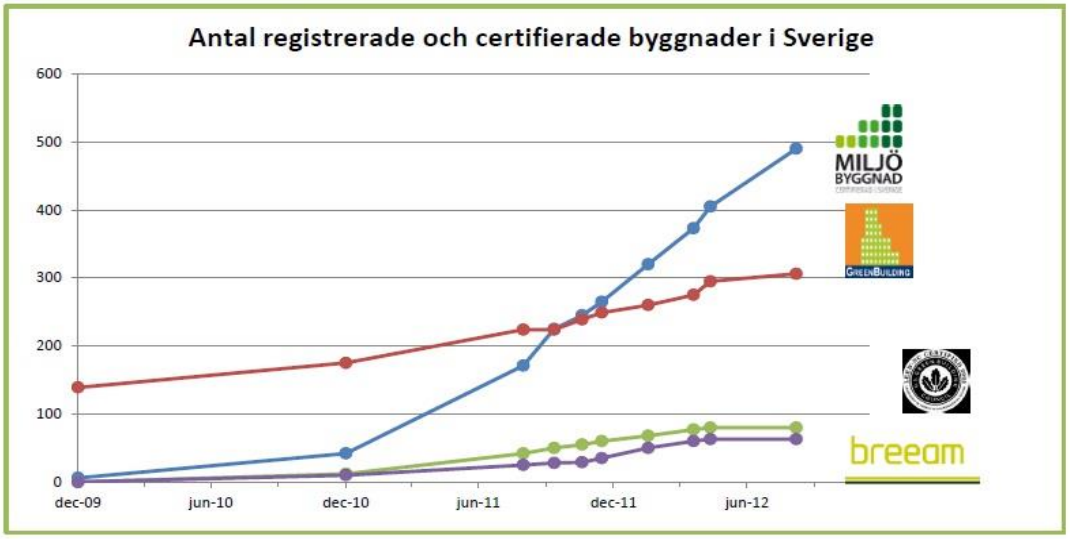

Figure 2.1 *The number of registered and certified (environmentally classified) buildings in Sweden (presentation material from the meeting "Hållbarhetscertifieringar av stadsdelar & lokalt nätverk SGBC-Syd")*

Beside the main certification schemes, there are also other labeling schemes in Sweden such as Svanemærket (Denmark), Minenergi (Sweden), Passive house (Germany), Minergie-ECO (Switzerland) or HQE (France) (Sand et al., 2012). However, I am not looking at them, because the labeling schemes represent just one particular aspect, usually energy efficiency, as the main criterion of sustainability phenomenon in the built environment.

The organization - Swedish Green Building Council has been established by the International Alliance World Green Building Council (World GBC) (SGBC, 2012). This organization has created a joint foundation of values from which the members of this non-profit organization act

for faster development with the help of certification schemes and with focus on Swedish needs and values (SGBC, 2012). However, the transition towards *sustainable* development has been relatively slow and sustainability is often seen as being about "green buildings", with a focus on managing environmental impacts, waste and energy cost savings via technological solutions or covering just particular areas of the built environment as presented in the *Table 2.1 Environmental Sustainability Parameters of Green Building Certification Schemes* (Gardiner, 2010).

Table 2.1 *Environmental Sustainability Parameters of Green Building Certification Schemes*

Certification scheme → Parameter ↓	LEED	MILJÖ BYGGNAD
Land use	☑	
Infrastructure/Communication	☑	
Ecology	☑	
Pollution	☑	
Energy	app. 35%	app. 30%
Water	☑	
Materials	☑	☑
Waste	☑	
Indoor air quality	☑	☑
Production	☑	
Management	☑	
LCA/LCC		
Economy		
# of indicators	50	16

Furthermore, a general comment about the score-based systems is that "*the overall environmental impact of a building is not directly taken into account*", which means that huge buildings using immense amounts of resources and materials can be still certified with a very good result though there are more environmentally-friendly alternatives (Dirlich, 2011).

Moreover, certification schemes in Sweden and their use are to a large extent driven by the construction industry/investors, for instance NCC, Skanska and others using certification, for instance, in connection with branding or as a selling parameter (Sand et al., 2012).

2.2.1. Leadership in Energy and Environmental Design for New Construction

LEED (Leadership in Energy and Environmental Design) is a voluntary, consensus-based, market-driven program that provides third-party verification of green buildings and covers a variety of building types form individual buildings and homes to entire neighborhoods and communities (USGBC, n.a.). Participation in the voluntary LEED process is based on existing and proven technology (USGBC, n.a.) which provides building owners and operators a possibility to evaluate "*environmental performance from a 'whole building' perspective over the building service life*" (Nornes, 2005), while providing healthy indoor spaces for a building's occupants (USGBC, n.a.). Within each of the LEED credit categories (*Table 2.2.*), projects must satisfy prerequisites and earn points what later determines the level of LEED certification, for instance, *Certified*, *Silver*, *Gold* or *Platinum* (USGBC, n.a.). According to the LEED reference guide, to meet particular certification level the projects needs to earn: 26-32 point to be "*Certified*", 33-38 points for "*Silver*" certificate, 39-51 for "*Gold*", and 52-69 –point for "*Platinum*" (Cryer & Corbet, 2006).

Table 2.2 *Main credit categories to satisfy green building requirements (Source: http://new.usgbc.org/leed/rating-systems)*

Main credit categories		Characteristics	Points
	Sustainable sites credits	Encourage strategies that minimize the impact on ecosystems and water resources	26
	Water efficiency credits	Promote smarter use of water, inside and out, to reduce potable water consumption	10
	Energy & atmosphere credits	Promote better building energy performance through innovative strategies	35
	Materials & resources credits	Encourage using sustainable building materials and reducing waste	14
	Indoor environmental quality credits	Promote better indoor air quality and access to daylight and views	15
		Total:	100

2.2.2. MILJÖ BYGGNAD

MILJÖKLASSAD BYGGNAD (Environmentally Classified Building) or MILJÖBYGGNAD have been formulated in cooperation between the Swedish government and companies and municipalities called Bygga-Bo (Build-Live) dialogue. Firstly it was developed for residential

housing and premises, while today the certification schemes cover industrial buildings as well (SGBC, 2012). MILJÖBYGGNAD gives grades using 16 different environmental indicators in the areas of energy, indoor climate and chemical substances which are measurable indicators (SGBC, 2012). When the Bygga-Bo Dialogue has been discontinued the Sweden Green Building Council took over the system.

There is no one simple calculation and grading for MILJÖBYGGNAD certification scheme. These 16 indicators (*Table 2.3.*) are rated in the system and summarized in a classification level (Skanska, n.a.) depending on the building inner area size and energy, material flows per m^3, solar heat loads, the levels of radon, how well the area is ventilated, lighting possibilities, summer and winter comfort levels and other criteria (Kjällén & Warfvinge, 2012). The rating that is achieved in the respective level is based on the lowest rating attained for the indicators. The three levels achieved are consolidated in the building's environmental rating (Skanska, n.a.). Environmental rating also provides a basis for assessing improvement measures. A primary rating can be carried out at the construction documentation phase and if this is the path taken, it must be followed up and verified not later than two years after completion. The major aim is to rate the building after at least one year of operation when the systems have been well-tuned and a user survey can be carried out (Skanska, n.a.).

Table 2.3 *Areas of control under MILJÖ BYGGNAD certification scheme (Source: Linda Kjällén and Catarina Warfvinge presentation material)*

Energy	Indoor Climate	Materials
Energy use	Acoustics	Documentation
Heat load	Radon	Phasing out hazardous substances
Solar heat load	Ventilation	
Type of energy	Traffic pollution	
	Moisture safety	
	Comfort winter	
	Comfort summer	
	Daylight	

The best it can be explained by providing an example of criteria evaluation in the *Table 2.4.* (the following page).

Table 2.4 *Examples of criteria evaluation to achieve particular level of MILJÖBYGGNAD certification (Source: Linda Kjällén and Catarina Warfvinge presentation material)*

Building regulations → Best available techniques

Qualification criteria	Bronze	Silver	Gold
Energy use	BBR[1]	75% of BBR	65% of BBR
Solar heat load	<38 W/m^2	<29 W/m^2	<18 W/m^2
Radon	≤200Bq/m^3[2]	≤100Bq/m^3	≤50Bq/m^3

Within each of the MILJÖBYGGNAD credit categories (*Table 2.3.*), projects must satisfy prerequisites and earn points what later determines the level of MILJÖBYGGNAD certification, for instance, *Qualified*, *Bronze*, *Silver*, or *Gold* (SGBC, n.a.).

[1]BBR - Basic Building Requirements for Energy

[2] Bq – radioactivity measurement in Becquerel

CHAPTER III
THEORY AND A SET OF SUSTAINABILITY CRITERIA

3.1. Environmental Psychology – Residential Satisfaction Theory

Research on housing has gone far beyond the study of physical and environmental features of the build environment (Lord & Rent, 1987). Currently more and more interest is shown towards examining of how people think of their housing and how it affects sustainability. These theoretical considerations are based on environmental psychology which is described as "*the study of the moral relationships between behavior and experience*" in built and natural environments (p.6) (Bell et al, 2001). Since the early 1960s residential satisfaction was used as the basis for modifying the architectural design of housing development projects where evaluation was collected from residents about the physical features of the buildings and then feeding those perspectives back into the design process (Mohit & Azim, 2012).

Residential satisfaction was defined by Francescato et al (1979) as the feeling of contentment when one has or achieves what one needs or desires in a house and it is an important indicator exploring success of housing development projects and highlighting areas of improvements in the current housing environment (Mohit & Azim, 2012; Lord & Rent, 1987).

Empirical studies on residential satisfaction are of two types: residential satisfaction as a forecast of individual behavior or as a determinant of housing quality (Mohit & Azim, 2012). The former one assumes that low satisfaction of dwelling unit determines "*behavior of the resident in terms of making changes to the housing unit or the decision to move to another housing unit*" (Mohit & Azim, 2012). This means that due to "*incongruence between housing conditions and desired aspirations"* dwellers make changes to existing housing or move to a property that satisfies their actual socio-economic needs (Mohit & Azim, 2012). In cases where this is not possible, they simply adapt to a new needs (Liu, 1999).

Studies that apply residential satisfaction as a criterion of housing quality use dwelling unit features, access to services and facilities in the built and the surrounding environment to determine the degree to which an occupant is satisfied with the residential environment (Mohit & Azim, 2012). In this case residential satisfaction has two different scales: *objective* where physical aspects of housing features are evaluated and *subjective* which includes perceptions, satisfaction, aspirations, and also disappointment (Sam et al, 2012).

Theoretical foundation on residential satisfaction is based upon an idea that "*residential satisfaction measures the difference between actual and desired housing* "and community conditions (Mohit et al, 2010), and are clearly determined by physical (e.g. location with it attributes such as accessibility to green spaces, educational and medical institutions, etc.) and

social factors (Bell et al, 2001). However, it might not cover all aspects of the three sustainability pillars, and even it covers, those aspects might be not fully sustainable.

If the residents are satisfied with household conditions there are no complaints and there is "*a high degree of congruence between actual and desired situations*" (Mohit et al, 2010). In this situation the ignorance factor is also important which can be caused by doubt and uncertainty about the actual and desired situation in the property. The main factors helping to predict housing satisfaction are: 1) the physical aspects of the housing (the quality of buildings and how well it is designed to satisfy occupants' needs), 2) the housing space (with respect to density and privacy), 3) safety, including safety within the unit and in the local society, and 4) community networks and the sense of neighborhood (p.406) (Bell et al, 2001). Similarly Bell et al, Mohit et al, (2010), in their papers summarize Varady's and Carrozza's work which highlights that housing satisfaction is related to satisfaction with "*physical aspects and personal preferences of the housing unit, satisfaction with services provision, and satisfaction with the neighborhood and area*". However, "*incongruence between housing conditions and desired aspirations may lead to dissatisfaction*" (Mohit et al, 2010). In other words, if those factors outlined above diverge, residential satisfaction cannot be achieved.

Mohit et al, (2010) note that the majority of empirical studies on residential satisfaction due to its complex structure have used a combination of frameworks and variables representing housing and neighborhood's characteristics, individuals' socio-demographic attributes, and the perceptions about dwelling unit features and neighborhood conditions. In my work I will focus more on residential satisfaction as a determinant of housing quality rather than a forecast of individual behavior to move. Moreover, in the next section I will present a framework which serves as a composite construct to evaluate residential satisfaction, and focus on areas of improvements within the dwelling units in the southern Sweden.

3.2. Identification of a Set of Sustainability Criteria

During the recent years building certification schemes have begun to focus on communities and social issues rather than solely on building technology and design (Retzlaff, 2008). However, there is no consensus about which sustainability criteria are appropriate to the building development projects (Retzlaff, 2008). It is clear that those building certification systems are not able to assess the whole socio-economic and environmental criteria, and as Ardebili and Boussabaine (2007) note, many of those can only be assessed subjectively. Based on the triple-bottom line factors associated with complex sustainability issues in the housing sector, a three-category framework (environmental, social and economic) of sustainable housing criteria have a potential to assess the sustainability of the buildings and areas for improvements in the certification schemes. Therefore, the next stage involves identification of a set of sustainability criteria. More specifically, the study is based on the premise that true sustainable housing development must reflect (Turcotte & Geiser, 2010) the majority of the criteria from the three

dimensions of sustainability. The criteria of three sustainability dimensions are presented below in *Figure 3.1*.

Huong & Soebarto (2003) evaluating different perceptions of actors about sustainable housing involved the following criteria:

- *Social aspects*: design, convenience for user, safety and location.
- *Environmental aspects*: resources conservation, location and building's durability.
- *Economic aspects*: affordability and business opportunities in the area.

Further, after an extensive literature and certification schemes review, I have summarized and added aspects outlined below which falls into the three categories of sustainability. The upgraded framework additionally included those aspects:

- *Social aspects*: active community organization, heritage values of the building, social activities within the community, population density in the area, internal and external housing conditions (e.g. space, ventilation, natural lighting, provision of meeting places, sense of neighbourhood, playgrounds for children, accessible for people with impediment), and certified building.
- *Environmental aspects*: waste recycling, green spaces, access to facilities, energy from renewable energy sources and environmental quality.
- *Economic aspects*: willingness to pay (WTP) more for environmentally-friendly housing, community energy tariff and certified building.

The framework is presented in the *Figure 3.1*. in the following page.

Figure 3.1 *A set of three-dimensional sustainability criteria (environmental, social and economic)*

The criteria presented in the framework were chosen not only to best fit the main research questions, but also to tie the whole research to a larger sustainability realm.

McFadden (1977) (p.1) notes that "*the classical economically rational consumer will choose a residential location by weighing the attributes of each available alternative*". Those alternatives includes accessibility to a workplace, shopping and educational facilities, quality of neighborhood life and safety in the area; costs, including housing prices, taxes, and travel costs, dwelling characteristics such as property age, number of rooms, and environmental characteristics such as green spaces, playgrounds and others (McFadden, 1977). Those choices help to *maximize the utility* among all housing alternatives and satisfy the residents' expectations (McFadden, 1977).

Bell et al, (2001) summarize that there is general agreement among architects and designers that "*buildings and other designed environments should fulfill three basic purposes: commodity, firmness and delight*". The first one refers to the functionality of a design, the second – to the structural integrity and permanence (or building's durability), and delight encompasses aesthetic concerns (p.376) (Bell et al, 2001). Different architects may place different emphasis on these interrelated dimensions; however, the final design must include all of them to satisfy the occupants living in the setting.

The convenience for user means that internal/external housing conditions are good quality, useful, provides comfort and saves time and efforts. For instance, an increase of convenience could come from the system automatically switching on and off lights upon room entry and exit (Montano et al, 2005).

Rising energy, water and district heating demands, increasing costs and limited natural resources mean that householders are more conscious about managing their domestic resource consumption (Chetty et al, 2008). Researchers found that "*currently resource consumption is mostly invisible to householders and that they desire more real-time information to help them save money, keep their homes comfortable and be environmentally friendly*" (Chetty et al, 2008). Therefore, emphasizing on resource conservation in housing settings enables domestic sustainability to occur and improve the visibility of resource production and consumption as well as support behavioral change (from consumers to producers) (Chetty et al, 2008).

Business opportunities in the area you live are able to build sustainable and healthy inner city community and provide competitive advantage on business opportunities that are genially profitable (Porter, 2012). Also it provides community with better social cohesion, reduced costs on travel to-and-from work and time savings.

Another factor falling under social sustainability category is a heritage value of the building. As "*one of the primary goals of a design is to evoke a pleasurable response from the people viewing the finished setting*" (p.398) (Bell et al, 2001) and the next one is to keep the primer aesthetics and further create a heritage value. As the most common aspirations and desires to increase a heritage value of the building are opportunities to preserve natural and built environment

habitats, improve environmental quality or quality of life and sense of place, and enhance local distinctiveness (English Heritage, 2010).

"Sense of community", "place attachment" and "neighborhood social networks" are the concepts which address a sense of emotional connection between people and their communities (p.358) (Bell et al, 2001). The presence of sense of neighborhood and social networks may help "*regulate access to an area by strangers, leads to less reliance on police or other officers dealing with disturbances, and increase the diffusion of social responsibility and communal activities*" (Bell et al, 2001). In this paper I have separated "*active community organization*" from the "*sense of neighborhood*", because according to the activities within the community ranking in the survey questionnaire I will try to interpret if there is an interest in a community at all about the communal organization.

Further, most researchers believe (Bell et al, 2001) that playing and game activities are an important instrument for learning about the surrounding environment, therefore provision of urban playgrounds may serve an opportunity for children to learn, play and socialize. Acknowledging this fact, I have placed this criterion in the category of external housing conditions.

As further criterion falling under external housing conditions is place accessibility for people with impediment. Here I focus "*on physical access to buildings, public spaces, and any other place a person might need*" (Rabinowitz, n.a.). Physical access includes things like accessible routes, curb ramps, parking and passenger loading zones, elevators, signage, entrances (p.493-498) (ADA, 1994).

The internal housing factors should not be overlooked as well. Illumination or natural lighting plays an important role "*for successful performance on tasks requiring good visual acuity or in making color discriminations*" (p.387), also lighting "*has an effect on mood, cognition, and social relationships*" (Bell et al, 2001).

Satisfaction with inside space is closely related to furnishings and size of housing. For instance, "*the arrangement of the interior environment may induce social interactions; provide comfortable home environment, and influence the occupants' performance and productivity*" (p.388) (Bell et al, 2001). Adequate ventilation helps to combat condensation dampness and avoid mold, provides a supply of oxygen and prevents wood rot in roof spaces or areas under the ground floor (westlothian.gov.uk, 2013).

Bell et al, (2001) summarize that "*most early research on human crowding assumes that high density would lead the humans to uniformly negative effects*". One of the most common assumptions that can be found in the personal space literature and that people make about high densities in the area (or crowding) is that it makes them to "*feel bad*", creates more anxiety, and

in some cases lead to physiological effects, such as increased heart rate and blood pressure (p.303,304) (Bell et al, 2001).

The importance of green spaces is well described in various bodies of literature. For instance Bell et al, (2001) note that "*the presence of trees and maintained grassy areas increases feeling of safety* (p.349), *provide quiet vistas and opportunities for reflection* (p.350)" and meeting places. Also green spaces may induce "*creativity in play for children* (p.349) and "*desire to participate in organized activities* (p.350)" (Bell et al, 2001).

Speaking about environmental quality it is important to note the fact that "*we often walk around in the air that is filled with toxic particles, aerosol spray emissions, and factory discharges, as well as gaseous and solid airborne particles from industrial waste*" (p.240) (Bell et al, 2001). Perception, that your environment quality is not adequate due to the factors outlined above, causes stress or annoyance and in some cases it can be associated with and contributed "*to complaints of sick building syndrome*[3]" (Bell et al, 2001). Also environmental quality involves not only clean air, but also water and soil. Therefore, including this aspect into the framework may propose some ideas for further action (if needed).

Recycling is another criterion in an environment category. Since waste landfilling is generally considered as a non-sustainable and environmentally questionable option, recycling provides an alternative to lessen environmental burden (Brems et al, 2012).

Locations chosen for an analysis are expected to grow and this growth will increase a demand for infrastructure services (or access to facilities) (Fay & Yepes, 2003). An access to infrastructure (or facilities) covers the areas such as education services, transport, employment services, manufacturers, insurance and housing services (rnib.org.uk, 2013). Access to facilities ensures more efficient resource use in the area, fostering information, goods and services share, and satisfying human needs (Fay & Yepes, 2003).

A criterion of willingness to pay (WTP) is a reflection of the maximum amount a consumer thinks a product or service is worth (Hanemann, 1991). This behavior indicates how consumers make buying choices on the basis of prices, which in return signals the real estate market about the customer demand for the environmentally-friendly housing. In general, there are two main types of additional costs with obtaining certified building. The first is payment to the certifying body (e.g. the company), and the second – production costs required to meet the certification standards (Fuerst & McAllister, 2011). In majority of the cases, unwillingness to pay occurs due to the second precondition.

[3] Sick building syndrome - an illness affecting workers in office buildings, characterized by skin irritations, headache, and respiratory problems, and thought to be caused by indoor pollutants, microorganisms, or inadequate ventilation (thefreedictionary.com).

Lastly, community energy projects are one of the best ways to scale-up small- and medium-scale renewables technologies (as introduced in the framework) which offer a number of benefits (Clark & Chadwick, 2011). For instance, "*transmission losses can be kept to a minimum*, because generation takes place near the point of consumption, *local generation encourages people to use energy more carefully, provides more sophisticated metering that usually accompanies those projects and highly empowering, boosting a sense of the community as a whole*" (Clark & Chadwick, 2011). Community energy tariff in this case would mean that the provided electricity is not only green and its price are revised/adapted to the community consensus, but the tariff should also create an additional environmental benefit too. For instance, contribution towards community energy projects (e.g. solar panels on the roofs) (Clark & Chadwick, 2011). In this manner, two criteria – energy from renewable energy sources and community tariff's provision - would be fulfilled.

CHAPTER IV

METHODOLOGY

4.1. Research Design

The research design was chosen as several comparative case studies where different perspectives about sustainable housing are compared and later the gaps are revealed in the survey results. The research was based on inductive reasoning rather than deductive where with reference to established set of sustainability criteria and residents perception, the observations and patterns could be confirmed or not (Burney, 2008).

As a research method I have chosen triangulation, using mixed-methods. As Cohen and Manion (2000) note "*triangulation attempts to map out, or explain more fully, the richness and complexity of human behavior by studying it from more than one standpoint*". Therefore, I have used qualitative and quantitative (validation) research where quantitative results were compared with qualitative, and also literature review was compared with questionnaire findings. This type of research equips me with an epistemological position as being interpretivist, meaning that I am able to analyze and understand "*the social world through an examination of the interpretation of that world by its participants*", specifically, building occupants (Bryman et al., 2008). Also this type of research provides me with *inductive view* (Bryman et al., 2008), which is based on a number of observations of the individuals and their experiences/perceptions about the phenomena (e.g. sustainable urban environment), and allows me to enrich the theory form the research results, and "*construct the social properties"* (Bryman et al., 2008). Via qualitative research I have discovered underlying meanings and patterns of sustainable housing phenomenon and further via quantitative research I have been able to test and verify theoretical standpoints of residential satisfaction.

Furthermore I have used descriptive statistics (quantitative method) that helped to reveal particular patterns of building tenants' perceptions that have formed the inferences about the population sample (certified/uncertified buildings tenants). In addition, it helped making predictions for further improvements of certification schemes and the built environment, and helped estimating unobserved values in population being studied (Breiman, 2001).

4.2. Case Studies Selection

As the case studies for the research I have chosen Malmö's Western Harbour/Västra Hamnen Bo01 "sustainable city" district (*Figure 4.1*) because it is a good model for sustainability and reflect many of the sustainability criteria and also links urban goals with management/design goals and actions across different levels.

Figure 4.1 Western Harbour/Västra Hamnen Bo01
Source: *http://malmo-copenhagenwebsite.blogspot.se/2011/11/western-harbour.html*

Other two locations *Lillviken Hus 4* in Kalmar (*Figure 4.2*) and *Villa Trift 3.0* in Kobjer were selected because they represented certified buildings category. The former house has been awarded LEED-NC status and the second house was Silver-certified by Miljöbyggnad in 2010 (Bergström & Save-Öfverholm, 2011).

Figure 4.2 *Lillviken Hus 4* in Kalmar
Source: *Skanska (2013)*

Additionally all the locations were selected because they were in the same regional market (Turcotte & Geiser, 2010) with relatively differing affordability options. For instance, in Malmö Western Harbour/Västra Hamnen Bo01 district 1 m^2 costs around 34 000 SEK (booli.se, 2013) while in Kalmar 1 m^2 costs approximately 25 000 SEK (numbeo.se, 2013). In Lund the

apartments near the city canter cost around 30 000 SEK/m^2, and the apartments located a bit further from the city center cost approximately 25 000 SEK/m^2 (booli.se, 2013). Property price is a detrimental variable not only as a primary criterion acquiring the property, but also it affects socio-economic aspects, such as a greater sense of opportunity and security while holding household assets (DPMC, 2008). Another issue is that varying pricing set different opportunities to afford the housing property. For instance, younger residents might find great difficulties in acquiring the property, and need to safe a larger deposit, or take on more debt in order to buy the property. Whereas, the elder residents who already have a deposit, or earning more, also have a higher opportunity to acquire a property in more expensive locations.

As for the uncertified building locations I have chosen *BRF Lunna Töser* building in Södra Vägen 13 and one building in quite newly built neighborhood in Tryckerigatan 2.

4.3. Data Collection and Analysis

Phases helping to answer the research questions and collect data are as follows:

1. Literature review
2. Observations in the selected study locations
3. Survey questionnaire compilation and distribution to the key informants
4. Results analysis

An extensive literature review was conducted covering a broad range of subjects to ascertain the importance of certification schemes and sustainable housing. The documentation covered reports, proposals, formal evaluations and studies, newspapers, media articles, and other documents from the internet (Turcotte & Geiser, 2010). The key findings are introduced in the last sections of the thesis.

Further direct observations through the visits were conducted for each case location selected as a case study with information about the buildings, area and possible neighborhood activities (Turcotte & Geiser, 2010). For instance, in March I have joined guided tour of Malmö's Western Harbour/Västra Hamnen Bo01 "sustainable city" district led by *Louise Lundberg*, the founder of Grönare Stad (Greener City) AB. Also I have visited *Lillviken Hus 4* in Kalmar, and *Villa Trift 3.0* in Kobjer.

The third step was survey questionnaire compilation and distribution to the key informants. The survey comprised of printed questionnaires based on a set of questions to obtain both quantitative and qualitative responses. The first part of questionnaire assessed background information, such as residents' age, years of living in a property, number of people in the household and minors inclusion. The second part of the questionnaire was formulated in a manner to gain some insights into the attitudes towards green building concepts and personal incentives as a base for social sustainability. The third part of questionnaire examined perceptions of the environmental, social and economic dimension of housing.

In the beginning questionnaires were discussed in a study circle and then sent to Ramböll Sverige Project Manager who is working with certification schemes to get input and advice from the professional side. In order to simplify the evaluation of sustainability performance of the certified and uncertified buildings, the questions were presented as multiple choices with possibility to comment. In addition, for ranking I have used a five-point Likert scale. It ranged from "1" = very dissatisfied to "5"= very satisfied, and was used to measure respondents' level of satisfaction on two housing conditions (internal and external) and for overall housing evaluation. Copies of questionnaires are attached as Appendix I and II.

Three types of questionnaires were distributed to the key informants: one for the certified buildings' residents from whom I got 35 questionnaires answered. The second questionnaire was distributed for the uncertified building residents (22 questionnaires answered out of 30), and the third one to the construction industry professionals (5 questionnaires answered out of 40) from the companies YIT, Skanska, NCC and Ramböll Sverige.

The intention to choose two different living contexts (uncertified and certified buildings) was to see the differences (or similarities) that potentially indicate residential attitudes reflecting a shift from green to sustainable urban environment. In addition, to answer the second subsidiary question, industry's professionals' perspectives on green houses and transition to sustainable buildings were acquired to gain knowledge from the other type of stakeholders – not living in those buildings but providing people with those properties that buildings already have. In addition, those individual professionals "*are expected to make major decisions while a whole community of the households can only propose the ideas*" (Huong & Soebarto, 2003).

Finally, the key findings from the survey questionnaires will be analyzed in the following sections using *Residential Satisfaction* theory and via an established set of sustainability criteria.

CHAPTER V

RESULTS

In this part the green (certified) and uncertified buildings' the residents' attitudes that reflect a shift from "green" buildings to sustainable urban environment, and building industry professionals' opinions on sustainable urban development will be presented.

5.1. Survey Results: Green buildings

The certified building questionnaires were completed during the visits to Western Harbour/Västra Hamnen Bo01, *Villa Trift 3.0* in Kobjer and to *Lillviken Hus 4* in Kalmar. In total there were 35 respondents. Since the background information did not set any implication for further research it is presented as additional information in the Appendix III *Table 5.1*.

When it came to building certification schemes only very few (5) people knew that their property was environmentally classified. Twenty indicated that they did not know and the other 10 said that they knew that their building was not certified by any certification system. *Figure 5.1* presents an overview of green building residents' main reasons for acquiring their housing property.

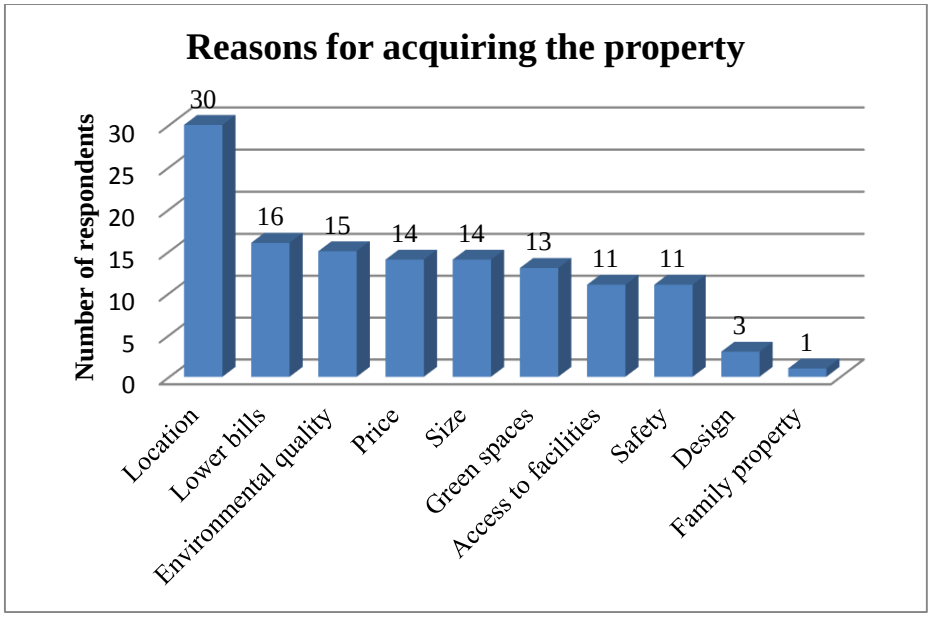

Figure 5.1 *The main reasons for acquiring the property (Certified buildings survey, N=35) (own illustration)*

The results of the survey indicated that only 2 % of the respondents were very familiar with the concepts and methods of green buildings. Thirty four and 38 % of the respondents were somewhat or barely familiar with the issue, and the remaining 26 % was not acquainted at all. Media (54 %) and personal research (24 %) were respondents' main sources of information on green building practices. Eighteen % of the sample did not indicate any sources of information.

For people interested in green building concepts and practices the most influential sources of knowledge were ideas, concepts or publications (13 respondents). Six of them indicated personal experience as a source of knowledge and 2 persons noted that the most influential source in developing their interest in green buildings were TV documentaries. Since personal incentives and active community organization builds on social capital which in return enhances social sustainability, I asked the respondents to rank social activities. It is important to note that 11 participants did not respond to this question. The rest of the responses indicated that residents had moderate interest (3 points out of 5 based on a Likert scale) towards engaging in the communal activities.

In the last part of the survey questionnaire the respondents indicated the biggest benefits of their current house compared to their previous housing situation. Twenty five respondents noted that in the current house they saved on heat. Thirteen respondents said that they noticed electricity savings and 7 respondents benefited from lower water bills. When asked about the possibility to buy electricity from a renewable energy provider and to introduce a community tariff more than half of the respondents (52 %) wanted to buy electricity from a renewable energy provider, 44 % were not sure (did not know), and only one reply was negative, while another one said that they were already using electricity from renewable energy sources. Opinions on community tariffs were similar: Forty nine % did not know if they wanted a community tariff, 31 % said yes, and 18 % did not want. One respondent indicated that they did not need it (*Villa Trift 3.0*).

The following question examined the level of measures the interviewees have taken to reduce energy, water use and prevent waste. The results are presented in *Figure 5.3*.

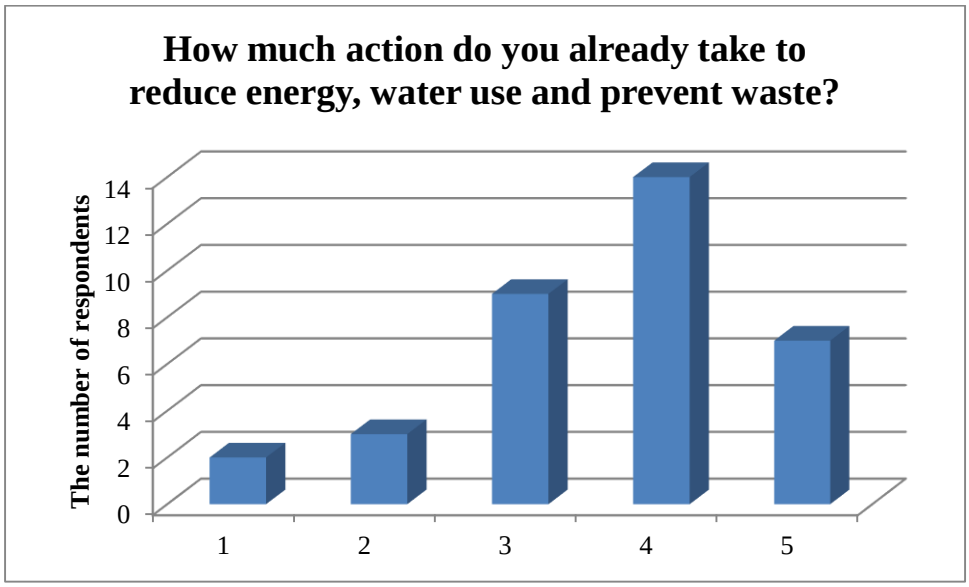

Figure 5.3 *Number of respondents (N=35) who have ranked their actions with regard to energy, water use reduction and waste prevention (5 – "I do everything I can", 1 – "I do not think I can do much") (Certified buildings survey) (own illustration)*

Inquiry about increase in environmentally-friendly routines (e.g. turning off the appliances when not in use, drying clothes outside when warm, waste recycling and others) revealed that the majority of respondents (39 %) while living in green building did not increase their routines to become more environmentally friendly when compared to previous living situation. Thirty two % stated that the routines stayed the same, and 6 % have noted that environmentally friendly routines have increased. Twenty three % of the sample did not know.

The following questions assessed whether green building residents have an adequate access to public transport and connections to bike paths. Sixty three % were positively, 14 % indicated that access to the transport facilities was insufficient and 23 % were not aware due to the fact that they are driving. Sixty nine % of the respondents indicated that educational and recreational facilities are easily accessible in the area. Leaving 29 % that answered negatively and 2 % that are not aware of the issue.

Satisfaction with inside and outside housing conditions revealed that the majority of the respondents are satisfied (94 and 82 % respectively). Just a small part - 6 % were dissatisfied with internal housing conditions, and 18 % with external housing conditions.

The evaluation of the overall housing conditions highlighted that the majority of respondents rated their housing situation quite high. Fifty one % was satisfied and 49 % of the sample was very satisfied with housing conditions (5 – very satisfied, 1 – very unsatisfied).

One of the final questions asked respondents to give a priority to 5 criteria from the list which would represent the most important criteria within the built environment. The results are presented in *Figure 5.4*.

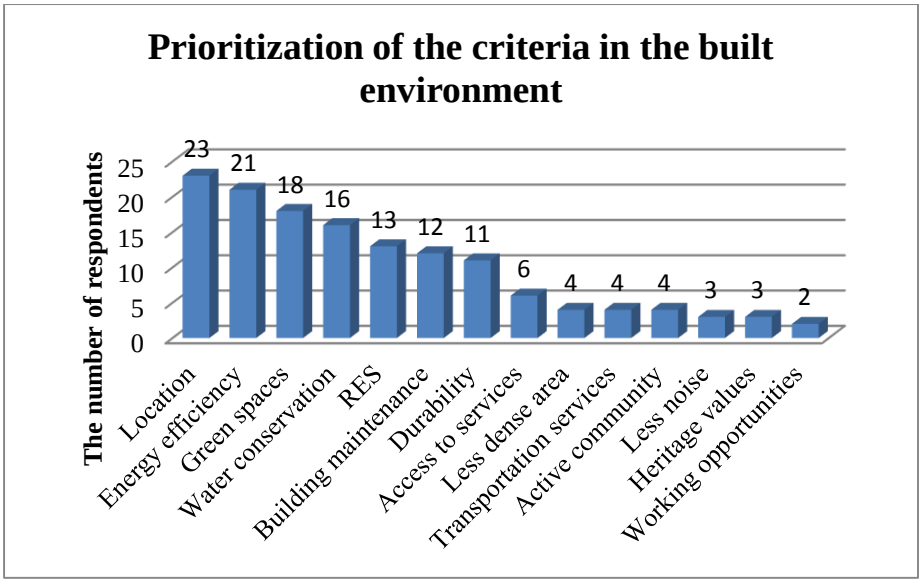

Figure 5.4 *Prioritization of the criteria in the built environment (Certified buildings survey, N=35) (own illustration)*

5.2. Survey Results: Uncertified buildings

The survey of uncertified buildings was conducted in *BRF Lunna Töser* ("The Lundian Girls") building in Södra Vägen 13, and Tryckerigatan 2. There were 22 respondents. Similar to the certified buildings survey the background information did not set any implication for further research, thus it is presented as additional information in the Appendix III *Table 5.2*.

The main preferences as perceived by uncertified building residents for acquiring their property are presented below (*Figure 5.5*).

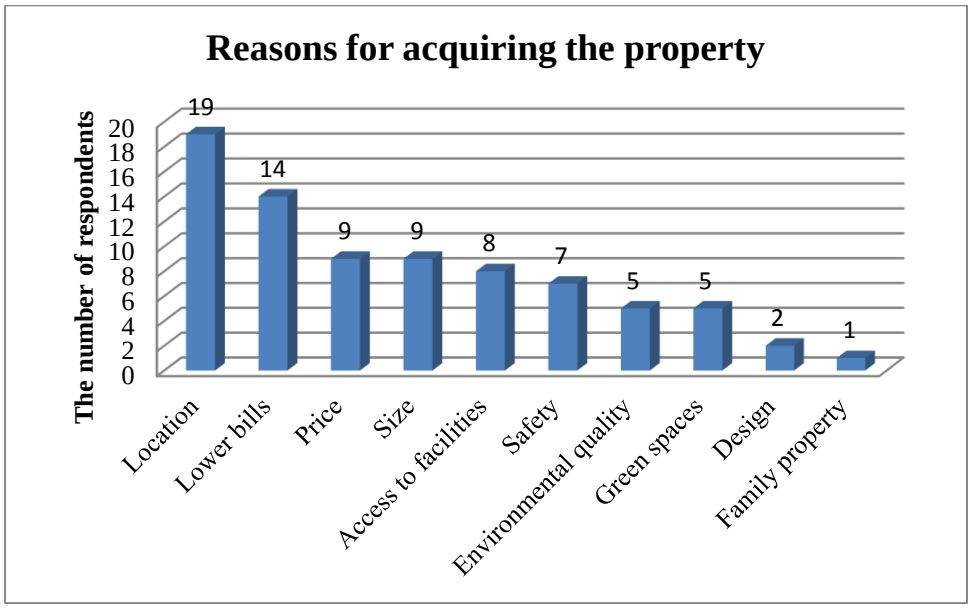

Figure 5.5 *The main reasons acquiring the property (Uncertified buildings survey, N=22) (own illustration)*

Further, the results showed that none of the respondents is very familiar with the concepts and methods of green buildings. Twenty three % and 50 % respectively were somewhat or barely familiar with the issue, and the rest was not acquainted at all. As the main sources of information on green building practices they have indicated mass media (68 %). Twenty seven % of the sample did not mention any sources of information. For people interested in green building concepts and practices the most influential sources of knowledge were ideas (what to have at home to improve the occupants' well -being), concepts (what/how to implement?) or publications (10 respondents). One of them indicated personal experience as a source of knowledge and 1 person noted that the most influential source in developing their interest in green buildings was an event.

With regard to the potential of personal incentives in community the results showed that only 2 respondents did not include any ranking of the activities. The rest of the results are synthesized in the *Figure 5.6*.

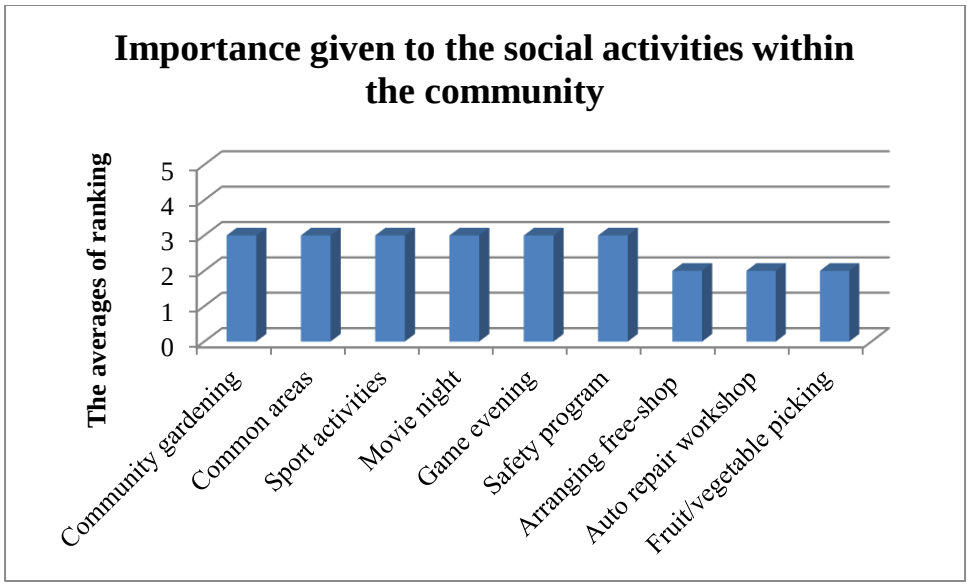

Figure 5.6 *The average values of the importance given to the social activities within the community (Uncertified building tenants survey, N=22) (own illustration)*

As the biggest benefits of their current house compared to their previous housing situation respondents indicated electricity and heat savings (11 respondents). Five respondents said that they have noticed water savings and 6 respondents did not notice any difference to the previous place. Concerning the option to buy electricity from renewable energy provider (the provider options and buying scenarios were not introduced in the survey) and to introduce a community tariff revealed that more than half of the respondents (59 %) would like to buy electricity from a renewable energy provider. Twenty eight % were not sure (did not know) and only 3 replies were negative. Opinions on a community tariff revealed that 77 % did not know if they wanted a community tariff, 23 % said yes, and no one gave a negative reply.

Further results (*Figure 5.7*) showed how much action the residents have already taken to reduce energy, water use and prevent waste.

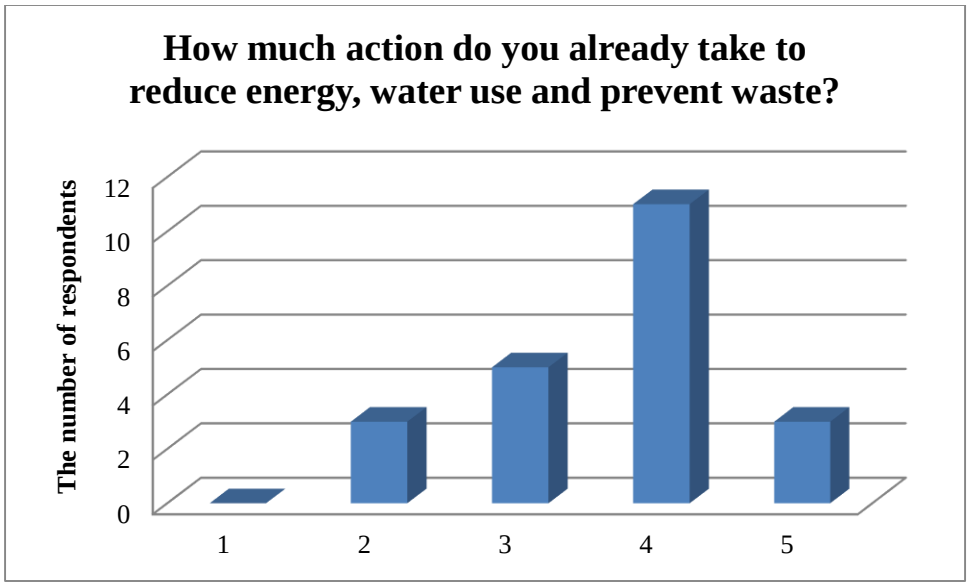

Figure 5.7 *Number of respondents (N=22) who have ranked their actions with regard to energy, water use reduction and waste prevention (5 – "I do everything I can", 1 – "I do not think I can do much") (Uncertified buildings survey) (own illustration)*

The following results represented whether uncertified building residents' perceptions about having an adequate access to public transport and connections to bike paths. Sixty nine % answered positively, 9 % indicated that access to the transport facilities was insufficient and 22 % were not aware as they are driving cars. Seventy three % of the respondents indicated that educational and recreational facilities are easily accessible in the area. Twenty two % disclosed negative answers and 5 % were not aware of the issue.

Satisfaction with the inside and outside housing conditions revealed that the majority of the respondents were satisfied (77 and 77 % respectively). The remaining 23 % were satisfied neither with the internal nor with the external housing conditions.

Evaluation of the overall housing conditions highlighted that the majority of the respondents valued their housing situation quite high. Over 20 % of the respondents were very satisfied, 59 % satisfied and 18 % slightly satisfied. (5 – "very satisfied", 1 – "very unsatisfied"). There were no responses that allocated a scoring below "3".

The final results (*Figure 5.8*) represented the most important aspects for residents within the built environment.

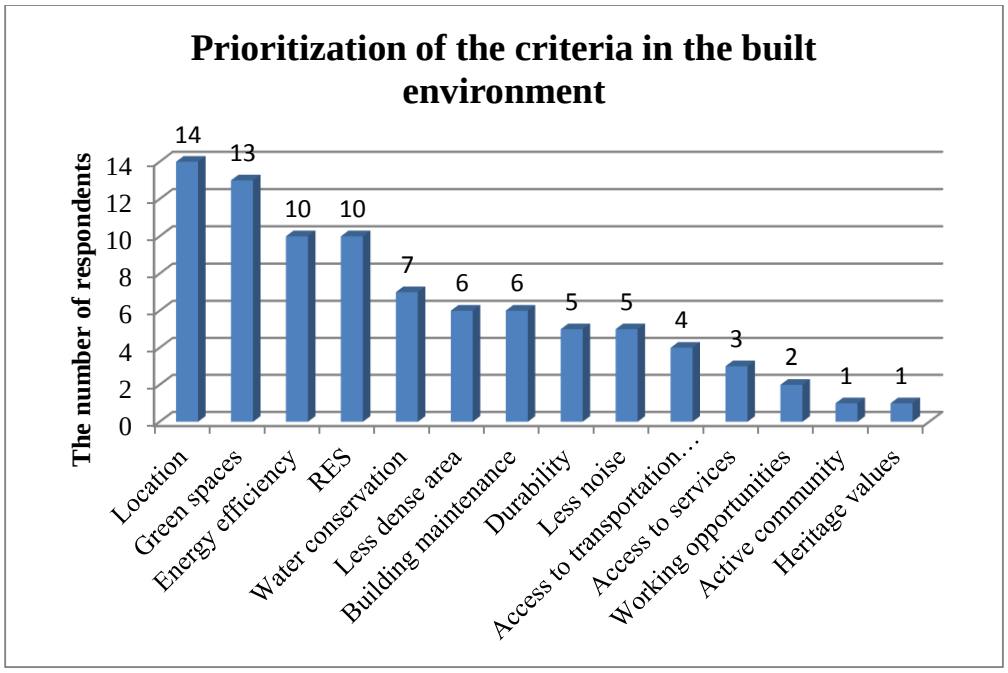

Figure 5.8 *Prioritization of the criteria in the built environment (Uncertified buildings survey, N=22) (own illustration)*

5.3. Survey Results: Construction Industry Professionals' Opinions

I have conducted few (5 responses out of 40) survey questionnaires with the industry professionals in Sweden, which gave me insights what are the main opportunities, barriers, marketing mechanisms or sustainability practices in the construction industry.

The majority of the respondents were engineers or sustainability consultants working with certification schemes (LEED, BREEAM or MILJÖ BYGGNAD) and methods for green buildings for approximately 5 years. Almost all the professional stated that the green building projects have increased substantially during the past three years. This confirms what Andresen et al, (2012) note in their paper that "…*the construction of dwellings seems to be increasing, where 24 500 constructions of dwelling units were planned in 2011, which was an increase of 50% compared to 2009*". Also all respondents expected the increase in green building projects over the next 3 years.

When I asked "What sustainability means in the construction industry", the respondents outlined the factors such as *low energy costs*, *environmentally friendly* or *recycled materials*, *buildings that have good indoor air quality*, *have positive impact on the climate*, *is built to hold for many years*, *is sustainable for the owner and users in the long-term perspective*. As the most common focus areas when marketing green buildings to potential customers, the professionals form Ramboll Sverige summarized that "…*the customers will get a "smart" building; energy efficient that will save the money during the lifetime of the building and people will live in a healthy*

environment". Another specialist highlighted the importance of *energy efficiency* which was also the dominant factor to incorporate in a new construction or renovation projects. Complementary *site location* and the *indoor air quality* were mentioned.

Figure 5.9 represents the main reasons for the implementation of sustainability practices and certification schemes as perceived by the industry professionals. Moreover, very often similar reasons are indicated when asking about the major factors/influences on how to choose particular certification scheme in a company.

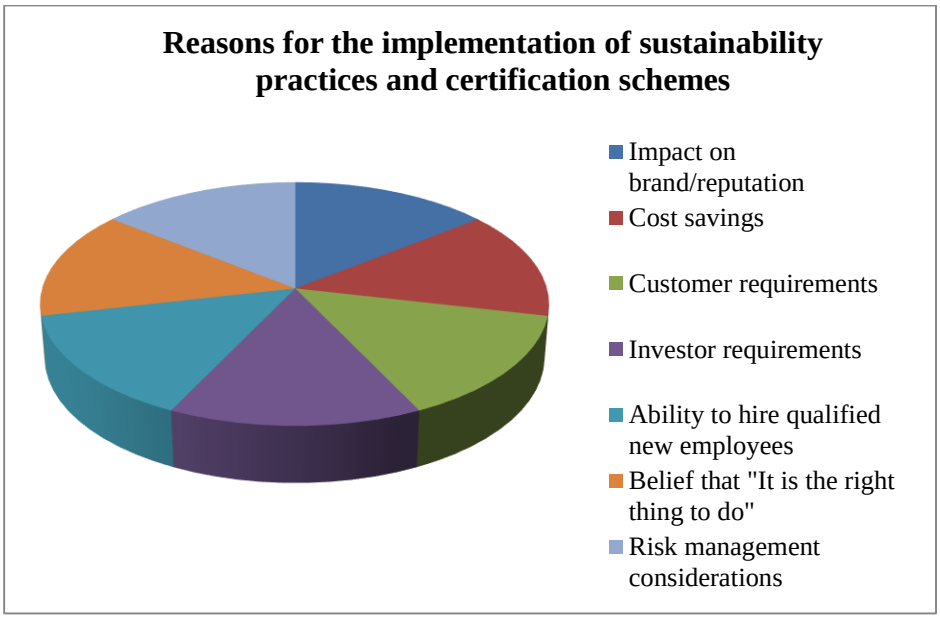

Figure 5.9 *Reasons for the implementation of sustainability practices and certification schemes perceived by the industry professional (Industry professionals' survey questionnaires, N=5)*

There were numbers of reasons determining social components in the certification schemes. One said that social aspects are sufficiently addressed in the certification schemes, other – *somewhat*, another – *barely*.

Further, I have asked to highlight the other areas which are not sufficiently covered by a building certification process. The areas for improvements are as follows: *meeting the governmental requirements*, *reducing operational and maintenance costs*, *increasing waste management possibilities* on the new projects' sites, *providing business opportunities in the area*, *increasing occupants' productivity*, *stimulating green competition* in the market, *raising public awareness about environmental issues*, and *preventing "green-wash" or false and exaggerated claims*.

Also I aimed to find out about the internal and external housing conditions (the same question was posed to certified/uncertified buildings' tenants). The results revealed that for internal housing conditions, the most important indicators were *space*, *natural light*, *good acoustics* and *ventilation*. Meanwhile the external housing conditions' indicators were named to be

geographical position, *sense of neighborhood*, *meeting places provision*, and *adequate access to services*.

In the second part of the industry professionals'' questionnaire I inquired about the different factors making influence on certification schemes. The results showed that the major influences were *lack of training/education in sustainable design/ construction*, *lack of expressed interest from clients (owners, developers, tenants, and investors)* or *project team members*, and *difficulty to assess information on green building certification schemes* if the guidelines are not in Swedish. Moreover, the majority believed that *green building options are too expensive* and *the recovery of long-term savings is not reflected in the projects*. As minor barrier the professionals noted *obtaining financing for green construction projects from banks*.

In conclusion, in both cases the results still represent strong emphasis on environmental criteria. Socio-economic criteria which might indicate a shift from "green" buildings to sustainable urban environment are still less dominant. Moreover, the results from industry professionals' questionnaire indicated the same attitudes which strongly emphasize environmental aspects. However, there are some aspects highlighting socio-economic criteria such as, providing business opportunities in the area, increasing occupants' productivity, raising public awareness about environmental issues, building house where residents can have a sense of neighborhood, providing meeting places and adequate access to services.

CHAPTER VI

COMPARATIVE ANALYSIS and DISCUSSION ON RESIDENTS' PERCEPTIONS

6.1. Comparative Analysis and Discussion of Residents Perceptions in Certified and Uncertified Buildings

The study findings indicate that in both cases the households showed some similarities and differences in the main reasons for acquiring the property. Despite the fact that the list of motives was very wide, location and reduced costs for electricity, water and heating were the main preferences in both cases. However, uncertified building residents highlighted price and size of the property as additional aspirations for buying the apartment, whereas certified building occupants depicted environmental quality, green spaces, and safety in the area as the top priority reasons for obtaining the apartment. It is not surprising that location was one of the most significant aspects, as it describes not only the physical location, but also the attributes of this location, such as accessibility of workplace, shopping and educational facilities, quality of neighborhood life and safety in the area (McFadden, 1977). The other factors addressed often almost equally were access to facilities or inherited family property. Also, the professionals form Ramboll Sverige confirmed that the most common focus areas when marketing green buildings to potential customers are "*…site location, that the customers will get a "smart" building; energy efficient that will save the money during the lifetime of the building and people will live in a healthy environment*".

Moreover, in both cases households displayed a lack of concern with the willingness to pay (WTP) more for environmentally-friendly housing. As a confirmation, results from other studies showed that in those cases reinforcing the shift from uncertified buildings to greener or even to sustainable ones as a price-based solution (WTP) cannot be employed, and provision of "*environmental public benefits*" is not viable (Fuerst & McAllister, 2011). Nevertheless, despite the unwillingness to pay (or stated preference not to pay) from residents' side, this might be attributed to the market failure as well. This can be endorsed by imperfect information in the market, split incentives, risk aversion or skills shortages from the developers (Fuerst & McAllister, 2011).

The results from both cases showed that residents' were barely or not at all knowledgeable and aware of the built environment and familiar with the practices of green buildings. The main sources of knowledge and information provision they outlined were media, articles or personal research. This meant that occupants were aware of the specific benefits (either tangible or intangible) that green buildings can provide, also there might have been existing biases against green buildings (expensive, no difference in costs, etc.) (USGBC et al, 2003). Therefore, residents were not willing to pay more to live in an environmentally-classified building. This barrier could have been overcome by providing assistance from professionals in the built environment (this desire was demonstrated in the survey). Also, highlighting a trend of green

buildings in local business publications, its rising credibility in the market, and large developers that are embracing the shift would be beneficial (USGBC et al, 2003). Other options include the publication of productivity studies that would demonstrate increased occupants' productivity and overall satisfaction with the housing conditions, inviting local manufacturers to introduce residents to new building products and their applications in creating a new standard in buildings (USGBC et al, 2003). Those alternatives might be topics of further research in the relatively new field of study in green buildings.

Moreover, throughout the thesis I highlighted the perceptions of green buildings as environmental, ecological or low-energy. This is confirmed in both cases via aspects of savings of water, electricity and district heating bills. For instance, in the Western Harbour/Västra Hamnen Bo01 each apartment unit was designed to use less than 105 kWh/m^2/year in energy (70 kWh/m^2/year in heating, 35 kWh/m^2/year in electricity). That is 70 kWh/m^2/year less compared to an estimated average in conventional Swedish apartments (CMHC, 2005). The questions about taking action to reduce energy and water use, and prevent waste revealed that in both cases residents put a lot of efforts (see the *Figures 5.3* and *5.7*) to minimize resource use and waste generation.

Despite the reduced water and energy use, as well as waste prevention, environmentally-friendly routines compared to previous living conditions did not increase or stayed the same in certified buildings. This can be explained by the fact that the Swedish community is already very aware of the majority of environmental issues and, therefore, environmentally-friendly routines are rooted in early childhood learning and practices such as waste recycling and others (Dahlstrand & Biel, 1997).

By framing issues with regard to sustainability in terms of the "*community activities*", a territorial dimension is applied which reflects firm ties of social activity and the physical setting (Dempsey et al, 2011). Also, participation in community activities is one of the domains of social capital (Dempsey et al, 2011). The activities ranking results are quite similar in both cases with the average importance of 3 for the majority of the activities. However, uncertified buildings' residents have showed higher interest in participation in collective group activities (only two people indicated that they were not aware of this), meaning that they were more socially sustainable according to the indicators used, whereas there were 11 respondents who did not respond to this question in the certified buildings case. Yet, Dempsey et al, (2011) summarize that if participation in community activities does not occur, it does not mean that such behavior is described as socially unsustainable. One conclusion from the survey results might be that certified building tenants have lived longer in their property compared to uncertified buildings' occupants (6 to 9 years on average versus 2 to 4 years on average), thus they have already established different type of social relations, cannot participate regularly, or do not share a particular interest (Dempsey et al, 2011).

Other research studies have shown that community participation is also associated with density in the area and accessibility to community facilities. For instance, "*increasing density may provide residents with a greater variety of activities*" and easier access (e.g. less travel time) which facilitates participation in community activities (Dempsey et al, 2011). In addition, community activities may provide business opportunities in the area which was mentioned in some of survey questionnaires as desirable outcome.

The following results show that in both cases the residents wanted to buy electricity from renewable energy provider. In the Western Harbour/Västra Hamnen Bo01 energy sources are already 100 % local and renewable (wind, solar, heat from seawater, biogas) (CMHC, 2005), the same as in *Villa Trift 3.0* in Kobjer, but in *Lillviken Hus 4* in Kalmar there are still open possibilities to buy electricity from renewable energy provider, and 7 out of 8 respondents expressed their interest. Another aspect related to renewable energy provision was a community energy tariff of which 49 % of respondents from certified and 77 % from uncertified buildings did not know if they want a community tariff. The obtained percentages are very high, and there are two possible explanations: either respondents did not understand the concept of community energy tariff (which is very possible option I have explained in the section above about the lack of information and respondents not being introduce to green building practices), or the residents are reluctant to introduce community energy tariff due to uncertainty of possible revenue streams generation via tariff adoption (NREL, 2010). The respondent from *Villa Trift 3.0* in Kobjer said that they do not need community energy tariff since it is a solo family house with already functioning renewable energy installations (e.g. solar panels).

The last part of the analysis is explained using sustainability performance framework and theory of residential satisfaction. It addresses particular issues related to satisfaction with internal and external housing conditions, and prioritization of the criteria in the built setting which need improvements to achieve better quality of physical, social and economic environment. Also by highlighting areas of refinement the criteria that should be introduced or added to certification schemes are crystalized.

From the survey results we can see that in both cases the respondents were satisfied with access to public transport and connections to biking paths (69 % from uncertified and 63 % from certified buildings). Fourteen % of certified and 9 % of uncertified buildings respondents indicated insufficient access to the transport facilities. There were also respondents who used a car and were not aware of what the access to public transportation meant. However, in the case of residential areas where a public transport system is poorly developed, the residents are forced to drive long distances to work, with major effects on both the environmental and social sustainability (Winston, 2010). Again, the aspect of affordability is encountered which determined whether residents were staying in the particular area (with higher property prices) or moving further away from the central locations with business/work opportunities to obtain a less expensive property. Travelling longer distances accounts for environmental damage from private

vehicles including air pollution, GHG emissions and land used for roads (Bergman et al, 2008). From social sustainability perspective, inability to afford the property reduces the possibility of a diverse social mix in the community (Winston, 2010). Therefore, to avoid those negative effects and satisfy occupational needs, it is important to provide housing at an affordable price and ease the access to public transport.

Very similar results were collected about accessibility to educational and recreational facilities in the area. In urban sustainability studies, those services are considered as social services (Choguill, 1996) contributing to overall satisfaction of the built environment. Furthermore, provision of recreational facilities and social/cultural services are believed to be beneficial to residents' well-being as they "*provide venues for health-supporting activities as well as informal meeting-places, outside home/work, where social relationships can be formed and maintained*" (Witten et al, 2003). In addition, improving access to educational facilities has an impact not only on educational outcomes, but also there is growing awareness that educational facilities in nearby areas play a role in shaping attitudes towards environment and contribute to future urban development (Hinum, 1999). Moreover, in both cases the majority of the respondents (see the percentages in the *Results* section p.36 and p.40) indicated the high levels of satisfaction in terms of access to educational and recreational facilities nearby. Of course there were some who indicated that access was insufficient (e.g. driving longer distances (to another neighborhood) to bring children to schools or children gardens). Therefore it is necessary to develop strategies for managing to build educational facilities in nearby areas to achieve fulfillment of residential satisfaction (Hinum, 1999).

Satisfaction with inside (in relation to design) and outside (surroundings) certified buildings' conditions revealed that the majority of the respondents are highly satisfied. Just a small part of respondents indicated low satisfaction of dwelling unit's conditions, but did not indicate the issues. As it was expected, higher percentage (see *Results*) of respondents from uncertified buildings indicated low satisfaction with housing internal/external conditions. This was followed by lower satisfaction with overall housing situation. The main reasons indicated were lack of space, too little light in the rooms and natural ventilation issues (internal conditions). This could be solved via initial design process or taking action while living there. For instance, the lack of space is closely related to furnishings and size of housing. The problem at a household level could be solved by rearranging furniture making more space, or increasing size of the house (architectural decisions inside the property). In broader perspective, due to increasing construction market, the costs of acquiring the property (SEK/m^2) might decrease in the forthcoming years.

Natural lighting also plays an important role not only "*for successful performance on tasks and has an effect on mood and cognition*" p.387 (Bell et al, 2001), but also on electricity savings. Increasing the natural light in the house could be achieved through maximizing the light income through existing windows. For instance, not blocking the window light with furniture, using light

colors throughout the room to reflect natural light that comes. Other options are using mirrors, sliding doors, or tabular skylight (Peterson, 2013). Natural ventilation systems depend critically on the design of internal spaces, and the size and placement of opening in the building. However, the designers face the challenge of simultaneously designing natural and mechanical ventilation. Therefore, usually the structures are intended to rely on one of them – if natural ventilation is not viable, it is preferred to use mechanical (Walker, 2010).

The survey results also showed that there was a common view among the actors in both cases while evaluating the overall housing conditions with very high or high scores. Only a few respondents from uncertified building indicated moderate level of satisfaction (or slightly satisfied); therefore, there is still need for further improvement in the uncertified housing provided. Based on this work further research may include more extensive analysis of particular housing features, both inside the house and in the surroundings to highlight the areas needed for further advancements.

The question concerning the improvements or priority criteria perceived by residents was supported by the basic hypothesis which states that "*Providing sustainable housing should have equal emphasis on environmental, economic and social aspects"*. As the survey results showed residents did not have a common view on prioritization of the criteria in the built and the view depended on the socio-economic and environmental conditions of each of the context.

The first five prioritized aspects in the built setting in both cases were *location*, *green spaces*, *energy efficiency*, *water conservation* and *RES utilization*. From these results we can see that residential preferences are strongly tied to environmental/ecological and economic aspects of sustainability. As it was discussed in the theory section, the *location* and *green spaces* represent the rational consumer choice to have access to workplace, shopping, educational facilities and transport services, and have a provision to meeting places, opportunities to participate in community activities, and increase feeling of safety. Feeling safe in a community is closely related to other dimensions of community sustainability, such as increase levels of social interactions and participation in communal activities (Dempsey et al., 2011). The other three elements have presented the economic (monetary) aspects of the housing. Highlighting *energy efficiency*, *water conservation* and *RES utilization* indicates occupants' awareness of environmental issues (e.g. depletion of natural resources) which are tied to economic benefits. The same trend is confirmed by Ramböll Sverige consultants who states that while marketing the green building the most important aspects are that "[…] *the customers will get a "smart" building; energy efficient that* ***will save the money*** *during the lifetime of the building […].*"

Another considerable group of prioritized elements both in certified and uncertified households was related to *density of the area*, *building maintenance*, *durability*, *noise levels*, and *access to services*. These aspects were related to social and environmental aspects.

Density of the area as negative aspect was perceived in uncertified buildings more often compared to certified ones. Respondents said that living in high-rise buildings creates more anxiety and reduces the feeling of neighborhood.

Building maintenance was also addressed equally in both cases. That indicates the need from property manager/owner "*maintenance and proper management of buildings to prevent their deterioration, keep them safe and tidy, provide a pleasant and comfortable living environment and uphold their value*" (BMG, 2013). Also, *building maintenance* is closely related to building's *durability*; the better the building is maintained the longer it will serve the purpose. For this reason, the process of creating durable houses involves three steps: the first is right design, the second is selection of durable products and materials, and the third is achieving longevity by reusing the building (Wilson, 2010). It is important to highlight that, residents acknowledging the importance of building's durability, show a concern with the issues sustaining high environmental sustainability aspects.

Desire to decrease the *noise level* was indicated from the uncertified buildings survey questionnaires. This is due to the proximity to double-line streets and train station (Tryckerigatan 2). As surveys have indicated automobile noise was the most often mentioned source of urban noise. Generally there are two sources of noise: transportation and occupational noise (p.146) (Bell et al, 2001). In my research I did not address occupational noise because exposure to that type of noise usually occurs in the workplace. Bell and colleagues (2001) suggest that reducing noise in residential setting may be achieved by "*adding noise-attenuating fences along freeways, or constructing bypasses to route traffic away from sensitive areas*".

Further, *access to services and functional areas* was indicated as one of the prioritized elements in the proposed framework in both cases. This means access to educational (e.g. schools, day-care centers, libraries), recreational facilities, health institutions, and services providers (e.g. banks, shops, etc.). As residential satisfaction theory summarizes there should be "[…] *satisfaction with services provision in the area […]*". However, despite the fact that majority of respondents are satisfied with services provision, the ones who are not, indicated the problem of *travelling longer distances* to reach other (different) facilities which are not in the neighborhood. The reasons for those actions vary greatly. For instance, it may be better product or services selection, friends' recommendations, price, etc.

The least prioritized but still mentioned group of elements were *active community organization*, adequate *access to transportation (but not biking paths)*, increase in *heritage values* of the property, and *business opportunities* in the area.

As the results showed *active community organization* gained moderate interest, and this can be explained by the living time in the property, where social connections and networks are already established, suitable conditions in the physical setting and others (Dempsey et al., 2011).

Access to transportation has gained a sense in an access to *public transport* (trains, busses and their connections). None of the respondents mention inadequate access to biking paths, which are well developed around Sweden. Another reasonable explanation for residents' desire to have greater access to transportation is that in a broader perspective "*buildings' sitting close to public transportation reduces the demand for costly expansions of infrastructure*" which is funded by tax payers' money (Landman, 1999).

Another element mentioned as a priority was *heritage value* of the building. It is important to highlight that the concept of heritage value in this context captures communal building value which differs very much from the view held by official heritage institutions (Mydland & Grahn, 2011). Moreover, heritage interpretation and valuation is highly influenced by location, social and cultural experiences and diverse values attached (Mydland & Grahn, 2011). Therefore, natural desire to uphold heritage value of the buildings shows respondents awareness about the representativeness of the location and the actual property, its authenticity. It is also linked to various building materials and styles, designs and techniques, which can be example for the future constructions (Mydland & Grahn, 2011).

Finally, the last criterion emphasized in the survey of both cases was *business opportunities* in the neighborhood, which fosters community's engagement with the local businesses, and drives neighborhood economic vitality by attracting other businesses to targeted localities (NSBGS, n.a.).

Via the survey questionnaire concerning awareness of built environment and familiarity with the practices of green buildings, and satisfaction/stated preferences with the environmental, social and economic aspects in the housing setting, I found that the majority of respondents were knowledgeable (awareness rooted from childhood) and had an intention to contribute more to sustainability of the housing and its surroundings. However, a number of problems arise when attempting to operationalize the above mentioned preferences and criteria with respect to the multi-faced sustainability framework. First, difficulties to operationalize public opinion via the policy measures aiming at the optimal fulfillment of the sustainability factors. The solution for this might be social capital enhancement which in return provides more benefits (multifunctional outputs) in the community. For instance, socially sustainable community may be more motivated to engage in new business opportunities in the area or care more about environmental aspects of the housing setting. The second solution for public opinions' operationalization might be strengthening the links between market (technology, building materials, etc.) and non-market (social activities, satisfaction with the place, etc.) inputs and outputs and at the same time interlinking three dimensions of sustainability. Also identifying areas of improvements opened broader ways for the buildings' development process to ensure sustainability. I argue that through facilitating a greater understanding of residential preferences it may also inform certification schemes. In particular Miljöbyggnad - the Swedish certification scheme which is still at a development stage and incorporates mainly environmental aspects such as *Indoor Air Quality* (IAQ), *Energy* and *Materials*. Although the respondents preferences may not be

representative for the whole Swedish population, and the same criteria cannot be applied in different contexts (due to a need to highlight different issues). Nevertheless this is a good example of the local leaders whose opinion about sustainability criteria may be sensitized to further foster the shift from green buildings to sustainable ones in the urban development projects.

6.2. Reflections on the Discussion via broader Sustainability Lens

The concept of sustainable urban development has come to encompass various interpretations, ranging from housing developers to users perspectives regarding how to meet challenges of global development within finite ecological limits (Hagbert et al, 2013). As the building sector and supporting sectors are the main contributors to the environmental stress, major social and financial implications of the built environment should also be considered, as playing a key role in economic growth and human development, their satisfaction with housing environment (Hagbert et al, 2013).

Since sustainability has increasingly been part of general agenda in the Swedish building sector, creating more sustainable urban environment can be seen as an emerging interest not only on the local level, but also as a supporting factor on a global scale by an increased competence for sustainability issues within building sector (Hagbert et al, 2013). Also, sustainability assessment can be integrative process which fosters greater awareness of connections between global and local concerns, encourages stronger connections between strategic and project level assessments, better links assessment methodologies, and provides more effective inclusion of different stakeholders opinions (Gibson, 2006).

Moreover, speaking about sustainability assessment and its indicators on a broader perspective it is important to note that they provide a general evaluation based on a comprehensive balance, integrating a multiplicity of phenomena that may even be non-homogeneous; they attempt to evaluate general behaviors from the viewpoint of global sustainability, with special reference to the problems of resource overexploitation or energy waste (Puselli et al, 2007). In my case, indicators evaluating sustainability performance in the housing sector were anchored more in the micro-level (the Swedish context) rather than global. However, the framework also included some criteria, for instance from the Environmental Sustainability Index (SEDAC, n.a.) which are indoor air pollution, effective conservation (resource conservation in research framework) or indices from the World's Bank Business Council for Sustainable Development (WBCSD, n.a.) such as business for sustainable development, (business opportunities in the area to fulfill socio-economic needs in research framework), accessibility to markets (accessibility to services and markets), cooperation (active community organization) and others which represent a broader sustainability research perspective. Moreover, it is important to note that even the indices from the framework are accredited to be "sustainable", in some cases not all of them can serve a purpose of sustainability. For instance, one of the main preferences for acquiring the property

was location. However, not all location possibilities can be assigned to sustainable ones. A very similar situation occurs with preferences to reduced costs for electricity, water and heating. In one case, non-renewable energy sources can generate more benefits compared to renewable ones, for instance, knowing that using renewable energy sources cause less damage to the nature, residents might increase resource usage, while acknowledging limited potential of natural resources may lead to reduced usage of natural reserves.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

7.1. Conclusions

Currently more and more both urban development projects and academic debates surrounding housing are embracing sustainability concept as a selling or awareness rising parameter. The primary aim of my research was to critically assess the residents' perceptions about multiple sustainability factors in the housing setting that reflect a shift from green buildings to sustainable urban environment. As practice showed, building projects still emphasize the features of environmental sustainability such as location, or environmental quality, while social and economic aspects are often neglected. Nevertheless, the data analyzed in the thesis point that we can see a trend in residents' attitudes shifting form solely "green" buildings (physical setting) to more sustainable and broader urban environment involving buildings, community and services. Furthermore, information on the current green building practices delineated via certification schemes also sowed that building tenants perceptions and the individual preferences (including three strands of sustainability) could be fulfilled as advancements in the housing setting via enhancing communities' social capital. Speaking in terms of the larger realm of sustainability research it could be said that operationalizing sustainability factors we can achieve notable changes that help to create an integrated perspective of sustainable built environment, and increase the quality of the certification schemes.

This research also proposed a sustainability criteria set assembled from literature to evaluate the sustainability performance in the housing sector. The survey results showed that different settings hold different priorities and varying sets of criteria. Therefore, due to diverse perceptions the best alternative to explain the results was using residential satisfaction theory.

The first five prioritized aspects in the built setting in both cases were *location*, *green spaces*, *energy efficiency*, *water conservation* and *RES utilization*. The second group of elements was related to *density of the area*, *building maintenance*, *durability*, *noise levels*, and *access to services*; and the third one was *active community organization*, adequate *access to transportation*, increase in *heritage values* of the property, and *business opportunities* in the area. The results showed that even there are some aspects highlighted from social and economic perspective, the majority of the criteria are still "locked in" the "green", environmental dimension. Therefore, highlighted elements should be put forward to open broader ways for improvements in new urban development projects which in return enhance overall sustainability in the built environment. Moreover, since several certification schemes are used in Sweden, the question raises if there is a need for all of them. Potentially national classification system (Miljöbyggnad) could be developed further incorporating aspects presented and examined via sustainability framework (*Fig.3.1.*). Furthermore, the overall results from survey demonstrated

that the majority of respondents were knowledgeable and had an intention to contribute more to sustainability of the housing setting and its surroundings.

Finally, it is clear that all the proposed solutions for further advancements cannot be translated directly into certification schemes and the built environment. However, the establishment of the most important features of sustainability and their significance for residents is a good foundation to foster the shift from green buildings to truly sustainable ones.

7.2. Recommendations for Further Research

Few suggestions for further research have been highlighted throughout the paper. In addition, since thesis case is very practical (pointing out the actual improvements needed in the built environment and to add to certification schemes) the main inquiries I recommend as further studies are:

- Evaluating urban social sustainability since more and more urban development projects are looking at community issues in the neighborhoods.
- Longitudinal studies (short-, medium-, and long-term) that would provide the empirical evidence of the impacts of housing and their contribution to making urban development more sustainable.
- How the suggested three-strand sustainability criteria framework could be established for a standardized assessment and certifications scheme to produce comparable results?

7.3. Study Limitations and Reflections on Research Process

The primary idea of this Master's thesis was given by the Company that wanted an investigation on evaluation of water criteria in the certification schemes. However, in order to expand the research scope I developed this idea further and tried to evaluate sustainability performance in two types of buildings.

There were several potential limiting factors for the conducted study. The first one was related to time constraints, because the data collection period was relatively short and it might not represent an extensive analysis. The constraint could be seen as not that many questionnaires collected (from 22 uncertified building tenants and from 35 certified building tenants). This was due to personal factors such as clarification of misunderstandings or more detailed questions and concepts' explanations. Also this aspect may cause the analysis to be less thorough and not very extensive. Moreover, the generalization of the case study results may be fallacious, because the behavior of a small sample may not reflect the bigger population.

Secondly, something that would have shifted the research into different direction could have been the questions formulated in a way that the respondents had more options for the statements

and that the comments would be mandatory. Hereby, there would have been more details obtained about specific features in the housing setting.

In addition, the research questions were not entirely developed when I conducted survey and this made me asking questions (2) that afterwards can be seen as of no use to me.

Next limitation was that there is no one uniform definition of green or sustainable buildings. Thus, the definition used in this work is based on compilation of the factors found in the literature. Also it is important to acknowledge that as the time pass the definition can be revised and formulated anew.

Another limitation of the study was a lack of certified residential properties. The majority of certified buildings are commercial or industrial property. If there were more certified residential buildings I could have provided more examples and therefore the study results would have been more representative.

In addition, the selection of case studies may have had influence on the results. The study focus was on the Swedish green building market and framework to assess the three sustainability pillars was chosen from the case study in Adelaide and Hanoi (with some alterations and criteria additions). Complementary, this paper introduces the reader into a relatively new field of study, thus the process of data collection and context, interpretations and further analysis might be limited due to a lack of similar studies conducted in another contexts.

Moreover, since a Likert scale is bipolar scaling method, measuring either positive or negative response to a statement, it may be subject to distortion. Respondents may avoid using extreme response categories (*central tendency bias*), or try to portray themselves in a more favorable light (*social desirability bias*) (King & Bruner, 2000).

Finally, even the majority of the data on green/sustainable buildings and architecture was in English, for the Swedish certification system majority of the data was in Swedish. Since I am not a native speaker, sometimes it was quite difficult to access some information, and in some cases, acquiring the information took much longer than usual. Also, all the comments from the survey questionnaire were translated by the researcher, thus it may have pose some inaccuracies in phrasing, definitions wording, etc.

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APPENDIX I

The same questionnaires as below (without question No. 16) were distributed among uncertified building residents.

Green Houses in Sweden: Occupants' Perceptions

Dear Green House Dweller,

I am a Master student at Lund University's Centre for Sustainability Studies. I would like to invite you to participate in questionnaire on Sustainable Housing in Sweden which investigates a wide range of issues related to sustainability in the built environment. In particular, the collected information will contribute to understanding the public preferences in the green building market which can improve the quality of buildings and their surroundings, and provide recommendations for improving certification schemes for sustainable housing.

While the information from the questionnaire may be published, such as in my MSc. Thesis titled *Local Leaders in Sustainability: How public perspectives could improve both sustainability of buildings and quality of certification scheme*s, your identity and personal results will not be divulged.

Thank you very much for your participation in this research!

Sincerely,

MSc. Candidate Ruta Varnaite
Lund University Centre for Sustainability Studies, LU
Cell phone No.: +46764091242
E-mail: **varnaite.ruta87@gmail.com**

The questionnaire is filled in by ticking off the question options or answering/commenting the questions.

Housing Background

1. **Indicate your age group:**
   ☐ age 20-29 ☐ age 30-39 ☐ age 40-49 ☐ age 50-59 ☐ age 60+
2. **Do you own your home or do you rent?**
   ☐ Own/mortgaged

   ☐ Renting from private landlord

   ☐ Renting via company

3. **Was the property easy to acquire?**

☐ Yes
☐ Yes, with some minor issues (You may specify) _____
☐ No

4. **Household type:**

4.1. Does your household include minors (<18)
☐ minors ☐ no minors

4.2. How many people live in your home?

☐ 1 ☐ 4

☐ 2 ☐ 5+

☐ 3

4.3. For how long have you been living in the building? _____

5. Which certification system is applied in the building?

☐ BREEAM ☐ MILJÖ BYGGNAD ☐ LEED ☐ Do not know ☐ No system applied

6. Have you been willing to pay more for environmentally-friendly housing?

☐ Yes, 0-2% ☐ Yes, 2-5% ☐Yes, >5% ☐ No ☐ I was not aware

7. **Why did you buy/acquire this apartment? (check all what applies)**

☐ Safety in the area
☐ Size
☐ Location
☐ Smaller bills
☐ Green spaces
☐ Price
☐ Design
☐ Certified building
☐ Access to facilities
☐ Local environmental quality
☐ Other_____

Attitudes towards Green building concepts and personal incentives

8. How familiar are you with the concepts and methods of Green Buildings?

☐ Very ☐ Barely

☐ Somewhat ☐ Not at all

9. What have been your main sources of information on green building practices?

☐ Personal research

☐ Media/articles

☐ Workshops

☐ Courses

☐ Other _____

10. What ideas, people, or events were most influential in developing your interest in green buildings?

☐ Ideas/concepts/publications _____

☐ People/groups _____

☐ Events _____

☐ Experience _____

11. How much importance do you give for the following activities?
Rank activities from 1 to 5 (5-very important activities; 1- not important at all)

	5	4	3	2	1
Community gardening	☐	☐	☐	☐	☐
Common areas	☐	☐	☐	☐	☐
Arranging “free-shop” (sharing)	☐	☐	☐	☐	☐
Auto repair workshop	☐	☐	☐	☐	☐
Fruit/vegetable picking	☐	☐	☐	☐	☐
Sport activities	☐	☐	☐	☐	☐
Movie night	☐	☐	☐	☐	☐
Game evening	☐	☐	☐	☐	☐
Safety program	☐	☐	☐	☐	☐

☐ Other suggestions_____

☐ None of these

Perceptions of the Environmental, Social and Economic dimensions of Housing

12. What is the biggest benefit of this house compared to your previous living situation?(You may comment)

☐ Electricity savings _____

☐ Water savings _____

☐ District heating savings _____

☐ No difference _____

13. Are you interested in buying electricity from a renewable energy provider?

☐ Yes ☐ No ☐ I do not know

14. Are you interested in switching to a community energy tariff?

☐ Yes ☐ No ☐ I do not know

15. How much action do you already take to reduce energy, water use and prevent waste? Rank activities from 1 to 5 (5 - I do everything I can; 1 - I do not think I can do much)

5	4	3	2	1
☐	☐	☐	☐	☐

16. Which sustainable (environment-friendly) actions/routines do you incorporate in your daily life?

Actions

☐ Energy-efficient lighting
☐ Energy-efficient appliances
☐ Solar water heating (installed)
☐ Smart meter
☐ Reduced flow water taps

Routines

☐ Turn off the appliances when not in use
☐ Dry clothes outside in warm weather
☐ Only run the dishwasher when full
☐ Only partly filling the kettle when making a cup of tea

☐ Other _____
☐ None

17. Did you increase environment-friendly routines living in green building compared to your previous living situation?

☐ Yes ☐ No ☐ Stayed the same ☐ I do not know

18. Is access to public transport and connections to bike paths adequate to your needs?

☐ Yes ☐ No ☐ I am not aware, I use a car

19. Are educational (schools, day-care canters) recreational facilities easily accessible in the area?

☐ Yes ☐ No ☐ I am not aware

20. How satisfied are you with the overall housing situation?

Rank satisfaction from 1 to 5 (5 – very satisfied; 1 - not at all)

5	4	3	2	1
☐	☐	☐	☐	☐

21. Are you satisfied with inside housing conditions (e.g. space, ventilation, natural lighting, etc.)?

☐ Yes (You may specify)

_____

_____

☐ No (You may specify)

_____

_____

☐ I am not aware

22. Are the external building's design and surroundings convenient for users; (e.g. provision of meeting places, sense of neighbourhood, playgrounds for children, accessible for people with an impediment, etc.) and is it a safe place?

☐ Yes (You may specify)

_____

_____

☐ No (You may specify)

_____

_____

☐ I am not aware

23. For which 5 of the criteria would you give a priority?

(You may specify/comment)

☐ Location _____

☐ Increase green space_____

- ☐ Improve building maintenance_____
- ☐ Improve access to services _____
- ☐ Access to transportation services _____
- ☐ Decrease population density in the area_____
- ☐ Increase energy efficiency_____
- ☐ Use renewables_____
- ☐ Increase durability of the building_____
- ☐ Increase water conservation_____
- ☐ Increase opportunities to recycle_____
- ☐ Increase working opportunities in the area_____
- ☐ Increase heritage values of the building_____
- ☐ Active community organizations in the area_____
- ☐ To make more pedestrian friendly neighborhood _____
- ☐ Increase safety_____
- ☐ Increase air quality_____
- ☐ Reduce noise _____
- ☐ Other_____

☐ None

24. What support from other (professional) stakeholders would be beneficial to make the built environment more sustainable?

_____

_____

_____

APPENDIX II

Green Houses in Sweden: Industry Professionals' Perceptions

Dear Participant,

I am a Master student at Lund University's Centre for Sustainability Studies. I would like to invite you to participate in questionnaire on Sustainable Housing in Sweden which investigates a wide range of issues related to sustainability in the built environment. In particular, the collected information will contribute to understanding the public preferences in the green building market which can improve the quality of buildings and their surroundings, and provide recommendations for improving certification schemes for sustainable housing.

While the information from the questionnaire may be published, such as in my MSc. Thesis titled *Local Leaders in Sustainability: How public perspectives could improve both sustainability of buildings and quality of certification schemes*, your identity and personal results will not be divulged.

Thank you very much for your involvement in this research!

Sincerely,

MSc. Candidate Ruta Varnaite
Lund University Centre for Sustainability Studies, LU
Cell phone No.: +46764091242
E-mail: **varnaite.ruta87@gmail.com**

The questionnaire is filled in by ticking off the question options or answering/commenting the questions.

Background

1. **Name** (optional) [CONFIDENTIAL]
   Email address (optional) [CONFIDENTIAL]
   Firm/Company name [CONFIDENTIAL]

2. **What is your professional affiliation**?
   ☐ Architect
   ☐ Designer
   ☐ Engineer
   ☐ Contractor
   ☐ Green building consultant/Sustainability consultant
   ☐ Developer/Property owner
   ☐ Other _____

Practice and Attitudes

3. **How many years have you been working with certification schemes and methods of Green Buildings?**
   ☐ 0-2 years
   ☐ 2-5 years
   ☐ 5-10 years
   ☐ >10 years

4. **Have you experienced and increase in green building projects over the past three years?**
   ☐ Increased substantially
   ☐ Increased somewhat
   ☐ Stayed the same
   ☐ Decreased

5. **Do you expect an increase in green building projects over the next three years?**
   ☐ Yes
   ☐ No
   ☐ I do not know

6. **Which certification scheme (-s) have you used in previous projects**?
   ☐ LEED
   ☐ BREEAM
   ☐ MILJÖ BYGGNAD
   ☐ Other _____

7. Type(s) of building projects you have worked/work on (check all that apply)

☐ Public ☐ Commercial ☐ Residential ☐ Institutional
☐ Private ☐ Renovations ☐ Schools ☐ Health care
☐ Sport arenas ☐ Special buildings ("bespoke")

8. What does "sustainability in the construction industry" means to you?

_____
_____
_____

9. What do you believe is the most common focus area when marketing Green Building to new clients or potential customers?

_____
_____
_____
_____

10. Reasons for the implementation of sustainability practices and certification schemes:

☐ Impact on brand/reputation
☐ Cost savings
☐ Belief that "It is the right thing to do"
☐ Customer requirements
☐ Expected future legislation and regulations
☐ Investor requirements
☐ Risk management considerations
☐ Expectations of current employees
☐ Ability to hire qualified new employees

11. Mark two the most important green features to incorporate in a new construction or renovation project?

☐ Energy Efficiency
☐ Water Efficiency
☐ Indoor Air Quality
☐ Green Materials
☐Other_____

Why?

_____
_____

12. Do you feel that certification schemes (outlined above) sufficiently address the social aspects of the building and are effective tools to increase the overall sustainability in built environment?

☐ Yes ☐ Somewhat ☐ Barely ☐ Not at all

13. Which areas do you feel are not sufficiently covered by the certification process?

	LEED	BREEAM	MILJÖ BYGGNAD
Extend useful life/durability	☐	☐	☐
Meet government requirements	☐	☐	☐
Increase occupant productivity/comfort	☐	☐	☐
Reduce operation and maintenance costs	☐	☐	☐
Future facility alteration	☐	☐	☐
Reduce energy footprint	☐	☐	☐
Reduce water footprint	☐	☐	☐
Increase waste management	☐	☐	☐
Improvements in the overall infrastructure	☐	☐	☐
"Green" materials	☐	☐	☐
Building maintenance issues	☐	☐	☐
Providing business opportunities in the area	☐	☐	☐
Health & well-being of occupants	☐	☐	☐
Greater satisfaction with the environment	☐	☐	☐
Preventing 'green-washing' (false or exaggerated claims)	☐	☐	☐
Transformation of the building market	☐	☐	☐
Stimulation of green competition	☐	☐	☐
Companies' commitment to sustainability Practices	☐	☐	☐
Increased productivity	☐	☐	☐
Greater public awareness about environmental issues	☐	☐	☐

Other goals_____

14. In your opinion, what are the most important internal housing conditions (e.g. space, ventilation, natural lighting, etc.) and why?

_____

_____

15. **In your opinion, what are the most important external housing conditions (e.g. provision of meeting places, sense of neighbourhood, playgrounds for children, accessible for people with impediment, area safety etc.)**

_____

_____

_____

16. **Are there any changes to method (certifying process) that you feel personally would be beneficial and make the industry more sustainable?**

_____

_____

17. **What support from other (private) stakeholders would be beneficial to make built environment sustainable?**

_____

_____

18. **In your opinion, to what extent do the following factors influence certification schemes' applications?**

18.1. lack of training/education in sustainable design/construction

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____

18.2. lack of expressed interest from clients (owners/developers, tenants, investors)

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____

18.3. lack of interest from others on the project team

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____

18.4. difficult to assess information on green building certification methods

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____

18.5. green building options are too expensive; competitive disadvantage

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____

18.6. difficult to obtain financing from banks for green construction projects

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____

18.7. recovery of long-term savings is not reflected in the project

☐ Major barrier ☐ Minor barrier ☐ Not a barrier
☐ Comments (if any) _____
Other, not mentioned barriers
_____

APPENDIX III

Table 5.1. *Background information from certified buildings survey*

Category	Sub-category	# of Responses
Age	20-29	3
	30-29	10
	40-49	12
	50-59	10
Minors (<18 year-old)	Yes	14
	No	21
Owning/renting a property	Owning	35
Years of living in a property	2	3
	3	4
	4	3
	5	3
	6	8
	7	6
	8	3
	9	4
Number of people in a household	1	1
	2	11
	3	15
	4	7
	5	1
Willingness to pay	Not aware	3
	Yes 0-2 %	5
	Yes 2-5 %	10
	No	17
Easiness to acquire a property	Yes	25
	Yes, with some difficulties	5
	No	5

Table 5.2. *Background information from uncertified buildings survey*

Category	Sub-category	Number of Responses
Age	20-29	6
	30-29	6
	40-49	5
	50-59	5
	60+	0
Minors (<18 year-old)	Yes	16
	No	6
Owning/renting a property	Owning	22
Years of living in a property	1	1
	2	4
	3	9
	4	7
	5	1
Number of people in a household	2	10
	3	8
	4	4
Willingness to pay	Not aware	5
	Yes 0-2 %	3
	Yes 2-5 %	4
	No	10
Easiness to acquire a property	Yes	21
	Yes, with some difficulties	1