Sustainable Architecture: A Solution for Scandinavian Housing Crisis – The Case of Snabba Hus Västberga Stockholm, Sweden

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Abstract: Sustainable constructed housing" also known as assembled houses" or" LEGO houses" has recently gained attention in Scandinavian government planning offices, sparking interest from a variety of scientific fields and providing lucrative investment opportunities for major Scandinavian construction firms. This appeal can be attributed to a shared desire to employ sustainability to address the housing crisis in Scandinavian nations, notably among the younger generation in Sweden. This publication presents economic progress and revisions to the house loan program for first-time homebuyers while highlighting the improvement measures done by Sweden's ministry of housing. One of the Scandinavian nations, Sweden, has seen a surge in its housing crisis, and it appears to have found the solution. In this paper addressing the socioeconomic updates on Swedish housing laws, as well as the benefits and drawbacks of the notion of eco-friendly constructed homes. Since the 1980s till the present, Scandinavian countries have undoubtedly seen rapid economic growth (Fellman, 2008). The purpose of this paper is to present a case study of Snabba Hus, a building in Västberga, in Stockholm, Sweden, discussing its design elements in detail. By creating easily assembled housing units that are resource- and environment-friendly, the project was built successfully while providing young people with affordable eco-friendly homes. To help the reader understand, this paper provides a sustainable, easily assembled building system and its components, in addition how this system is explained, comprehended, put into reality, and implemented using the data that has been gathered based on the case study to draw attention to the discussion over whether the housing crisis is a social or physical problem and whether a sustainable, time-saving assembled housing unit is the solution to the problem of young housing shortages, and refugees, as well as in case of natural disasters such as earthquakes? Determining complex issues from the perspective of sustainable design may be the total of all life on earth and the ultimate solution to the housing crisis facing the next generation.

Keywords: Assembled Housing, Eco-housing Concept, Earth-Friendly Architecture, Housing Crisis, Sustainable Architecture, Scandinavian Socio-Economy

1. Introduction

A paradigm shift from traditional Scandinavian housing to sustainable eco-friendly building design for the twenty-first century has been inspired by the sustainable eco-housing concept. In addition to addressing the problems with home construction methods, sustainable architecture aims to repair harms caused to the environment by pollution, emissions, waste, and other factors. New materials are used, as well as less waste that is harmful to the environment and the health of the building's occupants, to build, operate, design, and maintain sustainable structures. The hypothesis of sustainable architecture, best known as" Green Architecture" or" Earth-Friendly Architecture" is a term based on a theoretical science of buildings constructed according to environmentally friendly design principles.

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The conceptualization of sustainable architecture, also known as" green architecture" or" earth-friendly architecture" is a style based on a theoretical science of buildings 2 constructed according to environmentally friendly design principles. Sustainability is globally extensive term, therefore a perplexing and challenging topic to dive into. The dominant ideology has merged around this rapidly maturating movement of sustainable, and green architecture throughout the last thirty years (McLennan, 2004). The hypothesis of sustainability is critically important not only to architects but in all scientific disciplines because it's the ultimate transaction between design and the survival of human species for coming generations. Not only sustainable design affects almost every living being on the planet, but also eco-friendly design is one of the primary objectives for humankind to construct a better living condition. Thus, reasons to tackle around greener architecture in order to provide a well-constructed out plan is the primary aim of present architecture in modern time (Ahmadinejad, 2014) at is rate, developed countries are using unlimited resources insufficiently found in third world countries. It has come to light that unless there is a major paradigm shift in the approach of human race thinking and behavior, the coming generation does not take these sorts of issues dubiously. The complex subject of sustainable building design has no straightforward solution, especially taking into consideration that sustainability is a mutual global objective for all to achieve. Striving of new construction materials helps designers to reach this goal. Green architecture not only generates environmental, economic, and social prosperity in time, it will also reduce pollution, conserves natural resources, and prevents degradation for generations to come. Not only sustainable design improves the productivity in facilities, but also economically it offers designers better options to reduce cost efficiently spent during building operations on water and energy (Thomas, 2009). From the point of view of settlers, green buildings metaphorically are meant to aesthetically pleasing. Daily used buildings whether for shelter of for work protects us from extreme weather. These buildings also affect our health, and environment in countless ways shaping our personality in a society we live in. In 21st century as environmental impact of buildings and their design concept are more obvious, a new field called" green building" is gaining the spotlight globally. Green buildings in architecture point of view is a practice of designing a concept characteristic´s using more resource-efficient and healthier methodologies in construction process, renovation, maintenance, and demolition (Roy, 2008) 1.2 Sustainable principles and Eco-friendly building features.

1.2 Sustainable Principles and Eco-Friendly Building Features

To define green architecture, we must understand that green architecture serves the environmental-friendly design based on classifications contains somewhat universally approved aspects (Bishop 1995), as following:

- Systematic cooling and heating through ventilation system
- Efficient energy use in lighting and digital devices
- Safe and chemical free materials
- Locally collected woods and stones
- Resilient reuse of recycled building parts
- Use of architectural salvage
- Proficient use of space
- Material durability suitable for hot and cold climates

While the majority of green buildings do not possess the above listed features, the objective of green architecture is ultimately to be earth friendly. There are six major principles of Green Architecture that

designers should consider when conceptualizing and it is bound by the philosophy of sustainable design. Thus, the philosophical sustainable approach considers the following steps: (Mclannen, 2004)

- Respecting natural systems - in other words Bio-mimicry principle explained as mimicking the form, texture, or function of the nature's element.
- Respecting individualism - human energy principle: it constitutes of consideration or respect for individuals necessities. As well, respecting the diversity found in individual human beings accomplished through realization of individuals with their surrounding individual comfort.
- Respecting the nature - ecosystem principle: seeking the long lasting response of respect also known as the concept of regionalism. In addition, respecting the spatial aspects – value of the land – identity of the place.
- Respect for the Cycle of Life - "Seven Generations" principle: is the actuality and realization that we as human race are part of a cycle in which we take a role when disturbing the balance of the nature. Whatever we build will have short or long term effect to our environment- Thus, the ultimate goal is to produce a safe and eco-friendly design that is fitting the balance of the nature. For architects, the aim is safety for all buildings in all means necessary.
- Respecting natural resources - preservation principle: concentrating on raw materials as interdependent components to assure using what nature provides to mankind responsibly. The goal is to use the natural resources as little as possible to maintain it for generations to come.
- Respecting the process - holistic thinking principle: ultimate fundamental alteration in thinking that leads to a successful outcome.

1.3 Scandinavian Economic Updates- A Solution to Existing Housing Crisis

The paradigm shift in behavior, practice and revisiting the issues that can be solved through the use of sustainable approach. Scandinavian economic updates- a solution to existing housing crisis. The housing crisis started to merge in the Scandinavian countries in the year 1995 after the change of currency to euro in Europe. Another setback was the global banking crises striking the world in 2007-2008. Scandinavian countries – except Iceland – was less affected than other countries. In 2008 Finland economy experienced a severe depression also known as inflation where the purchasing power decreases due to increase of prices. In 2008 when GDP dropped by over 7% and revival was slow causing decades of delayed economic growth until now. The financial crises cut off Danish GDP by 0.9% in 2008 and 4.7% in 2009. In 2010, the 4 economy recovered, and developed quite favorably until 2019. The Norwegian and Swedish economies abbreviated in 2009, but both countries experienced a strong backlash in 2010. Sweden´s economy currency declined in purchasing houses and exporting goods, burdened by the euro zone crises. Norwegian economy has one of the highest productivity levels in Europe due to its natural resources while Sweden enjoys a high labor participation rate (Andersen, 2011). In 2017-2018 the economy was once again thriving in Scandinavian countries, but in the end of 2019 another crisis merged that was a result of worldwide COVID-19 pandemic.

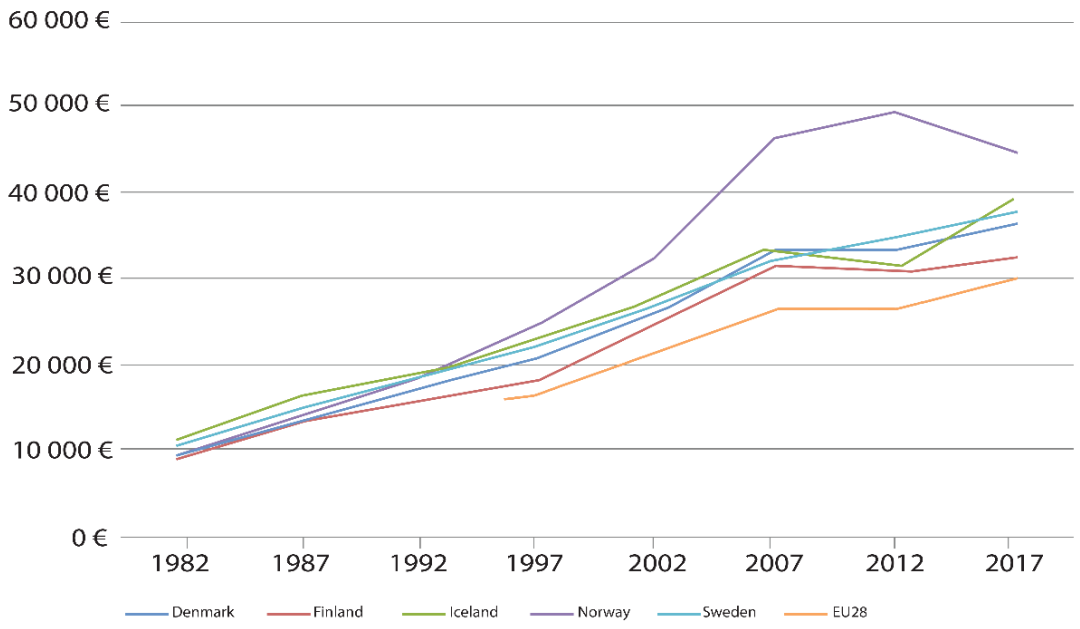

Figure 1: Denotes purchasing power standard that accounts for differences in housing loan levels in banks of five Scandinavian countries. No data available for the EU28, the average of loans prior to 1997 when most of the Scandinavian countries entered the European Union. Statistics from nordicstatistics.org

Update in Scandinavian economic development led to above tables Nordic countries adaptation in new economic housing loans and mortgage policies in the 1980s, and one of the main updates included housing purchasing guidelines for new house owners regarding loan level of banks according to each country's GDP income. The aim of updated house purchasing guideline was to target caused issues born during inflation to focus on workable government finance plans, everything seemed promising for young couples and first-time house owners. This strengthened the recovery of previous economic setbacks after inflation era in Nordic countries. For that purpose, banking supervision was improved to prevent the risk of new financial loan and mortgage crises happen in the future. The new update of housing regulations denoted more investments and funds to secure the housing loans and mortgage for future generations in Scandinavian countries. Collected data study in the above table shows purchasing power standards in Scandinavian countries including Denmark, Finland, Iceland, Norway, and Sweden denoted that purchasing power was growing at low rate until most of Scandinavian countries entered the European Union, many economic experts concluded EU playing good role in the increase of purchasing power. Although Norway is not part of EU they still maintained the purchasing power remain higher than all other EU countries, in the middle of the table is Sweden and Iceland although Iceland is not part of EU they still maintained their purchasing power at high rate until 2008 fell under financial crisis. According to Thomson Reuters data three largest central banks in Iceland defaulted in foreign dept. by 53 billion euros from 2008 to 2011 due to elimination of foreign investors in Iceland (Reuters, 2008). Finland and Denmark purchasing power maintained lower than Sweden as seen in the above table (Fig. 1).

The primary purpose for the Scandinavian governments was to find a solution for affordable, quickly built and environmentally friendly housing in Nordic countries that struggle to find the right balance between public and private housing. The goal was not to get government out of the housing projects all together, but rather find the right balance between governmental housing and private ones. Blaming the market is not right either, we need to shift the example into more sustainable mindset and update existing housing regulations before suggesting new housing regulations in today's market. Although the Nordic municipal housing associations, which still own half of all rental apartments in Sweden, Finland, Norway, and Denmark or one-fifth of the total housing stock (Torbe, 2007) let to increase of rent controls, which motivated and encouraged more construction of rental apartments in Nordic countries. Yet the landlords still asked premium prices from renters in Nordic capital cities.

Although the rent must match those of comparable apartments nationwide, the national government made deposits illegal. This let to tenants renewing their contracts indefinitely, thus protecting the renters from home evictions and homelessness. The European University Institute has calculated that rents would need to rise 70% percent to give developers a 5% percent return on their investment (Fellman, 2008). Slowly, more homes were built for buyers, who enjoyed tax breaks. Houses where taxed at a lower rate than other property and homeowners could deduct the interest they pay on their mortgage from their taxes. It has come to light that the crisis facing Nordic countries from 1990 to 2000 was a phenomenon bound with socio-economic aspects in the mentioned Nordic countries (Fig. 1).

This is also why middle- and high-income renters jump at the opportunity to buy their flat if they could. Home evictions became unheard of in Scandinavian countries. The result: average waiting times for rent-controlled apartments in Nordic cities. According to Professor Susanna Fellman, the creator of Nordic development of a periphery model, suggested the following steps for Nordic national governmental and in regional planning level should follow these steps to prevent housing crises; (Fellman, 2008)

1.3.1 National Governments Should

- Pressure municipalities, especially those of suburbs, to build more.
- Harmonize tax rules for homeowners and renters: as in Sweden's case
- Relax rent controls.

The latter will drive up rents in major cities, but that's the point: not everyone can live in downtown Stockholm. Higher rents would encourage more construction in the city (or conversion to rental apartments) and force some residents out.

1.3.2 We Need Regional Planning To

- Balance the demand for housing, and the transportation that comes with it, against the need to preserve biodiversity and reduce pollution.

1.3.3 Housing Associations Should

- Enforce their own income rules; and
- Sell off more of their apartments.
- That would create both more demand and supply in the middle segment of the private rental market.

2. Housing Crisis in Sweden- a Balance to Be Fixed

Stockholm has been dealing with a shortage of affordable housing especially in its capital city dating back as early as the 1960s due to a massive migration to the suburbs. On the high note such exodus put Stockholm's apartment building construction to a halt for some time, the deeper issue now lies with Sweden's rent control laws and its availability for the younger generation. Due to the low availability of affordable houses, many youngsters become homeless or share the hostel with high rent. The demand in the capital of the city has created a shortage of available apartment rentals, which shows through Stockholm's waiting list of over 650,000 names. To put such a project concept in perspective, Stockholm has a population of less than roughly one million, thus more than half of its residents are waiting for an apartment (Schwartz, 2010). The shortage in housing is not a new phenomenon ins Sweden especially in the capital of Stockholm. Housing shortage has let investors to find solutions in cheap and rapidly built housing for those incapables to find reasonable tenancy holdings. A data collected by Swedish central bank finance report about prices of tenant-owned apartments stated, rental properties in Sweden has been ascended in alarming rate estimated 200% increase since Sweden´s economic development from 90s while the increase in the capital of Sweden was even more higher exceeding 600% resulting in many of its residents to relocate to more smaller towns in the surrounding towns and depend on public transportation such as trains and trams to reach their work in the heart of Stockholm (The Riksbank, 2016).

From Nordic countries Sweden has set an example to be one of the most welcoming countries for asylum seekers. The most severe setback of housing shortages hit the capital of Sweden, especially in metropolitan area of the city such as: Gothenburg, Malmö, and Stockholm particularly in the surge of immigration and urbanization. According to a study in Stockholm business region evaluating population rate in Sweden denotes that Sweden faced one of the highest populations increase by approximately 20% between the years 2000 to 2015 while population decreased to 1% percent after 2016 when the government´s new policy regarding asylum seekers cut down by 80% percent. One of the key issues of Sweden´s housing crisis was the sudden acceptance of 100 000 asylum seekers in 2000 and in 2005 again 163 000 asylum seekers where accepted. Thus, providing independent housing for each immigrant became a heavy task for Swedish government that was just recovering from 90s inflation, and economic crisis. The town planning office set up a plan to settle immigrants to three largest cities in Sweden mentioned above (Asylum-seeker statistics, 2000-2021). Thus, housing shortages face local inhabitants who worked in Stockholm and where obliged to relocate away from the city center and depend on transportation services more to reach their workplace while those who remained in the city center faced higher rent increase due to shortages in housing. Sweden´s housing shortages caused by immigrants is one of the reasons behind the demand of housing. There are other factors that have led to the housing crisis in Nordic countries, among the policies that aggravated these issues set back to Second World War. Sweden´s largest banks made an analysis shown in the below figure comparing apartment demand rate for single starting from March 1988 until March 2016 between Stockholm and the rest of the country.

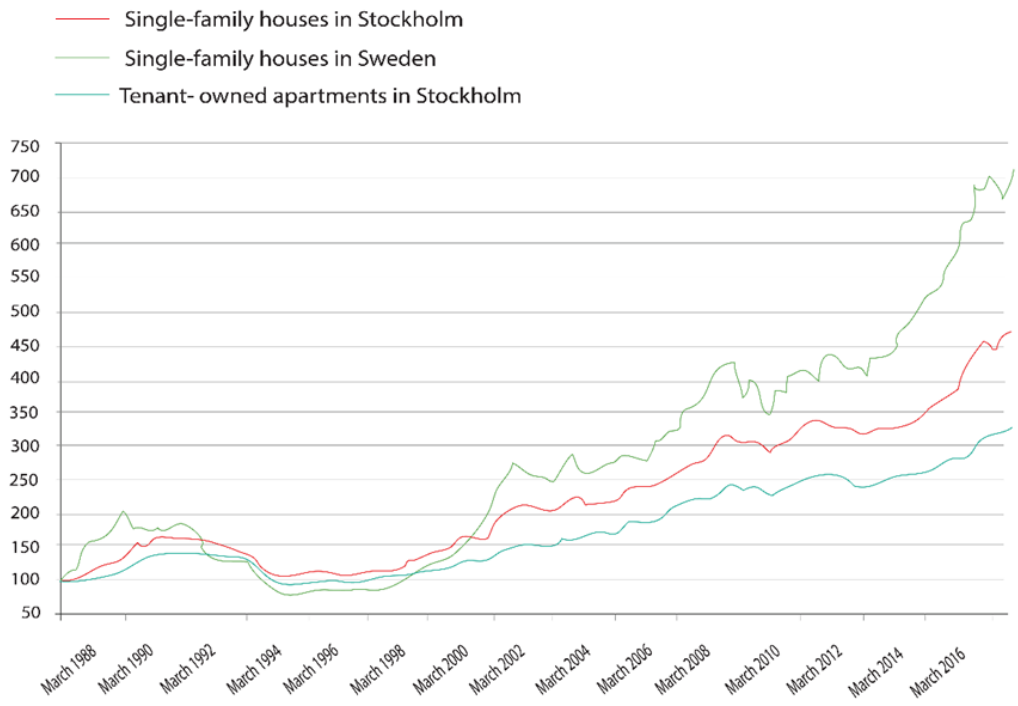

Figure 2: Denotes the demand of housing in Stockholm and Sweden, between owned houses of single families and tenant-owned apartments in 1988- 2016. Statistics from nordicstatistics.org

Housing loans and mortgage policies in the March 1988 was in its lowest point until 1990s thus there was a demand for single family apartments. When Swedish banks started to update new policies for first time homeowners there was a significant decrease in housing demands after 90s now that single families could afford to buy their own homes with the help of loan and good mortgage rates until March 2000. In 2000 there was an alarming rate increase in housing demand due to sudden acceptance of 100 000 single family asylum seekers settled in Stockholm and other parts of the country. The increase continued to worsen thus leading to housing crisis in Sweden and continued until after 2016 when the government´s new policy regarding asylum seekers cut down by 80% percent (fig. 1) & (fig. 2). From 2016 until now there has been many other updates in Swedish housing regulations and policies to solve the setback of the year 2000.

Among the many updated housing regulations in Sweden, one of the new legislations was regarding building maintenance regulation. The new legislation was related to apartment maintenance run cooperatively between tenant-owned apartments and the investor that give tenants a share in the building if taking care of the maintenance services (The Riksbank, 2016). Thus, instead for the investor to hire companies to take care of the building it is the responsibility of the tenant to live rent free and take care of the building. While Sweden has benefited from low rents from 60s until 80s, the gap in 1980s to 1990s was a setback of financial crisis facing the country leading to low purchasing rate as seen in (Fig. 1). Another updated policy in rental regulation was focusing in both municipal and privately held properties, it was to create a society known as “Folkhemmet” translated from Swedish language as “Home of the People”. This regulation played a significant role in Sweden´s history that later on became a political movement’s agenda for Social Democratic party. The concept of “Folkhemmet” was created in 18. January 1928 by Per Albin Hansson but never had a chance to apply it in practice until establishment of political movement of Social Democratic party in 1990. After the country´s recovery from inflation “Home of the People” concept was to denote capitalism rather

establish rights and set a more just outcome to all regardless of family history or income, thus renters who were poorest individuals in the country could afford to own their property instead of becoming part of the problem in Sweden´s housing crisis. The above updated regulations were applied in all Nordic countries as well.

According to Sweden´s National Board of Housing, Building, and Planning SNB-HBP more than three times more homes where under construction when housing demands arise in 2016. Privately developed and newly built housing units by commercial investors such as Wallenstam AB and Fastighets Balder AB known as largest housing construction companies in Sweden could not control the housing demands set by SNB-HBP. Thus, designers set back and observed to propose a new type of housing solution that is cost and time efficient to fulfil the demand set by the government. In 2017, number of residential units that were under construction was risen by 70 000 units still falling short from the housing demand applications sent to municipality. The housing demand increase to 90 000 units that were under construction (Fig. 3). After decades of falling short in housing demands Sweden slowly is taking shape and gasping the new sustainable solutions to prepare rapidly constructed units. Therefore, the chapter of housing crisis phenomenon will set as none exciting issue in Sweden but there are lessons to be learned from.

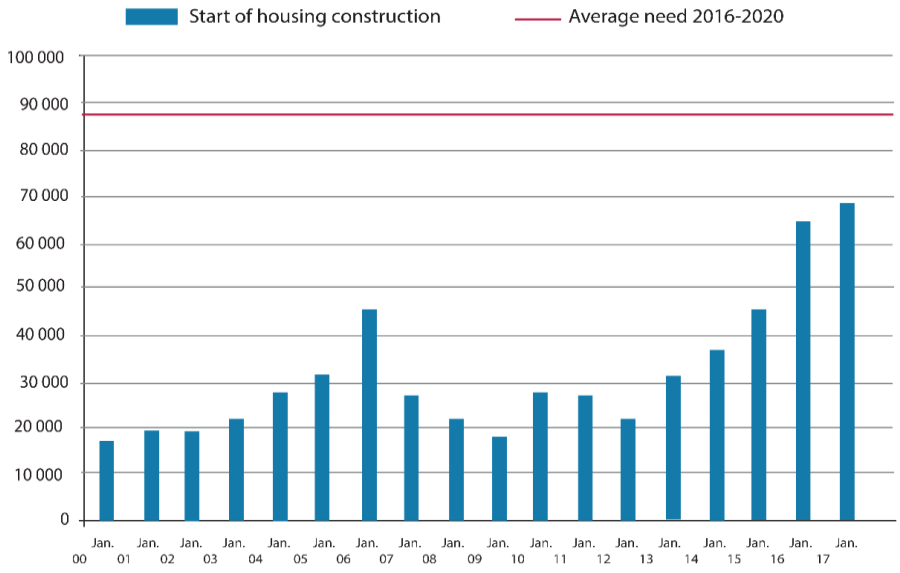

Figure 3: Construction of housing units started in 2016- 2017. The red line reflects the need of housing demand in market according to Swedish National board of housing, building, and planning forecast for average construction needs start to meet the demands after 2016 when Assembled sustainable housing projects came to market. Statistics from nordicstatistics.org

3. The Modularization Feature, Advantages, And Disadvantages of Eco- Friendly Assembled Housing

No doubt the 21st-century green architecture needs better modularization features in sustainable housing design since weak modularization features in building design causes unnecessary costs in production and construction. A well-planned modularization feature of environmentally friendly design makes the overall design convenient to fetch, modify and construct while the designer remains

in control through all the aspects and steps of the design. Modularization features in sustainable housing summarize the many advantages and disadvantages. Eco-friendly housing framework can include quickly assembled houses such as capsules, container, and vessel houses (Yu & Liu, 2009).

In sustainable housing, one of many advantages are easily assembled and rapid installation of small storage volume, inexpensive utilization, folding, factory production, and disassembling anywhere and anytime needed. There are as well disadvantages for example housing that has inadequate ability to resist harsh weather, limited space function, and poor hygiene conditions, if it has not been designed well. On the other hand, living in small space eco-houses is not desirable for long-term use or multi-family use as the family grows. The nature of green housing usually works as an assembled vessel houses or container houses that satisfy excellent sanitary conditions and desirable internal privacy due to its already pre-constructed structure. Nevertheless, the minimal living excrement and sanitary condition offer an ideal eco-environment for one or two occupants. Another advantage of sustainable assembled housing is not just considering the environment but also the individual psychology, and other metaphysical aspects to create a completely serviceable space to live in. These eco-friendly quickly assembled housing unites popularity has risen among Asian countries, it has become a key solution for housing crisis and a great alternative for disaster relives in Japan and China, where earth quick is a frequent natural phenomenon. Investors promise to construct quickly assembled houses under a month for victims who lost their homes is too good to be true but after the Chinese government invested in such project, the investors were able to provide more than one million assembled sustainable housing units under 40 days competed to be used and offered safe space with daily needs for the victims of earth quick (Li, 2008). Assembled housing unites has become a go to concept to housing crisis in Scandinavia but other countries that greatly benefit from this concept is China and Japan. A rapid alternative for disaster relives in Japan and China is sustainable assembled housing unit, where earth quick is a frequent natural phenomenon, constructing swiftly assembled houses under a month for victims of earthquakes and tsunamis to temporarily offer shelter and meet their daily needs has helped the government greatly (Li, 2008).

Firstly, modularization design concept of eco-friendly housing usable space is not only facilitating the rapid assembly of construction, but also expedites speed of construction as well. Secondly, sustainable assembled housing functional capacity is constructed to meet the needs of user's basic solace, privacy, and flexibility feature. Thirdly, sustainable assembled housing aims to keep lighting conditions in mind to prevent moisture, shrinkage, and damage over time. Fourth, sustainable assembled housing satisfies repetitive use of residents as families grow and relocate to multi-family houses. Fifth, increase better efficiency of production due to high efficiency of installation constructed with metal, glass, and insulation sandwich walls. Lastly, in the construction phase, it reduces costs by recycling, reusing parts, and reassembling. Eco-assembled housing may offer small storage space, but on the other hand, it offers enough extended space to fulfil the needs of user´s daily activities that is a part of the characteristic of installation and assembly integration. Above all, economic approach of space and manpower during housing construction is the primer aim in flexible features of sustainable temporary eco-housing concept which are fast to put together since the goal behind mass production of these unit is to prefabricate the foldable structure swiftly (Yu & Liu, 2009).

In United States, in 1997 the Californian government submitted an important proposal that shifted design approach in housing issues into sustainable rapidly assembled housing units due to the increase of homelessness in the state of California. Approximately, 28% of people experiences homelessness, as of 2019 according to Los Angeles construction of housing ministry estimates the shortage of 1.4

million affordable housing units of its population (Rountree, 2019). The result of government proposal was a new type of approach and experience in American construction and architecture as well which was to replace construction of poorly designed momentary shelters transitioning into more sustainable assembled housing settlements, instead build permanent eco-friendly simple yet minimal, and modern housing for homeless residents in Los Angeles. Thus, in disaster situations victims who lost their houses can return to normal life as soon as possible (Li, 2008). Through the paradigm shift of eco-housing, it opened the door for investors to invest in more affordable housing projects in Los Angeles. While the modularization features of sustainable assembled temporary housing have considerably improved in material, and concept design from then on (Sabuncuoglu 1998). The responsibility of residential affair for impermanent eco-housing has become a realization for economical reuse of affordable housing to fulfil the higher economic approach in metropolitan cities.

It´s clear that a sufficient house is the fundamental right of every individual. In case of non-availability of sufficient living space such as healthy standard of living that does not meet the user needs, residents will be affected psychologically and physically in a long run. However, due to systemic or in other words, unclear modularization feature handbook related to sustainable assembled housing design, green architecture designers face various issues for instance single space design approach, low solace, inadequate ecological efficiency, chaotic functions, and many others to name a few (Kang & Li, 2013). Nevertheless, insufficiency of identity in eco-housing will lead the future of architecture to unidentifiable, anomalous, and perhaps will lead to social and psychological exclusion of housing design (Zhang, Wang, Zhao, 2008). Therefore, for green architecture designers, it is crucial to improve the identity and concept of eco-friendly housing to according to the designer's architecture approach catering for the environment, cultural identity, and the needs of different functions for the user.

4. The Case of Snabba Hus Project in Västberga, Stockholm- Sweden

The Snabba Hus project site is located in Västberga, South West of Stockholm- Sweden. Consists of seven-story prefab buildings stood separate from each other harmoniously on 15 000 sqm plot. The project is a combination of rental unit homes primary designed for Sweden´s younger population while catering to the country's sustainable aims and efforts to solve housing crisis in Stockholm, Sweden. The eco-friendly housing unit concept is influenced by the city's democratic architecture and the sustainable solution it offers to its young renters. Designed by Stockholm-based architect firm Andreas Martin-Löf architecture firm. The concept was to build temporary structures onsite in a vacant plot for the time the land is empty. According to housing law of Stockholm´s town planning office, the project can remain up to 15 years with temporary building permits and if needed the parts can be renewed and reassemble again. The project was accepted by Swedish city planning office in 2014 and completed successfully within time and budget in 2016. The aim of this eco-friendly housing project was an affordable rent of at least 400 people living in 280 apartment prefabricated vessels that are made at the factory specialized in vessel housing. In the factory the concrete structures lighting conditions are set into minimal point keeling in mind prevention of moisture, damages, and shrinkage over the years. Snabba Hus housing project will be the architect firm's second site of the same kind that is expanding to a third and fourth by the end of the year 2021. To provide young locals with temporary

affordable eco-housing rent is around 5,000 Swedish Krona a month, equivalent to 527 USD (Matin-Löf, 2016)

Figure 4: Snabba Hus project located in Västberga in South West of Stockholm- Sweden. Site-plan from martinlof.se/projects/vastberga/ (Redrawn by the author)

4.1 Snabba Hus– Assembled eco-friendly Housing Project A Solution to Housing Crisis?

The architecture firm didn't act alone in constructing these rather large affordable housing endeavors, teamed up with Jagvillhabostad.nu, a youth organization that advocates for building more affordable eco-friendly homes in Sweden. The project building material has been constructed with metal, glass, and insulation sandwich walls, these moveable units are meant for residents between the age of 34 and under (Martin-Löf, 2016). The project aims to stay true of serving the city's young population who desperately need a place to stay, work, and study in the capital of the city. Each unit serves at best two people, complete consists of balcony, sleeping area, kitchen, and bathroom. Those interested in living in the units had to send in an application that got submitted into a lottery-type system.

From 8,000 applicants they received for the 280 available apartments made it obvious for this type of architectural projects that they are indeed needed since there is a booming demand for such projects. In the year 2020 to 2021, the architect firm is building two additional projects that total 380 new apartments in the city of Racksta in North West of Stockholm. The current projects like Snabba Hus Västberga seem to be a great example that they want to set for the Scandinavian sustainable housing concept ((New York Times, 2017). Not only does the Snabba Hus affordable housing project serve as a step toward resolving the housing crisis occurring in Sweden, but also set an example of how we architect´s and engineer´s alike need to be thinking about the country's young population and environmental challenges coming with it.

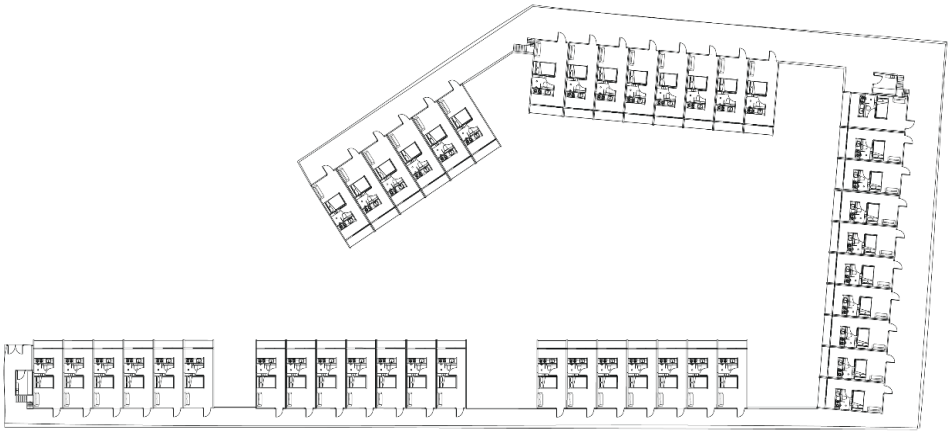

Figure 5: Plan of combined units, consists of seven floors. On the ground floor, there is space dedicated to fire escape, postbox´s and two laundry rooms for the units use. Plan of ground floor from martinlof.se/projects/vastberga/ (Redrawn by the author)

4.2 Design Discussion: Functional Space Module of The Unit

One of the key benefits of Snabba Hus assembled sustainable housing unit is, that it can be quickly installed and assembled, and it has sufficiently comprehensive functional space based on everyday need of the user. The only downside of assembled housing unit is: installation of the parts in construction phase requires professional construction team that is familiar with the installation kit. Another downside of eco-friendly unit is its high material cost that the parts are built with due to high quality insulation material and long-term durability but in investors point of view the high quality is more economical in the long run. The utilization and material cost are high enough to be reused, recycled, and relocated to different location. Since the parts are ready built, it requires great sum to become a beneficial project. This new approach of sustainable eco-housing vessel style houses can solve housing crisis rapidly and efficiently. Assembled sustainable houses that the Danish Architect Bjarke Ingels used in 2017 as concept of Lego housing in the future city.

Metaphysical design rectitude behind assembled eco-friendly house is strong enough since it has a good seismic deformation against resistance suitable for Scandinavian environment. Furthermore, efficiently assembled and dissembled while holding predominant sealing performance is another beneficial aspect in designers' point of view. At the same time, the assembled unit can be directly installed on the top of structure that drainage system has been reconstructed beforehand. The manufacturing of assembled sustainable house is designed for single family space function based on international standards of 8192 mm length x 5050 mm width x 2591 mm height (Neufert, 1970).

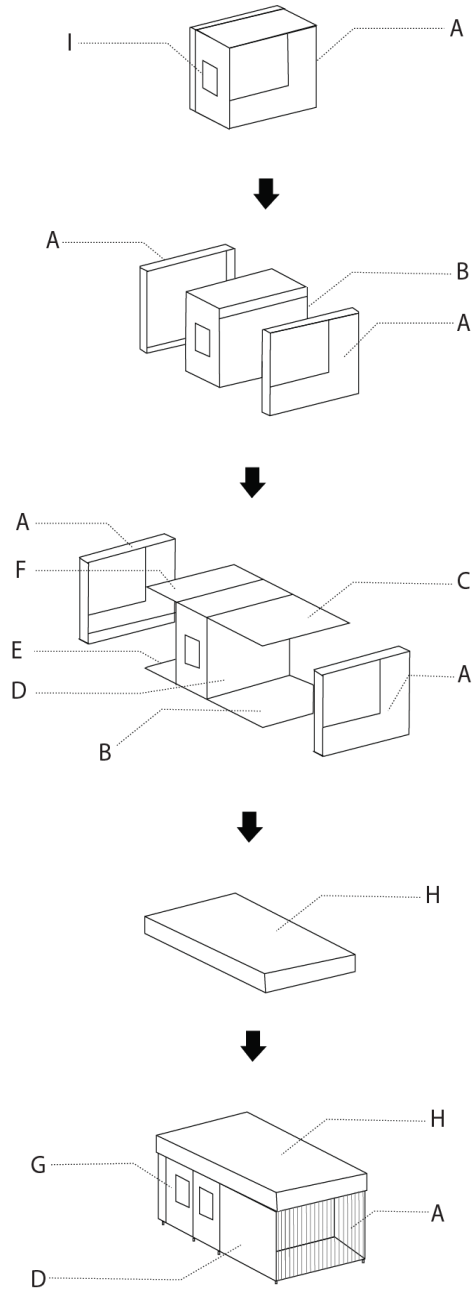

Figure 6: Isometric view of sustainable housing combined unit structure. A: Baseplate; B: Left apical plate; C: Roof tarpaulin; D: Left backside wallboard; E: Floor baseplate; F: Roof apical plate; I: window; G: Backside wallboard; H: Roofboard I; Roof apical plate.
From martinlof.se/projects/vastberga/ (Redrawn by the author)

The functional modularization of sustainable assembled unites in designer´s point of view, the concept consists of multi-functional living space that part of its space is used as sleeping area with functional storage space under and on the head of the bed, the rest of the space is divided into kitchen, dining area, and bathroom. To offer the user an independent space for everyday use, spaces are separated by sealed and folding plates to insulate the sounds coming from different spaces as well. Combination of

bedside and living room walls are located on the opposite side the kitchen and dining room area that are fixed structure of the main body. The bathroom is in the middle of the unit with its ventilation system, water heating and cooling system. The fixed structure framework of the roof is split into two layers, then the layers are divided into several clapboards. While floor layer, besides drainage and water pipe system also includes a mesh division of water heating and cooling system across the unit's floor used for the purpose of winter and summer while the electricity utilities are between the insulation sandwich walls, each space having its own control centre for the user to manipulate based on their needs. The water points located in kitchen and bathroom are connected to the city's sewage and clean water supply system. (Fig. 5 & Fig. 6)

Modular efficiency in assembled units surely has a place for improvement but for now it is working efficiently for short term use. The living room and bedroom space meets the needs of different functions with convenient storage spaces. On the other hand, the outer structural framework can stabilize and bind the whole housing units together as one Lego structure. This concept is influenced of assembled sustainable houses that the danish Architect Bjarke Ingels used in 2017 as concept of Lego housing in the future city.

4.3 Conveniently Assembled, Dissembled, And Reused Parts

Each unit total area is 41.36 m2 with basic functional spaces such as sleeping and living room area, bathroom, kitchen, and balcony. As shown in (fig. 7) the retracting bed enhances the space utilization area by turning the bedroom into living room as well. The design of industrial production unit is easily assembled, transported, relocated, recycled, and reused immeasurably improving the sustainable housing functionality in residents' point of view. Eco-friendly assembled housing units are the realization of higher economical requirements among new investors.

Stockholm-based architect firm Andreas Martin-Löf Architecture firm guarantees a perfect reuse of the housing units in case it is dissembled and transported to another site to be re-assembled again. Another positive side of the sustainable housing unit is, that it does not rely of professional workers to assemble. Any construction worker can easily assemble and dissemble the units using simple construction tools. In order to expand prefabricate housing units in faster pace such as Snabba Hus project, the town planning office should become involved with investors more when residential projects are announced.

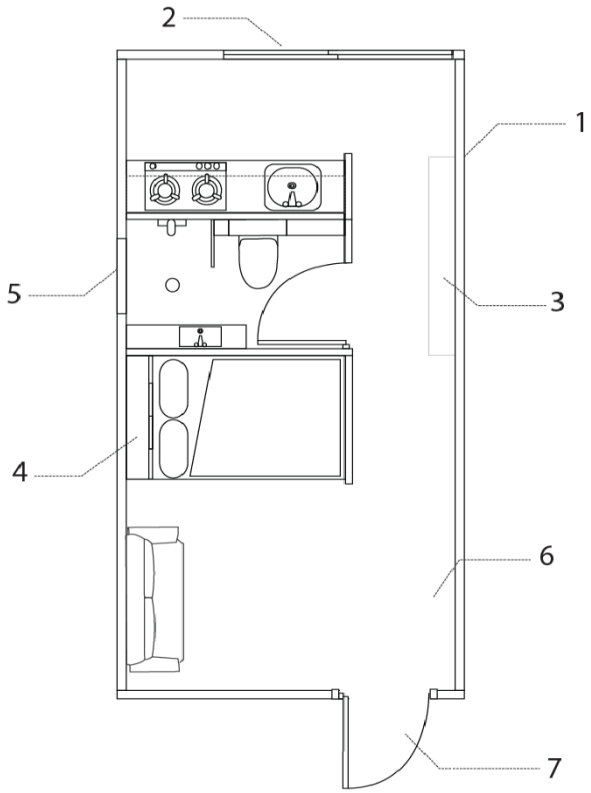

Figure 7: Plan of combined parts as one unit. 1: Right side wallboard; 2: Glass sliding door to the balcony; 3: Storage space; 4: Bed and Storage space; 5: Left side wallboard; 6: Living room space; 7: Main front door. Plan from martinlof.se/projects/vastberga/ (Redrawn by the author)

5. Conclusion

Although the popularity of sustainable housing concepts continues to rise in Scandinavian countries, there is still endless debate whether housing crisis in the Scandinavian countries a merge of social or physical issue? Based on the finding of collected data and case study of Snabba Hus Västberga in Sweden, the paper summarizes that housing crisis is the manifestation of deeper issues within socio-economic aspects in the country. After the fast pace of economic development of Nordic countries and upgrading housing regulations by increasing banking loans to first time homeowners and supporting investors to invest in quickly assembled eco-housing units the housing crisis slowly decreased in Stockholm, Sweden. The rise of housing crisis in Sweden seems to have found the answer for the countries housing crisis by suggesting fast and efficient assembled, dissembled, relocated, and reused housing units as in the case of Snabba Hus Västberga housing project.

In recent years sustainable design concepts has played a great role for housing shortage in the global environment. These eco-friendly quickly assembled housing unites has not only become the solution for housing crisis in Scandinavia but also a great alternative for disaster relives in Japan and China as well, where earth quick is a frequent natural phenomenon, constructing quickly assembled houses under a month for victims in order to meet their daily needs has helped the government greatly. Therefore, a combination of socio- economic update that provides banking loans and guidance for first time homeowners can help the government in the long run to solve housing crisis with the combination of financial support for mass producing factories and designers that construct and invent easily

assembled eco-housing units to build in short period of time, could eventually lead to realization of sustainable architectures potential in global level. Thus, globally existing housing crisis could greatly benefit from easily prefabricated assembled units that are environmentally friendly as temporary or long-term shelter in a global context for housing crisis anywhere in the world especially for asylum seekers in war torn countries.

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