Methods of survey for technical evaluation and planning of renovation strategies in residential building properties

Case Study, Tyresö municipality (Ekbacken).

Undersökningsmetoder för teknisk utvärdering och planering av renoveringsstrategier i bostadsfastigheter

Fallstudie: Tyresö kommun (Ekbacken)
Acknowledgement

First and foremost, I thank my family for believing in my dreams and supporting me during the time of my studies. Their unrelenting faith in me and the constant endeavors in keeping my morals up makes me realize their importance and the love I have for them. My special thanks to my supervisor Professor Folke Björk for noticing my interest in architecture and giving me this opportunity in the form of this research project and for the guidance and the understanding I received through my master degree studies in KTH.

Last but not the least, I thank Modexa AB, one of Scandinavia’s largest renovation companies for providing me the support to work on this subject with their collaboration, I would like to thanks Mr. Ulf Viktorsson, Mr. Kasper Nilsson and Mrs. Evelina Fältd.
Abstract

The thesis is an outcome of a collaborative work between the author and the renovation team of Modexa AB on project of housing renovation of Tyresö municipality (Ekbacken).

During this thesis we tried to analyse the ongoing process of renovation in Stockholm and try to provide a solution which helps to improve the data gathering and analysis by production of the BIM model. Further studies to provide further details about the possible outcomes of the BIM model and integration with other software for energy studies, project management and building management had been done.
# Table of Contents

Acknowledgment ..................................................................................................................... II
Abstract ......................................................................................................................................... IV

1-0 Building Renovation.............................................................................................................. 1
  1-1 Introduction to Building Renovation .................................................................................. 2
  1-2 Importance of Building Renovation in as a part of building construction industry ........ 2
  1-2-1 Building renovation and economy ................................................................................. 2
  1-2-2 Building renovation in developed countries ................................................................. 2
  1-3 Building renovation for residential improvements ............................................................ 4
  1-4 Current process barriers for building renovation ............................................................. 5

2-0 Housing Crisis in Sweden .................................................................................................... 7
  2-1 Current analysis of housing crisis in Sweden ..................................................................... 8
  2-1-1 Economical analysis .................................................................................................... 9
  2-1-2 Social analysis ........................................................................................................... 9
  2-2 Building renovation as part of the solution for housing crisis .......................................... 10

3-0 Methodology ......................................................................................................................... 11
  3-1 Introduction to Technical Survey ..................................................................................... 12
  3-2 Technical Survey and information process ...................................................................... 13
  3-3 The role of technical survey in the building renovation strategy ..................................... 14
  3-4 BIM analysis in correlation with a Technical Survey.......................................................... 16
  3-5 Case Study .................................................................................................................... 17
  3-6 E1 Original Documentation .............................................................................................. 19
  3-7 E2 Original Documentation .............................................................................................. 27
  3-8 Preparation of the pre-renovation checklist and Mobile App .......................................... 34
  3-9 Pre-Renovation Technical Analysis Check List ................................................................ 40
  3-10 Primary results of BIM modeling in Revit (Technical Detailing) ..................................... 67
  3-11 Introduction to Sefaira ................................................................................................... 95
  3-11-1 Result analysis of Sefaira .......................................................................................... 95
  3-12 Introduction to Vico Office ............................................................................................ 101
  3-12-1 Result Analysis of Vico Office .................................................................................. 104

4-0 Conclusion .............................................................................................................................. 105
  4-1 Result analysis of the implemented process .................................................................. 106
  4-2 Expected result and future development ..................................................................... 106
1-0) Building renovation
1-1) Introduction to building renovation:
In building construction, building renovation (also known as remodeling especially when the undergoing process is mostly about re-styling a property in the interior/exterior design and visual aspects) can be defined as any construction process by which an existing damaged, broken or outdated building will be improved.¹

Generally a renovation process for a building construction can be divided in:
- Architecture (Concerning the design, planning and pre-built management)
- Engineering (Mechanical/Electrical systems, HVAC, etc.)
- Structural repair
- Rebuilding (Destruction of unnecessary parts and Implementing the new spaces)
- Finishing

The reason leading to a decision for renovation of a building in many cases - mostly often for the private investors - is to create a new appearance for the property as well as some other factors such as: area redevelopment, building's physical condition, the building is not suitable for anticipated use, and fire damage.²

The important point about these four major factors is while in many cases they can be predictable and avoidable; when it comes to improve a building's physical condition, the cause can happen just regards to life cycle of the used material. That is also to make building renovations, a stable source of income for the renovation companies.³

1-2) Importance of building renovation as a part of building construction industry:

1-2-1) Building renovation in economy: Building renovation is not a modern business trend (it is dated back to beginning of recorded civilization, for example: Sergius Orata, who in the 1st century B.C. is said by the writer Vitruvius in his famous book De architectura ⁴, to become rich as a building renovator) renovation has several impacts, including ⁵:
- creating jobs
- increasing the sending and liquidity
- promoting gentrification
- generating tax revenue

1-2-2) Building renovation for developed countries: In developed countries such as EU, building renovation projects are holding a significant portion of annual financial investments in construction sector, especially during the recent years. This increase in financial investments is partly because of modern inventions in renovation both for planning and construction phases which helped to make the process more economically feasible, in

⁴ “What is home improvement?”, Paul Bell, September 2017
addition to the Energy Services Directive (2006/32/EC) as a plan for sustainable development strategies to improve the energy efficiency of buildings during the construction phase as well as the occupation period. In other words, while the construction companies must improve the sustainable aspects of the new constructions developments, because we are dealing with the developed economies in most of the sustainable development criteria we need to improve the energy performance of many buildings that were built by lower standards before the time when some modern threats like global warming had been considered - renovation of buildings is key to meet the EU's energy efficiency targets regards to this aspect as the renovation of existing building to improve the energy efficiency are expensive and the European union defined the plan to promote financial support strategies to encourage the building sector and property owners to renovate the existing old projects to improve the energy efficiency and reduce their consumption to control the well-known threat of global warming issue.

---

1-3) Building renovation for residential improvements
In home renovation we may face the improvement process on interior, exterior and other improvement for the property such as garden, etc., as well.
Different type of improvements for a home/residential project may be considered due to:

Comfort, can include:
- Upgrading heating, ventilation and air conditioning systems (HVAC).
- Upgrading rooms with luxuries, such as adding gourmet features to a kitchen or etc.
- Increasing the capacity of plumbing and electrical systems.
- Waterproofing basements.
- Soundproofing rooms, especially bedrooms and baths.

Maintenance and repair can include:
- Roof tear-off and replacement.
- Concrete and masonry repairs to the foundation and chimney.
- Repainting rooms, walls or fences.
- Repairing plumbing and electrical systems.

Additional spaces can include:
- Turning marginal areas into livable spaces such as turning basements into recreation rooms, home theaters, or home offices – or to turn attics into spare bedrooms.
- Extending one’s house with rooms added to the side of the house, sometimes, extra levels to the original roof. Such a new unit of construction is called an "add-on".

Saving energy can include:
- Energy-efficient thermal insulation, replacement windows, and lighting.
- Renewable energy with biomass pellet stoves, wood-burning stoves, solar panels, wind turbines, programmable thermostats and ground source heat pumps.

Safety factors can include:
- Home fire and burglar alarm systems.
- Fire sprinkler systems to protect homes from fires and improving the emergency escapes.
- Security doors, windows, and shutters.
- Storm cellars as protection from tornadoes and hurricanes.
- Bomb shelters especially during the 1950s as protection from nuclear war.
- Backup generators for providing power during power outages.

---

1-4) Current process barriers for building renovation

Regards to the above mentioned aspect a building renovation project can include almost all the process stages necessary for the construction of a new building. But while we discuss a renovation process as it can be also concluded from many experts in this field, how the problems due to the cost and time estimations are playing stronger roles for renovation projects. This can in many cases result in a failure arriving to the project’s realization.

Advancing the technology in visualization during the planning process and material production process helped those contractor companies being responsible for building renovations to realize more near to the clients need and benefit. The time and cost estimations would still be the major risk in a construction process, simply because the number of the variety of the unknowns are even more for a renovation process. In many cases, the main options to reduce the construction estimation risks are including:

- **Taking a top-down approach.** While it may be easier to start the cost-estimation process by plugging numbers and line items into a spreadsheet. This bottom-up approach lacks a strategic view and is time consuming. It’s best to start by looking at the entire project. Then, break it down to see how costs are distributed. In this way, it is possible to make adjustments and see how each adjustment affects overall profitability, as opposed to manipulating the costs for different line items until arriving at a decent profit margin.

- **Making successive risk estimation.** To determine risks and minimize uncertainty, it is good to analyze what has gone awry on previous projects. For example, it may not be the materials or the crew that drove up the cost. It could just as easily be the fact that the project was done in a city district with only one lane of traffic, making construction projects challenging.

But while dealing with a renovation process in some cases a simple removal of an existing floor finishing with new materials can drove up the costs of the project as well as creating timing problem even with proper top-down approach while we are making the pre-built project estimation.

An important point which helps us to improve the estimation of a construction project as mentioned above is successive risk estimation of the project by analyzing the previous projects but the concerns in a renovation project may arise as:

1. Unfulfilled necessity for a major organization due to lead of the building renovation projects.
2. Lack of data and previous records of the existing building.
3. Unexpected cause which may result some unique aspects for any project being impossible to foresee during the analyzing and problem solving phase based on the current experience of the contractor in building renovation.
4. Unlike the construction companies in new built projects, many contractors companies whom are in building renovations are not licensed by a reference regards to academic knowledge to demonstrate their knowledge and ability on engineering based motives but they are based and active over the experience of the managers.

---

5. Lack of utilizing the proper methods for doing the physical investigation of the building which drive from unawareness of the contractor about current technologies or lack of institutional knowledge.

The mentioned barriers in this part are including but not limited to these causes and the current trend of building renovation suffering from these types of problems brings direct impact on performance of the active building renovation contractors in the project which may even result to latency on arrival to the regional or national planning such as the European Energy Services Directive.\textsuperscript{11}

2-0) Housing Crisis in Sweden
2-1) Current Analysis of Housing crisis in Sweden

For many years the problem to find a dwelling in Stockholm and Gothenburg was familiar for the locals of these cities and all the people were aware of the fact that how difficult it is to find a proper accommodation, but during the recent years it grows big enough to be considered as a national problem for Sweden.

One of the well-known claims which is considered to be mentioned by a government agency is that Sweden needs to build 700000 new house for the next decade to keep pace with demand of the market. While the Radio Sweden’s report indicate an increase in the number of the houses build from 2015, Henrik Landelius, the head of building at the one of Sweden's biggest construction companies, NCC says it is going to be tough to reach the target. "Let me put it this way: It's twice the speed of what we are doing today," he says.  

Current statistic show that 255 municipalities out of 290 in Sweden are facing the lack of housing, these studies show an increase of 72 in number between 2015 to 2017 despite the increase of apartments built during the same period which demonstrate that this may not be the end of this trend and we may face further problems due to this.

But is the low speed building the new houses comparing the growing population is the only factor involved in the problem? And to speed up the building construction process in new houses and simplifying the construction process is this the only solution to eliminate our problem?

A recent article titled as “the story of Sweden’s housing crisis” tried to dig into this problem to find its initial playing factors and other possible scenarios.

“The reasons are up for debate, but what the experts The Local spoke to generally agreed on is that the problem has been decades in the making – a housing crisis doesn't just happen overnight, after all. Most said the roots can be found in the early 1990s, at a time when Sweden was hit by a severe credit crunch. "Some regard the main cause as the retrenchment of the state from the housing question, others regard the state interventions as the cause," Malmö University’s Martin Grander, whose research specializes in housing and housing inequality, told The Local. "The truth is probably found somewhere in between. Incremental changes in policies, legislation and development since the 1990s have made it beneficial for households to own their house and for housing constructors to construct a certain type of housing: villa houses and cooperative-owned flats (known as bostadsrätter in Swedish). It has become less beneficial to construct affordable housing meanwhile, and rental apartments, if built, are directed at high income households," he added. Until the early 1990s, state subsidies aimed at stimulating housing production meant the rate of construction was high, Boverket's analysis department explained to The Local in a meeting at their Östermalm office in Stockholm. And even when a credit crunch hit that decade and building inevitably slowed, moderate population growth meant the impact on the balance between housing stock and demand wasn’t immediate – instead, it was a slow burner.”

---

As we can see, while the first conclusion to come to our mind about this problem is to blame the increasing population, the truth is at the beginning this factor acted as a cover to this problem rather than a catalyzer.

Following the credit crunch, in later stages the growing populations become an important factor affecting this market but following aspects are necessary to be mentioned as well:

- To free up Larger homes which can house more people actually is not happening because the owner are scared of losing money by the payment of capital gain tax.
- The market become more interesting for the richer up level investor while they are not necessarily in trouble to have their primary housing, but are interested in speculation. This type of investment mostly will not be directed to build affordable housing.
- Immigration to Sweden as this country is a proper destination for people searching for job as the Swedish society is in need of educated work force for country’s further development planning.
- The existing housing system was designed in post war era which makes them not completely effective to solve current market expectations.
- Up trend in rental market is directing the consumers to prefer to buy a house instead of paying the current extremely high fees as house rent.

In Sweden, municipal and state-regulated rental companies are prevented from charging tenants above a certain price level, but a shortage of those kinds of properties and fewer of them being built means private owners have the opportunity to charge excessively for so-called "second-hand" leases.  

2-1-1) Economical analysis

Following the above mentioned details we can assume that the housing crisis in Sweden as a national problem is targeting the youngsters and people with low level income whom are not able to find the accommodation due to the economic problems they have and for many people in these categories, having a house in soon future is not more than a dream.

According to a recent report by the Swedish Union of Tenants (Hyresgästföreningen), almost a quarter of all young people aged between 20 and 27 in the country currently live with their parents – the highest number since the figures were first recorded in 1997, when the proportion was 15 percent. Only 57 percent of people in that age bracket have their own home either through a first-hand rental contract or a cooperative owned bostadsrätt – the lowest measured proportion ever. Being in the labor market for a short period of time means many young people simply can’t afford the expense of buying a property, so access to affordable rentals is essential. But those affordable rentals are in painfully short supply, according to Hyresgästföreningen’s Erik Elmgren.

2-1-2) Social analysis

The other level in which the housing crisis should be considered is social studies due to the fact that many of those mentioned to be exposed to this problem, if are not the Swedish youngster then they would be the immigrant (work force, asylum seekers and etc.). This

---

group may face the housing problem with the same reason which is regardless of their age, as they also have less time in Swedish labor market; economically it is not hard to understand that they will not be able to pace with the uprising rental prices. Adding this situation to other factors affecting their life while trying to integrate in the new society would bring a range of risks for both sides as well. This problem is necessary to be pointed out for 2 main reasons, first the fact that majority of Swedish population is held by immigrants and second that by checking back in not a far history we easily can find how these small pieces of puzzle can match together and make a conflict.

2-2) Building renovation as a part of solution for housing crisis
As explained before, building more of affordable housing in Sweden may not have been interesting for the current investors as well as construction companies. This has resulted in a housing crisis specifically in this range of the projects, current existing project mostly owned by the municipalities are suffering as well.

During a seminar titled as Bostäder & Infrastruktur by BIGGER SVERIGE on 15 March 2018 which is available in online sources as well, the main topic discussed was how to plan the renovation of 800,000 existing affordable houses. During the seminar it was presented that over 300,000 of these houses are needed to be renovated in an emergency plan. Comparing these numbers with the primarily discussed program from Swedish government to build 700,000 housing in a 10 year period, it is obvious while the authorities were not able to handle the housing crisis well, the current situation of the existing sites may result to alter the level of the crisis.

In this situation even if we assume that they may succeed, as all of the attentions are toward the new housings and big construction companies are investing their financial resources as well as work force in that area, the renovation of these blocks seems to be forgotten. This can be the main factor to make the renovation field in Sweden a court yard for small business – mostly without proper academic knowledge – to ride without a necessary attention. The concerns about this situation will be discussed in next step but to make a brief conclusion we may say the output may be either:

- A revolutionary planning to take over the ongoing process which may result in a solution to bring back many of the existing affordable housing to the market which further will help the housing market not to suffer further regards to lack of houses.
- Or by keeping the ongoing process, we may see how a new building in the future may just be enough to replace the existing insufficient housing as the number above mentioned will increase over the time.
3-0) Methodology
3-1) Introduction to Technical Survey

In previous chapters we explained the importance of building renovation in the construction field and this aspect of the industry seems to be forgotten by the authorities and governors in Sweden due to their primary focus on new built developments. This caused a gap between today's available building technologies both in management and construction and ongoing process and techniques that are used in the market. No need to mention the current market is mostly driven by small businesses which are not necessarily managed by people who have academic studies in this field, but series of managers whom are simply able to prepare the primary investment – which does not require to attract a huge amount of money- and making social contact and network to connect with potential clients.

In this way it is obvious as the current managers have no proper knowledge of building technology and management, they rely on experience that they earned by a try and fail process which they assume helped them to learn and improve! During the studies for this thesis as was expected before, many situations were faced which were demonstrating the fact that even primary stages of a building process such as data analyze and drawing readings which are the alphabets in this industry, is not known to most of them. Furthermore, Pre-renovation studies is considered to be completely unnecessary and a waste of time and budget regards to their business and by controlling the documentation about our case study there is no evidence of such analysis during the decades of these buildings life.

Now the question is why this is important? Simple answer to this question is without these studies it is not possible to make any firm decision about the interventions as any proceed cannot be based on guesses. Before starting a building renovation, it is essential to know where primary systems are located, where enhancements should be made to meet code requirements, and the condition of any deteriorated components. Years of proceeding by current principals did not bring us any result more that extreme delay in project deliveries and waste of budget.
3-2) Technical Surveys and Information Process

The information helps the parties to make more cost effective decisions in a building process. If this will be followed by creating the BIM model then designers and construction companies have all the elements necessary to complete the project. Without accurate measurement and status of building components the design professional cannot proceed in an efficient way regarding in time and cost.

Surveyors initially record the boundaries related to the current state of the entire property. This often includes the physical locations of structures and the measurements of each structure. If they used advanced technology such as Laser Scanners would provide a digital model of the existing structure that may then be used to coordinate design and construction efforts as the project takes place. When you are planning a building renovation, initial surveying offers several benefits comparing to old technics relied on existing drawings including:

- Accurate Measurements
- Boundary Identification
- Location of Physical Structures
- Internal Element Modeling
- Lower Renovation Costs
- Increased Margin for Error
- Decreased Waste
- Better Project Estimates
- Improved Design Characteristics

An initial survey functions as a blueprint for making safe, beneficial changes to any existing structure. In the end, it will increase the accuracy of the designer’s recommendations as well as decrease the cost required to complete the renovation. It also allows each involved party to coordinate their efforts for improved decision-making and better management of the entire project.

In the end the as-build survey will be accurate and every change can be made safely at the lowest possible cost.
3-3) The role of technical survey in the building renovation strategy

As it was briefly explained in previous part in the process necessary to be applied on a building construction and it’s comparison with some ongoing processes, especially in building renovation the majority of the current mistakes, resulting the inevitable application of extensions on project’s budget and timing are driven from the lack of proper analyze and studies during the planning phase of the project. In other words, if we invest a proper amount of time to:

- Study and analyze the current physical situation of the project (micro scale documentation about physical state according to the structure, mechanical/electrical systems, components, emergency system, wet area, claddings, etc.)
- Gather the records of the building to understand its initial physical state of the building and previous interventions that have occurred. (This possibly begins with the recorded data provided by the authorities to obtain the construction permissions and other sources such as ownership documentations, etc.)
- Gather the information in renovation of abandoned buildings or newly verified heritages from the current or previous occupants, workers, etc. As these information can provide some additional information to be used for analyzing the building technology or understanding the ongoing problems.
- Study the project in macro scale in neighborhood and the city, taking in consideration different ratio of impact in different projects. Also to compare this in the present time with the state in the initial construction period.
- Gather the construction systems data and technical details used in similar projects during the primary phase of building construction

The understanding is needed before proceeding.

The derivatives of these data which are made based on the documentations, report forms and measuring statements made by the survey team, being experienced in building construction with proper academic knowledge using measurement tools and techniques such as:

- Image documentation
- Laser measuring and layout tools for dimensions and leveling
- Infrared camera for visualization of air infiltration/exfiltration and moisture (in some cases especially in interior visualizations it can also help to detect the invisible materials and damages)
- X-ray process for the structure physical documentation.

On each project, will help to provide a documentation called: Technical Survey.

The technical survey made for the project can be divided in two parts:

- Technical Detailing, which demonstrates the current used technology and details of the project.
- Damage Survey, which demonstrates the physical examined damages occurred to in the building.
Wire mesh in 12” concrete. Image time =10 secs. Negative image (mesh shows as light lines).  

Left: Image detail showing rebar and conduit with ties. Actual size. Image time=10 seconds with 300keV x-ray source and a digital detector panel. Concrete slab approximately 8”.  

Right: Rebar and conduit in 8” concrete suspended slab. Image time 10 seconds. 

3-4) BIM analysis in correlation with a Technical Survey

As the information arrives from the first phase of the project, it needs to be followed by a proper tool to enable the engineers and designer to understand completely the current situation of the project to help them to make right decisions about any future interventions. In the traditional process used by the companies and contractors they would directly work on the drawings of the as built measures printed on blow-up papers. With regard to the primary needs this method would be effective if we do not take in consideration:

- The possible mistakes which would occur based on incomplete understanding of spaces in buildings full scale design. –
- Probability of errors in zone comparisons. –
- Need to print out the documentation in every single step of the project.

During the recent years by advancing the tools and software for BIM modeling (such as Autodesk Revit) and analyze which gives us the ability to fully insert, visualize and analyze the project and design digitally, we can reduce the possibility of making errors during this phase of the project beside this elimination of printing need which helps the companies to stay more regulated in the boundaries of sustainability.

Following the analyze of the technical survey BIM model and setting the SWOT (Strengths, Weaknesses, Opportunities and Threads) chart of the building design the last stage of the building design in planning can start to make the decisions to:

- Re-correct the damages caused to the building in structure
- Re-correct the damages caused to the building the components which we assume to preserve
- Improve the functionality of the building
- Improve the energy performance of the building
- Design the add-on (Extending one's house with rooms added to the side of one's home or, sometimes, extra levels to the original roof. Such a new unit of construction is called an "add-on").
- Improve the interior/exterior visual aspects and ...

Following the stage 3-4, we will process the design data in a BIM modeling platform which can help us to arrive to the same output of the information such as CAD drawings to be presented to the legal authorities, management and installation team and other parties in case they may need the hard copies, while providing the ability to:

- Store the current data in digital storage as a data center for unlimited amount of time in case we may use them in further changes of the project in future or to provide information to be used for the similar projects
- The possibility to arrange most of the supervising and construction management for the ongoing projects in real time management platforms.
- Integration of the design phase with other digital presentations and management tools like QR coding.

---

3-5) Case Study
The area studied is structurally divided into two parts, House A-C and House D-F. Most of the houses have 3-storey. Residential apartments with basement, house A4 also has a south-facing apartment. In the area there are 8 bomb shelters in the basement of the properties and 4 laundries. House A-C has 2-4 staircases, each staircases has 2 apartments per floor. House D has 3 staircases with 2 apartments per floor. House E-F has 4 staircases, 2 of the staircases have 3 apartments per floor the other 2 apartments.
The houses are built on unpaved concrete floor with a cast concrete slab. The outside walls of the basement are cast in concrete. Load carrying inner walls in the basement are cast in concrete, the other walls are lightweight concrete walls supported by the concrete structure.
The joists between the floors are cast into concrete with a varying superstructure depending on the situation in the house and floor plan, see separate document from the municipality archive.
In houses A-C, load and stabilization takes place through gable facades, staircases, flats separating walls and some walls in the apartments. The balcony facades are covered with lightweight concrete tiles for thermal insulation, in 2017.
House E-F has walled end panels of light concrete, which means that the stabilization takes place with staircase walls and inner walls. The facades of the long sides are lacquered with light concrete stones and paved, in 2017.
The roof is a gable roof with a cover of board. The windbreaker layer is insulated with mineral wool.
In the apartments of houses A-C, the installation shaft is built traditionally with the standing drainage trunks, KV & VV, ventilation pipes lined with lightweight chimney walls. Some of the fresh water and wastewater pipes are hidden in walls / pillars in the basement, while the rest are left visible in basements or storage areas.
In House D-F, the installation chute is embedded in concrete walls in both the living rooms and in the basement. This means that sewers and ventilation ducts are not accessible except where there are cleaning slots.
In the area there are several different varieties of bathroom / WC. The types differ for the areas; the types found in one area are not in the other. In the different areas there are essentially 2 different variants.
House E1 & E2
- 3 floors + basement with bomb shelter, laundry room and premises
- 4 staircases
- 2 apartments per floor
By comparison between the reference book of details during that period and documentations in the municipality archive the assumptions for block E1 and E2 are as follow:
- Ground floor detail (330 mm)> 150mm Makadam, 50mm sand, 60mm cellplast, 70mm concrete
- Basement wall 200mm Concrete, 90mm Lightweight concrete, 10mm White Plaster (or rendering).
- Floors detail Hall & kitchens, cast concrete slabs (160mm), Plastic foam EPS (40mm), filling of sand (30mm) concrete superstructure (50mm) and plastic or Linoleum mat.
Following our site visits and several meeting between Modexa Company, Municipality of Tyresö and its sub companies responsible for the buildings, they handed us numbers of digital files and presentations in addition to access to the blue print room of the municipality. In the blue print room, there were numerous information about the building which at first site would convince us to provide a complete initial documentation for the project but while we were studying the document we realized that in addition to an improper archiving of the documents which made it difficult to take the necessary information that led to mostly waste of time to understand how to track the records. The archive files were divided in the primary categories without specification based on the block and one of these folder were completely missing. Most of the documents were just copies of the old version, E1 block primary number of 66 drawings were actually 22 proper document and the other files were fake information and E2 block primary documents received were 60 while after our analysis we understood that they existing documents are 20 drawings. Further problems were including but not limited to:

- As it is presented in the following parts, the total documentation cannot be considered as complete dossier to study the project because many drawings are missing.
- Miss match between drawings and reality such as indication of a window while in the reality the component which has been installed is a door. Example: A 4187-17 House E1 Basement
- Lack of detail indication in drawing such as indication of door model KD8 without specification. Example: A4187-18 House E2 Basement
- Missing components in the drawing such as Electrical room door which has not been mentioned in the drawing and difference between the constructed basement ramp and indications in the drawing. Example: A4187-18 House E2 Basement
- Hand writing changes in the original documents without indication of reference for the changes. Example: A4187-18 House E2 Basement
- While there were indications on some documents about DWG documentations of the buildings, in the municipality archive they did not have any documents from those drawings. Example:
  - V50-E01 House E Basement, Heat recovery from extract air, Pipe 2007.03.12
  - V50-E04 Housing E Windshield, Heat recovery from exhaust air, Pipe 2007.03.12
  - V50-E011 House E Heat recovery from exhaust air, flow chart, sub plan UC, sections, pipes 2007.03.12
  - V57-E01 House E Windshield, Heat recovery from exhaust air, Luftbeh 2007.03.12
3-6) E1 Original Documentation:

A 4187-17 House E1 Basement

A 4187-19 House E1 Ground floor 1-2tr

A, House E, Basement
A. House E. Facade East

A. House E, Facade to the west

A, Hus E o F, Gavlar o Sektioner, 14
A, Hus E Våningsplan

E 4187-3 House E1 Basement

E 4187-4 House E1 Floor plan
K, List, Straight reinforcement, Basic Plan House E1, Drawingr 12

K1673-, House E1, Exterior staircase - Very blurred

K1673-12 House E1, Ground plan
K1673-34 House E1 Ground floor, Beam

K1673-42 House E1, beam over floor 2tr

K1673-52 House E1, Floor plan Stom drawing
V50-E01 House E B

V50-E04 Housing E Windshield, Heat recovery from exhaust air, Pipe 2007.03.12

V50-E011 House E Heat recovery from exhaust air, flow chart, subplan UC, sections, pipes 2007.03.12
V57-E01 House E Windshield, Heat recovery from exhaust air, Luftbeh 2007.03.12
3-7) E2 Original Documentation:

A, House E Floor plan

A, House E o F, Facade and Sections, 14

A, House E, Basement
Electrical 4187-6 House E2 Floor plan

K1673-13 House E2, Ground plan

K1673-23 House E2 Basement, Bjelklag over basement
K1673-33 House E2, beamed ceiling on the ground floor and 1tr

K1673-43 House E2, beam over 2tr

K1673-53 House E2, Stom drawing floor
Plumbing 2239-5 House E Basement, Drainage Drawing

V50-E01 House E Basement, Heat recovery from extract air, Pipe 2007.03.12

V50-E04 Housing E Windshield, Heat recovery from exhaust air, Pipe 2007.03.12
V50-E011 House E Heat recovery from exhaust air, flow chart, subplan UC, sections, pipes 2007.03.12

V57-E01 House E Windshield, Heat recovery from exhaust air, Luftbeh 2007.03.12
3-8) Preparation of the pre-renovation checklist and Mobile App
After the document analysis of the project in collaboration with Modexa, we moved forward to prepare a checklist which at initial steps had been designed as a paper based form to enable the survey team to make an accurate checkup of the building when going to the site. The following surveys from company are focused on the wet zones of interior spaces of the apartments as this is their focus point regards to their arrangements with the municipality. The preparation of these checklist helped us to prepare an app with the help from IT department of Modexa company to enable the survey team to prepare their analysis in real-time.
Fukt

Fuktämätare
- Gann
- Protimeter
- Flir
- Annan

Referensvärde

Tröskel max

Brunn max

Golv toalett max

Vägg max

Tak max

Luft RF

Kommentar

DIMENTIONER

WC_Dim_Djup

WC_Dim_Bredd

WC_Dim_Takhöjd

WC_Dim_Komme...

ÖVERGRIPANDE

Kommentarer

Köks

ProjektID

Tyresö001

Byggnad

Våning

Datum

2018-03-21

Umäge

Ekbacken

Adress

Pluggvägen 1

ObjektsID

10 008 0002

Deltagare

Ulf

STOMME

Stommens skick
- Bra
- Godtagbar
- Dålig
- Akut

Stommens densitet
- Mycket hög
- Hög
- Medel
- Låg

Diskmaskin, utrymme

Kamera

Adress

Pluggvägen 1

ObjektsID

10-008-0003

Andra bild
3-9) Pre-Renovation Technical Analysis Checklist
While preparation of the primary checklist and the final app helped us make a step forward for the technical survey of the project, because this information is specific about the wet areas, an additional checklist had been designed for general information about the case study. The checklist is containing the necessary information for an accurate technical survey but as it will be described further in the parts, due to investigation barrier such as lack of time and access permissions for many areas of the buildings, some part remained blank.
Pre-Renovation Technical Analysis Check List

Content:
1.0 Introductory Details
   1.1 Scope and Details of Instruction
   1.2 Limitations of Building Survey
   1.3 Desk Study
   1.4 Condition Ratings

2.0 Survey Details
   2.1 Company Information
   2.2 Date of Survey
   2.3 Weather Conditions
   2.4 Client Details
   2.5 Access to the Property
   2.6 Estate Holding
   2.7 Local Authority
   2.8 Planning, Conservation, and Development Guidance
   2.9 Orientations and Map of Location

3.0 Surveyor’s Overall Assessment
   3.1 Surveyor’s Opinion
   3.2 Areas of Concern
   3.3 Estimated Value of the Property
   3.4 Total Estimated Costs

4.0 The Main Building - Exterior
   4.1 Limitations to Exterior Observations
   4.2 Period of Property and Construction Principles
   4.3 Construction Type
   4.4 Roof
   4.5 Soffits, Fascia, and Bargeboards
   4.6 Rainwater Goods
   4.7 External Walls
   4.8 Lintels and Window Heads
   4.9 Windows and Frames
   4.10 External Doors, Frames and Security
   4.11 Floor Ventilation
   4.12 The Damp Proof Course
   4.13 Foundation Type
   4.14 Report Table and Photos

5.0 The Main Building - Interior
   5.1 Limitations of Interior Inspection
   5.2 Corridors and Staircase
   5.3 Ceilings
   5.4 Walls, Party Walls, and Partitions
5.5 Floors
5.6 Internal Doors and Fire Resistance
5.7 Basement, Mechanical and Laundry Room General Condition
5.8 Report Table and Photos

6.0 The Main Building - Apartment Interior
6.1 Limitations of Interior Inspection
6.2 Main Entrance
6.3 Main Saloon and Primary Area
6.4 Bedrooms
6.5 Kitchen, Toilet and Service Areas
6.6 Report Table and Photos

7.0 Building Services
7.1 Limitations to Observations of Services
7.2 Fire Alarms, Smoke Alarms and Fire Suppression Systems
7.3 Water Supplies and Plumbing
7.4 Electricity Supply and Installation
7.5 Gas Supply and Installation
7.6 Space Heating and Hot Water
7.7 Mechanical, Trickle and Passive Ventilation
7.8 Drainage: Foul, Surface, and Underground
7.9 Report Table and Photos

8.0 Dampness, Mold and Defects
8.1 High Moisture reading and Locations
8.2 Building Defects and Locations

9.0 The Structure - Alterations and Risks
9.1 Limitations of Inspection
9.2 Observation

10.0 Environmental Factors, Health and Safety
10.1 Flood Risk
10.2 Deleterious Materials
10.3 Invasive Species
10.4 Other Environmental Factors
1.0 Introductory Details

1.1 - Scope and Details of Instruction

This building survey report has been prepared for the benefit of thesis author as the master degree student of KTH royal institute of technology in Stockholm, Sweden. The author of the survey accepts no liability of the third party for the usage of this survey in whole, in part or relied upon by third parties for any use.

This is a general building survey report on the property to propose a mechanism to improve the current method of the building survey used by the companies in building renovation industry in Stockholm.

The purpose of this report is to provide a general overview of how to investigate the condition of the property and to enable the project parties to plan for future renovation planning and maintenance of the building envelopes during the life cycle of the materials and parts. Recommendations for further investigation have been made for the current case study regards to different obstacles before and during the surveying sessions.

1.2 - Limitations of Building Survey

These limitations are additional to any imposed by the conditions of engagement which were explained in details, and are a consequence of both the building and the circumstances of the inspection. These limitations are, therefore, additional items that are drawn to the attention. Other constraints may include but are not limited to floor coverings, furniture, stored goods, inaccessible areas, exceptional limitations (e.g. snow, parked vehicles, building works, etc.). Comment cannot be given in areas that are covered, concealed or not otherwise readily visible.

There may be signs of hidden defects, in which case recommendations are made for further investigation. During the surveying sessions of the case study, while there was a proper access to the building service areas, corridors and etc., for the indoor areas of the apartments specially for the hidden defects as we had to use the thermal camera and it was not mentioned by the facility owner to the occupants during their appointment set up communications, any kind of observation and documentation was almost not agreeable by the occupants which led to lack of information for these areas. In the absence of any such evidence, it will be assumed in producing this report that such areas are not included for this report as we agreed that mentioning these areas as free of defects would lead to misleading information causing improper decisions. If assurance is required on these matters, it will be necessary to carry out additional measurements (thermal and x-ray documentation) and exposure works if necessary. Each room with access permission by the owner has been inspected in detail. Moisture readings have been taken where possible. Fitted floor coverings have not been lifted.

This not a full invasive survey Also some service pipework is below flooring, making inspection impossible without exposure. In such circumstances, the discovery of leakages and rot if any may not be possible.

The building services such as electrical installation and gas have not been tested either. Therefore, appropriate advice has been given to having the services inspected by an
approved contractor.

No beams, lintels or other supporting components were exposed to allow examination. Therefore, it has not been possible to comment fully upon the condition of these concealed areas. Therefore, the risk of unseen defects has to be accepted to proceed without further investigation. This report reflects on the condition of the various parts of the property at the time of the survey. It is possible that more defects may arise between the date of the survey and the date upon future site visits. So it must be accepted that this report can only comment on what is visible and reasonably accessible to the surveyor at the time of the survey.

1.3 - Desk Study

In preparing this report, the following sources of information have been relied upon:

1. Municipality of Tyresö, Stockholm.
2. Modexa team of engineering and management.
3. Interviews and verbal information during survey visit with the occupants.
4. Technical information gathered by the surveyor using dimensional measuring tools as well as photographs, thermal camera and moisture measuring device.

1.4 - Condition ratings

A rating mechanism has been applied to indicate the condition of each component and level of attention required for each component. In a general view the surveyors opinion during the session about the technical aspects obtained, are useful regardless of the inquiry of the project as we believe this information would help the property owners and occupants for further renovation planning. Following the ongoing procedure between the project parties (municipality as the owner of the property, property occupants and the construction company) in most of the pre renovation studies the target and the goals of the projects are pre-defined regardless of the total project needs as a result of an intention to take action for high risk areas. In this case we decided to define the actions to be considered for the current renovation planning which are defined separately.

Rating mechanism:

- **High Risk** - Urgent attention is required. Further deterioration or disrepair may occur if repairs are not undertaken immediately.
- **Medium Risk** - Overall, this part of the property is in satisfactory condition, but some repairs are required to ensure that the component continues to perform its purpose and maximize its remaining life.
- **Low Risk** - The component is in a satisfactory condition and has a remaining life of at least 5 - 10+ years, subject to regular maintenance.
- **Not applicable** - Due to limitations, this component was not inspected or does not exist. Therefore, no comment could be provided.

Action mechanism:

- **IR** = Immediate Repair/Replacement
- **RR** = Replacement Reserves
- **NM** = Normal Maintenance
- **NA** = Not Applicable due to limitations
2.0 Survey Details

2.1 - Company Information
In field collaboration between “KTH Royal Institute of Technology” and “Modexa AB”. Modexa AB (“MODEXA”) offers kitchen appliance and kitchen designing solution. Modexa conducts business operations throughout Sweden, currently developing it’s activation field in building renovation.

2.2 - Date of Survey
March 2018

2.3 - Weather Conditions
The weather at the time of the survey was cloudy and pre-existing snow cover.

2.4 - Client Details
Municipality of Tyresö, Stockholm.

2.5 - Access to the Property
The property was accessed via pre scheduled site visit of the locations selected by the municipality.

2.6 - Estate Holding
Tyresö Boståder AB, Stockholm as the property owner with rental contract to individuals.

2.7 - Local Authority
Municipality of Tyresö, Stockholm.

2.8 - Planning, Conservation, and Development Guidance
To my knowledge, the property is not located in a conservation area and is not listed.

2.9 - Orientation and Map of Location

---

House E1 & E2
- 3 floors + basement including shelter, laundry room and premises
- 4 staircases
- 2 apartments per floor

---
3.0 Surveyor's Overall Assessment

3.1 - Surveyor’s Opinion

A survey has been undertaken to ensure that any defects identified at the time of the survey are included in this report and that the structure is in a condition whereby you will not suffer unexpected financial losses in the future. In the opinion of the surveyor, the structure of the property is in a satisfactory condition, except the defects listed in the main body of this report. The surveyor is not able to provide you with an answer as to whether you should proceed with the building renovation or not, as the result of major limitations due to the site visit and lack of the proper documentary data by municipality. Further investigation in accordance with better access to the building especially the internal space of apartment which have to be selected by the surveying team, can result a more accurate data gathering and analyze to help the renovation team to achieve better result while these data can be used in future planning of the area.

3.2 - Areas of Concern

The areas of concern are listed below for ease of reference. You should refer to these sections accordingly for further information. An accumulative cost sum for each category of these areas is included in the summary of repair costs table below.

- Roofs
- Windows, Frames, and Sills
- External Doors, Frames and Security
- Floor Ventilation
- Internal Door and Fire Resistance
- Kitchen Fixtures Fittings
- Sanitary Fixtures and Fittings
- Fire Alarms, Smoke Alarms and Fire Suppression Systems
- Water Supply and Plumbing
- Electricity Supply and Installation

3.3 Estimated Value of the Property

The important role of the estimated value of the property for any proposal is inevitable, but valuation is not included as part of this survey. This holds both in the primary estimating value of the property in existing condition and in cost estimation of the renovation process.

3.4 Total Estimated Costs

In this report, we have highlighted a number of repair items along with improvements and provisional works that may only be required subject to further investigations and reports but there is no cost estimation and financial evaluation for renovation studies based on this survey.
4.0 The Main Building – Exterior

4.1 Limitations to Exterior Observations
The external of the roof was not physically accessible at the time of the survey due to a lack of access permission to be provided by municipality as the owner of the property, while there were other parts of the main building exterior which are not inspected during our site visit due to the lack of time. According the communications between Modexa and the facility owner there was a very limited period of time given to the surveying team for both interior and exterior studies. It was therefore not possible to physically check the mortar beds of tiles and mortar joints and roofing materials.

4.2 Period of Property and Construction Principles
The property is including series of the residential building constructed during the 1960s using traditional techniques of casted concrete and materials. The elevations are of clay bricks and finishing with a lime mortar and painting. Buildings of this kind are described as "Skivhus, lättbetong" Reference book: Så byggdes husen 1880~2000

4.3 Construction Type
Solid Construction

4.4 Roof
Pitched roof with a tile covering. The windbreaker layer is insulated with mineral wool. While the tile covering of the roof generally has a long material life cycle, an estimation of the last maintenance and current situation must be carried out.

4.5 Soffits, Fascia, and Bargeboards
The soffits and fascia to the front, side and rear are timber, which appeared to be in a satisfactory condition but painting should be done. The timbers should be decorated in 5-10 years so an estimation of the last maintenance and current situation must be carried out.

4.6 Rainwater Goods
The guttering to the front is steel type. The downpipe is steel and is well connected to the guttering. The downpipe extends into a gulley at the front of the neighboring property. This section of guttering was in a satisfactory condition, and no repairs are required. The downpipe was in a satisfactory condition, and no repairs are required.

4.7 External Walls
The elevations are constructed of concrete panel with cement Shot-Crete and painting finishing. General condition was satisfying while I observed signs of color change which may be the result of improper external insulation and heat loss sign during thermography from joints. Further thermography during the night time must be provided.

4.8 Lintels and Window Heads
In satisfying condition, with no sign of deterioration and major cracking, but as it may be subject to recent façade painting and renovation, further analysis following the night thermography should be done.

4.9 Windows and Frames
In satisfying condition, with no sign of deterioration. No observation of major thermal loses.
4.10 External Doors, Frames and Security
In satisfying condition, with no sign of deterioration. With observation of thermal loses.

4.11 Floor Ventilation
External Floor ventilation should be modified as signs of humidity was present at the time survey in lower parts of the external wall.

4.12 The Damp Proof Course
External Floor ventilation should be modified as signs of humidity was present at the time survey in lower parts of the external wall.

4.13 Foundation Type
Casted Concrete, in satisfying condition with no sign of major deterioration.
### 4.14 Report Table and Photos

<table>
<thead>
<tr>
<th>Item</th>
<th>![ ]</th>
<th>![ ]</th>
<th>![ ]</th>
<th>![ ]</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>NA</td>
</tr>
<tr>
<td>Soffits, Fascia and Bargeboards</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>NM</td>
</tr>
<tr>
<td>External Walls</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>RR</td>
</tr>
<tr>
<td>Lintels and Window Heads</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>NM</td>
</tr>
<tr>
<td>Windows and Frames</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>NM</td>
</tr>
<tr>
<td>Floor Ventilation</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>RR</td>
</tr>
<tr>
<td>The Damp Proof Course</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>RR</td>
</tr>
<tr>
<td>Foundation Type</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>![ ]</td>
<td>NM</td>
</tr>
</tbody>
</table>
Signs of deterioration due to thermal bridge.

Thermal Loss in exterior door, red color on profile indicates high thermal conductivity in door profile.

Thermal Loss in exterior windows to be checked in window u value and join instalation details.

Presence of humidity and algae which indicates problems in damp proof course.
Thermal Loss in exterior door, red color on profile indicates high thermal conductivity in door profile.

Presence of humidity and algae which indicates problems in damp proof course.

Damage in external wall at some places.

Rainwater Goods generally in satisfying condition but connections to be revised.

Rainwater Goods generally in satisfying condition but connections to be revised.

Presence of humidity and algae which indicates problems in damp proof course.
5.0 The Main Building - Interior

5.1 Limitations of Interior Inspection
Because of limited access made by the facility owner during the time of survey some of the interior spaces of the building were not physically accessible at the time of the survey due to a lack of access permission to be provided by the owner of the property - Tyresö Bostäder AB - while there were other parts of the main building interior mutual spaces which are not inspected during our site visit due to the lack of time. According the communications between Modexa and the municipality there was a tight period of time given to the surveying team for both interior and exterior studies. It was highly recommended to reestablish the site survey.

5.2 Corridors and Staircase
Painted wall with granite flooring, generally in satisfying condition.

5.3 Ceilings
Generally in satisfying condition, no major sign of deterioration. The ceilings to all rooms except the lean-to appear to be of plaster type. The ceilings appear to be in a satisfactory condition. There are some cracks in the ceilings. However, these can be repaired during the next program of decoration.

5.4 Walls, Party Walls, and Partitions
Painted wall with granite flooring, generally in satisfying condition. In some points as it is presented in the visual documentation there must be analysis due to the current situation of electrical system.

5.5 Floors
Generally in satisfying condition. No major sign of deterioration and sulphate attack. In some places in mechanical room there were signs of humidity and algae due to leakages in piping system. It is recommended to undertake the renewal of the affected area.

5.6 Internal Doors and Fire Resistance
Generally in satisfying condition.

5.7 Basement, Mechanical and Laundry Room General Condition
Leakages in piping system. It is recommended to undertake the renewal of the affected area.
### 5.8 Report Table and Photos

<table>
<thead>
<tr>
<th>Item</th>
<th></th>
<th></th>
<th></th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridors and Staircase</td>
<td></td>
<td></td>
<td>✓</td>
<td>NM</td>
</tr>
<tr>
<td>Ceilings</td>
<td></td>
<td></td>
<td>✓</td>
<td>NM</td>
</tr>
<tr>
<td>Walls, Party Walls, and Partitions</td>
<td></td>
<td></td>
<td>✓</td>
<td>NM</td>
</tr>
<tr>
<td>Floors</td>
<td>✓</td>
<td></td>
<td></td>
<td>RR</td>
</tr>
<tr>
<td>Internal Doors and Fire Resistance</td>
<td></td>
<td>✓</td>
<td></td>
<td>NM</td>
</tr>
<tr>
<td>Basement, Mechanical and Laundry Room General Condition</td>
<td></td>
<td>✓</td>
<td></td>
<td>IR</td>
</tr>
</tbody>
</table>
Thermal Loss in exterior door, blue color on profile indicates high thermal conductivity in door profile.

Corridors and Staircases.

Loudry room.

Improper choice of material for apartment doors concerning thermal conductivity and security.
Signs of flame in electrical components.

Electrical component heat sign

Signs of flame in electrical components.

Piping leakage in basement.

Moisture and deterioration in basement ceiling.

Structural crack in shelter door.
6.0 The Main Building - Apartment Interior

6.1 Limitations of Interior Inspection
Because of improper arrangement made by the facility owner during the time of survey some of the interior spaces of the building were not physically accessible at the time of the survey due to a lack of access permission to be provided by municipality as the owner of the property, while there were other parts of the main building interior mutual spaces which are not inspected during our site visit due to the lack of time. According the communications between Modexa and the municipality there was a tight period of time given to the surveying team for both interior and exterior studies which lead to simplification of the observations to toilet and kitchen area, in addition to the problem that as the furniture were already in place even in this areas a complete survey could not take place. It was highly recommended to reestablish the site survey.

6.2 Main Entrance
Generally in satisfying condition, no major sign of deterioration.

6.3 Main Saloon and Primary Area
Not Accessible.

6.4 Bedrooms
Not Accessible.

6.5 Kitchen, Toilet and Service Areas
Generally in satisfying condition, no major sign of deterioration but minor signs of water leakage. As the previous renovation of the wet areas in the apartment had taken place many years ago, possible renovation in these areas is highly recommended.
### 6.6 Report Table and Photos

<table>
<thead>
<tr>
<th>Item</th>
<th>Red</th>
<th>Yellow</th>
<th>Green</th>
<th>Grey</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Entrance</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>NM</td>
</tr>
<tr>
<td>Main Saloon and Primary Area</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Bedrooms</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Kitchen, Toilet and Service Areas</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td>RR</td>
</tr>
</tbody>
</table>
Apartment entrance with concerns of security due to old and improper material choice.

This dust should be checked for possible asbestos.

General conditions of toilet.

Corrosion in the bathtub for one of the apartments.

Deterioration due to humidity in toilet furniture.

Deterioration due to humidity in window frame.
Difficulty for investigation due to presence of furnitures which made it impossible to have access to the surfaces.

General conditions of visible surfaces are good but concerns of old renovation which can cause hidden defects.

General conditions of visible surfaces are good but concerns of old renovation which can cause hidden defects.

Corrosion and sulphate in piping system.

Corrosion and sulphate in piping system.
Signs of thermal loss in window frame of toilet.

Recent painting renovation led to concerns of possible hidden defects as renovations were only about the finishings and paintings.

Old tiles can host algae and fungi.

Other rooms of the apartments were not accessible, this is the only photo we could take with the owner's permission.
7.0 Building Services

7.1 Limitations to Observations of Services
Because of limited access made by the facility owner during the time of survey some of the mutual interior spaces of the building were not physically accessible at the time of the survey due to a lack of access permission to be provided by the owner of the property - Tyresö Bostäder AB - while there were other parts of the main building interior mutual spaces which are not inspected during our site visit due to the lack of time. According to the communications between Modexa and the facility owner there was only a short period of time given to the surveying team for both interior and exterior studies. It was highly recommended to reestablish the site survey.

7.2 Fire Alarms, Smoke Alarms and Fire Suppression Systems
Generally in satisfying condition, but it is highly recommended to be subjected for further investigations because of lack of time during the current site visit. Standard control and testing should be provided. Some of the doors should be also considered for standard control for fire protection as most of them were the old doors without any specification.

7.3 Water Supplies and Plumbing
The piping system should be considered for replacement as previous changes had been arranged partially and there were signs of water leakage and sulphate.

7.4 Electricity Supply and Installation
The electrical system should be considered for testing according to short connection and be subjected to replacement as previous changes had been arranged partially and there were signs of fire.

7.5 Gas Supply and Installation
No observation of gas supply and installation.

7.6 Space Heating and Hot Water
Generally in satisfying condition.

7.7 Mechanical, Trickle and Passive Ventilation
Generally in satisfying condition.

7.8 Drainage: Foul, Surface, and Underground
Generally in satisfying condition, in some places there were signs of humidity but further investigations should be provided to understand the primary reason as it can be also the result of piping system leakage.
### 7.9 Report Table and Photos

<table>
<thead>
<tr>
<th>Item</th>
<th></th>
<th></th>
<th></th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Alarms, Smoke Alarms and Fire Suppression Systems</td>
<td>✓</td>
<td></td>
<td></td>
<td>RR</td>
</tr>
<tr>
<td>Water Supplies and Plumbing</td>
<td>✓</td>
<td></td>
<td></td>
<td>IR</td>
</tr>
<tr>
<td>Electricity Supply and Installation</td>
<td>✓</td>
<td></td>
<td></td>
<td>IR</td>
</tr>
<tr>
<td>Gas Supply and Installation</td>
<td>✓</td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Space Heating and Hot Water</td>
<td>✓</td>
<td></td>
<td></td>
<td>NM</td>
</tr>
<tr>
<td>Mechanical, Trickle and Passive Ventilation</td>
<td>✓</td>
<td></td>
<td></td>
<td>NM</td>
</tr>
<tr>
<td>Drainage: Foul, Surface, and Underground</td>
<td>✓</td>
<td></td>
<td></td>
<td>RR</td>
</tr>
</tbody>
</table>
Signs of corrosion and lack of maintenance for piping system.

Improper joint detail in the previous maintenance and thermal insulation installation.

Improper finishing in the previous maintenance.

Color change in the closure of previous piping duct which can be the result of humidity.

Signs of previous leakage which despite the maintenance of the piping system it is not considered to be cleaned and painted.

Incomplete maintenance of piping system which represents major corrosion and deterioration.
Standard control and replacement for electrical installations should be provided.

Improper maintenance of piping system, lack of thermal insulation and missing closure of previous piping system.

Mechanical room is generally in satisfying condition with no sign of deterioration and dysfunction.

Major signs of humidity in basement walls.

Major signs of humidity in basement walls.

Minor signs of humidity on the floor which can be the result of periodic tests but technicians.
Corrosion of the valves can be modified during the normal periodic maintenance.

Concerns of standard control due to presence of flammable liquids in mechanical room.

Mechanical components are in satisfying condition with no sign of deterioration and dysfunction.

No signs of dysfunction and deterioration in basement windows and ventilation.

Standard control should be provided for doors specially for the apartments and shelter.

Standard control should be provided for doors specially for the apartments and shelter.
8.0 Dampness, Mold and Defects
8.1 High Moisture reading and Locations
8.2 Building Defects and Locations
(Not applicable due to investigation barriers.)

9.0 The Structure - Alterations and Risks
9.1 Limitations of Inspection
9.2 Observation
(Not applicable due to investigation barriers.)

10.0 Environmental Factors, Health and Safety
10.1 Flood Risk
10.2 Deleterious Materials
10.3 Invasive Species
10.4 Other Environmental Factors
(Not applicable due to investigation barriers.)
3-10) Primary results of BIM modeling in Revit (Technical Detailing)
Primary to start making the BIM model based on the data arrived from documentation and analysis we choose Autodesk Revit as our BIM modeling platform. Revit provides proper tool and system to design and model architectural, structural and MEP design system as well as primary tool of management for construction professionals. Due to its limitation in 5d programming we followed our process by VICO software for analyzing the construction program.

General preview of BIM 3d Model made by Revit:
<table>
<thead>
<tr>
<th>Mark</th>
<th>Family and Type</th>
<th>Level</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Floor 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>214</td>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>F1</td>
<td>1</td>
</tr>
<tr>
<td>215</td>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>F1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Floor 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>186</td>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>F2</td>
<td>1</td>
</tr>
<tr>
<td>188</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>M_Casement Dbl with Trim: F2 2010 x</td>
<td>F2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>192</td>
<td>M_Casement Dbl with Trim: F3 1000 x</td>
<td>F2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1000mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>193</td>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>F2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Floor 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>187</td>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td>189</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>194</td>
<td>M_Casement Dbl with Trim: F2 2010 x</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>195</td>
<td>M_Casement Dbl with Trim: F2 2010 x</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>196</td>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td>197</td>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td>198</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>M_Casement Dbl with Trim: Balcony's</td>
<td>F3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>window F4 1910 x 1400mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tyresö kommun**

**Mängdlista Fönster 2**

- **Ebacken**
- **Project Number**: A108
- **Date**: 2018-01-23
- **Drawn by**: Unknown
- **Checked by**: Unknown
Sefaira Walls - Interior (for guidance only)
Sefaira Walls - Exterior (for guidance only)
<table>
<thead>
<tr>
<th>Mark</th>
<th>Family and Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>M_Casement Dbl with Trim: Balcony's window F4 1010 x 1400mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F1 (E1 &amp; E2)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F3 1000 x 1000mm</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F6 1200*900mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F6 1200*900mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F6 1200*900mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F6 1200*900mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F6 1200*900mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F7 1200*700mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F7 1200*700mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F7 1200*700mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>M_Fixed with Trim: F7 1200*700mm E1 &amp; E2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Tyresö Kommun**

**Ebacken**

**Fönster Mängdlista 1**

**Project number**: 201000107

**Drawn by**: Sauda Tarmo

**Checked by**: Fule Bäck

**Scale**: A107 E2
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
</table>

**Tyresö Kommun**

**Fönster Mängdlista 2**

**Ebacken**

**Project Number**

**Project Number**

**Date**

**Drawn by**

**Checked by**

**Scale**
3-11) Introduction to SEFAIRA

In order to simulate the energy performance of the design, there are several software for energy calculation software in the market, such as DesignBuilder and Energy Plus which have the ability of changing lots of variable related to energy performance of a building envelop and HVAC system etc. However, in this case one of the main concerns was to connect the 3d model from the BIM software with these software to start the calculation and taking Energy Plus as an example to import the model easily in the software we should try to export it to 3DS file which will eliminate all the component properties we had been provided during BIM modeling. In comparison with IDA-ICE, we had to provide a brief information about overall energy consumption of the building in short amount of time while by using IDA-ICE this timing would be a huge concern. SEFAIRA is software which helps in this situation, it has some features which made us to choose this software to work with. Such as: The ability of importing the design file from Revit, being user friendly and easy to understand, the ability to manipulate the main important ruling factors of the energy performance, it is very fast compared to IDA (same calculation in IDA can easily take plenty of time) and the ability to also calculate the total cost.

General preview of Energy analysis made by SEFAIRA:

3-11-1) Result analysis of SEFAIRA

To start with the calculation in SEFAIRA normally we had to do some indications and component properties input in our design which make the data standard and readable format for SEFAIRA. Defining ceiling and roofs and clarifying the external and internal wall types were some changes in this step while the primary setup was saved from our BIM model in Revit. After importing the file in the SEFAIRA, we had to make some related changes in the part of Building Envelop, such as changing the U-values from the default number to the ones...
we took from our reference data. Building orientation is also an important factor in the simulation and we orient the whole building as the real case designed in Revit. Finally, after choosing the type of HVAC System (fan coil) we started the simulation and in the below we put some brief information of the final results:

Total Energy
184,844 kWh per year

Total annual/monthly energy use

Total Cost
$280,681 per year

Total annual/monthly energy cost
Total annual/monthly CO2 emission created by the building HVAC system
U-Value and Energy Use:
By SEFAIRA also we can proceed to run different u-value for different building components to calculate how this change would affect the final result. This can be considered as one major benefit of this software when it comes to decide in which component we should invest more to reduce the energy consumption more effectively as this reduction will not happen in a cheap way.
According to the graphs demonstrated blow by reduction of 50% in u-value of both windows and wall we can see while the consumption reduction in walls is around 9.5%, the same reduction of u-value in windows would result to 11% of reduction in energy consumption. According to this result when it arrive to project’s financial decisions we can easily conclude to invest more budget to purchase more expensive windows rather than improving the thickness of the walls.
Assembly U-Value (W/m²K) for windows:
Assembly U-Value (W/m²K) for walls:
3-12) Introduction to VICO OFFICE
VICO office is not a glue ware application and it does not just stick a 3d-model to a schedule and create a movie. It combines 3d-models and uses a patented location management, leverages location-based quantities, creates accurate schedules and optimize them to provide essential production control for our projects and also 4d simulations. Photo from Vico Office website: https://www.construsoft.com/site/products/detail/vico-office-suite.96.html

- 3D model: In addition to it tools which enable the user to draw 3d-models starting with the 2d drawings, it can import our BIM model from Revit software. It can support any changes on the base Revit model as new version of the 3d model with a flag indication in document registries for record tracking. This helps us to know different modifications on the project.
- Location Management: It uses a patented non-destructive element splitting technology. This helps us in construction phase management.

- 4D planning and optimization: It provides the similar Critical Path Method (CPM) service for project management. This helps to graphically analyze the phases in which people need to work and compare to phases were people should not work to understand the working force waste in construction management and optimize the balance and reduce the numbers of the uncertainly in workflow to protect against uncertainties to make sure the schedule is achievable.

Arriving from the estimate we can go to deliver the integrated workflow and exploit the part of the work already done by the estimator. The task is then loaded with quantities, cost and resources for each location where there is work. There will be an accurate scheduling because of the calculation for duration in every location because of the varying quantities of work we have a in different duration. These assumptions then can be modified.

Location based management was initially used in Empire state building (finished on 1931) with 102 stories which was built in 18months. They used this method for continues and aligned work with the emphasis on controlling the work; they managed by productions and not just by end date with the maximum reduction in the risk of cascading delay. In this software BIM is added to take another step further to have accurate data sync.
- Production Control: Most traditional scheduling tools focus on the planning and the recording of the data but in the controlling process it’s actually to execute according to that plan using schedule planner and production controller with the BIM inputs we are able to up our gain. We can prepare a more accurate plan by leveraging location based quantities, productivity data, cost and resources to drive our schedules. Analysis of actual productivity data provides us forecasting and warning of any potential clashes in the field and we use these forecasts to inform site meeting implement mitigation measures and really control the plan. There will be a learning loop to provide better starting data and improve our next plan.
3-12-1) Result Analysis of VICO OFFICE
4-0) Conclusion
4-1) Result analysis of the implemented process

By producing the BIM model based on the data analysis and information arrived from our technical survey we can assume to have a complete understanding of the current building situation before planning any intervention. In an ideal case a planner should have full access to all the information about the building. According to the ongoing process used by majority of the municipalities and companies, data about the facilities are missing. So, at the time of decision they have to rely on incomplete records of data. For this reason they have to do the planning based on guesses and assumptions rather than facts and reality. As we discussed in details before, due to the lack of financial resources, any decision made by the facility owners for renovation of their properties must be fully studied but as we observed during the process of this thesis mostly they prefer to rely on their own limited data when asking the renovation companies for bids. As response to this situation the companies instead of a full study and analysis of the building, they try to understand the facility owner’s assumptions to overlay their bids on them to guaranty their success to take the projects. To need to say this process is like to tailoring a coat after choosing the buttons!

The result of a process of this kind may be waste of resources without proper studies to understand the actual needs of each project. But with providing the BIM model and by using the derivatives of this method we can study the building from macro scale down to the micro details and decide the importance of each of the phases of the building renovation being planned.

In the proposed process all the data both in input and output can be categorized in 2 parts:

- 2D files in .dwg format which in the most well-known format supported by almost all the programs which are used by the offices world wild.
- 3D files in .dwg and .ifc format which are most well-known formats for BIM files.

In this way any company participating in renovation projects can integrate the received files with their own work flow from the beginning of the process and their submissions for the digital data with the indicated instruction will help the facility owners to maintain a standard process of data production. Additional benefit for this process can be mentioned as the ability to create a data hub for the information of each building from the starting date of the construction till the last renovation of the building. This data hub can be controlled by the facility owner in terms of access provided to each participant of a renovation project while providing a full control of input/output of data for the facility owner.

In addition to this benefit we also can prepare the maintenance planning, both in predictive and preventive ways. This will help the owners and occupants of the properties to arrange in a sufficient way the further budgets necessary for the building without any parties to be forced to up stand any sudden cost.

This data gathered in the BIM model will also help for the further renovation projects in the future as there won’t be the necessity for each company to start the information gathering process from the beginning which is a time consuming part of renovation process. This will also reduce the number of meetings to be held between the facility owner and renovation companies and makes the process more efficient concerning the time and costs.

As the initial costs for this procedure may result in disagreement between the participants in a building project, learning from the primary steps of energy efficiency standard implementation in European countries for existing buildings the authorities can support plans
to encourage the companies and startups to start the data collection for BIM models by introducing them the supporting financial benefits. Moreover, by making an open call for future renovation projects and asking the participants to demonstrate their assumptions and analysis which are arrived from their own technical analysis to justify their renovation proposal and make this field more competitive, it may result to have better and more detailed technical analysis from the companies whom are trying to win the competition.

4-2) Expected result and future development
Following the results of this steps as today’s technology is advancing specially in IT sector by introduction of Block chains as the most advance technology to trace the information and data analysis, the BIM model can be easily applied to this platform by using QR coding systems as the entrance to access the data hub. Considering the data tracking as one of the major problem for decades in IT sector, developing the technologies such as block chain, resulted not to only a much faster process for tracking and locating the data but also to store a full record of each and every single modification happened over that data. This means by integrating this technology while we may can provide a real time access to data of the building in the model; we will also be able to have a full record of all the changes occurred to those data during the time stamped by the information of the profile (in our case can be the renovation company) which made the access to those information. Moreover not like in the process of yesterday or today where the modifications can be hand writings from unknown persons making changes to some dimensions – as explained before – on the data chain major modifications can be programmed to be dependent on approval of the higher responsible nodes of the chain by a voting system.

The opportunities arriving from the integration of the proposed process and QR coding are not limited to the above mentioned parts as this technology can also introduce a new way of value transfer which can be a financial concern for those construction companies when it comes to financial transfer between different departments to keep their records more clear to control, which causes them to lose a part of their financial resources simply because of unnecessary banking transfers.