A synthesis of studies on renovation profitability

Farsäter, Karin; Wahlström, Åsa; Mjörnell, Kristina; Johansson, Dennis

2015

Document Version:
Peer reviewed version (aka post-print)

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Abstract

Still, the building sector in Sweden repeatedly fails in using experiences from both fulfilled projects through feedback or existing research information. Doing so would be beneficial for the process of developing appropriate and competing product and services, and to avoid crucial mistakes that risks the functionality of the constructed buildings. It is also important that the quality of the information is known to be able to make relevant risk assessments of constructions and decisions. Particularly since the topic of building renovations has such an interdisciplinary nature, there is an urgent need for a comprehensive knowledge base and a quality model taking into account research and practical experience. As part of a five year research project on the interdisciplinary renovation of buildings, this paper proposes a start to synthesis existing research and experience of renovations. A synthesis of a number of profitability analysis for renovation projects was performed. It will give examples of existing information and how it is accessed. The result will function as a pre-study for a tool that will be continuously improved and extended over the coming years. It will be part of the work of Swedish National Renovation Centre with the aim to optimize the renovation process in an interdisciplinary manner.

Keywords: Holistic, profitability, renovation, sustainable

1. Introduction

Still, the building sector repeatedly fails in using experiences from both fulfilled projects through feedback or existing research information. Doing so would be beneficial for the process of developing appropriate and competing product and services, and to avoid crucial mistakes that risks the functionality of the constructed buildings. It is also important that the quality of the knowledge is known to be able to make relevant risk assessments of constructions and systems that will form the basis for decisions. Particularly regarding renovation of buildings, where interdisciplinary is important but also creates constraints, there is an urgent need of a comprehensive knowledge base and quality model taking into account research and practical experience.

The aim of this study is to gather and structure experiences on the profitability aspects treated in renovation projects, to increase accessibility, assess ability and manageability of the information. Some examples of data, based on existing research and experience from renovation projects is gathered in this study, with profitability aspects in focus. The Swedish National Renovation Centre, RC, work to optimize the renovation process taking into account all relevant aspects. The long term aim is to create a more sustainable national renovation practice by learning from already performed renovation projects and introduce all relevant aspects of a sustainable renovation into the process. The result of this study will function as a pre-study to a tool that will continuously be improved and extended over the coming years, and it will be part of the work of RC.

This study includes larger renovations of Swedish multi-storey apartment buildings, where the whole building is being considered and several aspects are treated. Renovation projects for maintenance and aesthetic purpose are not included. Information from specific renovation projects planning phase was gathered without consideration of whether the execution of the renovation being performed or not.

2. Economic aspects in renovation projects

Buildings are in need of renovation and society needs the renovations to be sustainable for both users and the environment. Sustainable development, as defined by the Bruntland commission is "...development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987). The definition generates questions about what the need is and what will compromise the possibility for future generations to fulfil theirs. Narrowing down the meaning of sustainability in contexts and studies connected to building renovation projects show dissimilarities in the use of the expression of sustainable renovation. A study from the technical University in Istanbul evaluate sustainability from two aspects; environmental and economic (Cetiner & Edis 2014). An upcoming standard in Austria, to evaluate sustainable buildings states environmental, social, economic, functional and technical aspects to be treated to achieve an holistic sustainable evaluation (Kreiner et al. 2014). The

variation of sustainability content, expression and also the division of main categories with subcategories is evident in the studies. In Sweden the performed renovation project Brogården aimed for a sustainable renovation and treated the aspects of economic, ecological and social (Alingsåshem & Skanska n.d.). In addition, an important conclusion revealed during the renovation process was the positive effect of the entrepreneur contract form 'Partnering', leading to higher degree of partner involvement resulting in higher quality and an efficient building process. The aspects of life-cycle cost (LCC), energy, indoor environmental quality and hazardous materials are treated in the report "Sustainable assessment of renovation packages for multi-family buildings in Sweden" (Brown et al. 2013). The expression of sustainability in this report is explained to be used to describe a method that involves more than "simply long-term environmental performance" (Brown et al. 2013). It is also stated that the purpose of using of the term sustainability is not to give it a definition. A common aspect treated in the studies is economic as three of the studies state it and the fourth study partly includes with life-cycle cost (LCC). By performing LCC calculations, it is possible to include an estimation of a project's profitability. In the economic aspects a wider view of, for example, accounting methods and financing options could be treated.

Reasoning about the different calculation methods and input data that should be used for profitability calculation are evident in several projects (Högdal 2013). The calculations should support decisions relating to investment. Several methods can be used such as payback time, net present value (NPV) and life-cycle cost (LCC) (Byman & Jernelius 2012)(Lind 2014b). Also internally developed methods by companies without references to earlier theories can be used (Hastig & Tapper Jansson 2014). Profitability can be calculated from the companies' perspective or from the communities' perspective (Byman & Jernelius 2012). The companies' calculations can be performed with costs, expected incomes and invested capital. In the socio-economic calculation with the communities' in addition to companies' perspective, societal benefits are also included. Societal benefits are, for example reduced unemployment, lower crime and use of local work resources, can be considered. A web based tool for profitability calculations has been developed by BeBo (Energy agency's client group for energy efficiency apartment buildings) with the aim to be used in early decision stage in renovation projects BeBo (2014). A function to include societal benefits is included in the tool. The input data required for the profitability calculation depends on the calculation method. Even with a clear methodology the calculations rely on realistic input values for e.g. energy price and lifespan. The article "Feasibility of energy saving renovation measures in urban buildings: The impact of energy prices and the acceptable payback time criterion" includes an analysis of the high impact of energy prices alteration on profitability calculations (Papadopoulos et al. 2002). In 2009 the energy prices were too low in China for energy efficient measures to be profitable according to a study published in "Energy Policy" (Ouyang et al. 2009). A study on the effect of different lifespans, which considered 40, 50 and 60 years, came to the conclusion of the impact of different lifespans being small or even negligible (Bonakdar et al. 2014).

3. Conduct of a review of empirical research on building renovation in Sweden

Publications on renovation projects were collected with focus on the treatment of profitability calculations. The data search was performed with database searches, pearl growing (in which used references in found publications includes) and recommended literature from the collaboration within the strong research network called 'SIRen'. Within the Lund University, several databases are accessible both within the University and open accessed. Databases used in this study were general or engineering and technical-oriented. These are presented in Table 1. The search carried out in the presented databases was specified with search words and strings of search terms.

Table 1: Databases used in the performed literature search.

Business source complete	*Business oriented database managed by EBSCO.*
LUBsearch	*General database managed by the Lund University library.*
Science Direct	*Same subjects as Scopus and Elsevier manages. It is open to use without a membership. Open access journals and books can be searched for.*
Scopus	*Publications in the subjects: health, life, social and physical sciences are searchable. Managed by Elsevier but contains publications from several other publishers. Includes conference papers.*
SwePub	*Scientific publications from Swedish Universities. Managed by LIBRIS, the Swedish National Library System*

The search carried out in the presented databases was specified with search words and strings of search terms. Boolean operators were used in this study to focus towards the specific field of sustainable renovation. Also truncations were utilized and contributed to a more effective search approach. In the research field of this project several words are used for the same purpose therefore were search strings e.g. (renov* OR refurbish* OR retrofit* AND sustainab* AND economic*) used.

A synthesis of reviewed studies was carried out based on found information on specific renovation projects in publications. The used methodology and input values for profitability calculations in the renovation projects were collected and compared. A synthesizing qualitative study was performed on the projects where the needed specific information was accessible.

4. Result

A literature search for research- and renovation projects considering "sustainable renovation" result in 465 publications treating a broad spectrum of aspects, some presented in Figure 1. In 70% of the publications the aspect of energy was included in sustainable renovations. Economic aspects were treated in 45% of the found publications. This implies a high importance of these

factors in regard to sustainable renovation projects, while aspects such as thermal climate and ecologic both appeared in less than 20%.

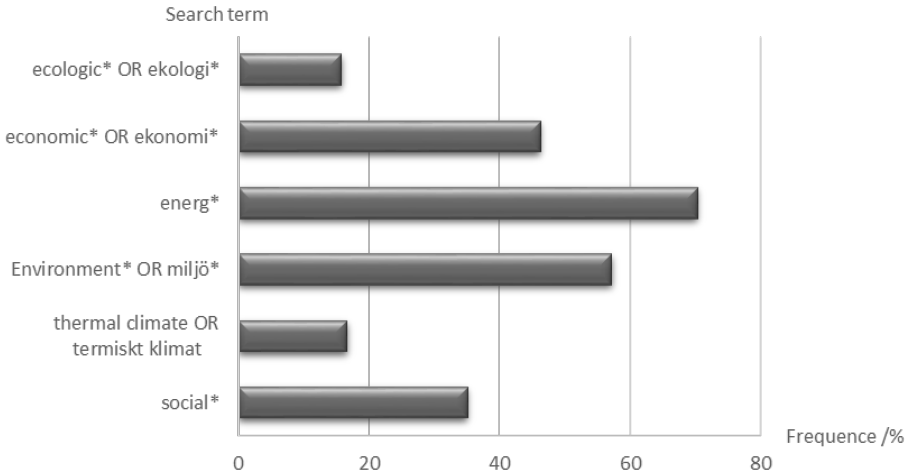

*Figure 1. Number of hits on different search terms in gathered literature list on sustainable renovations. Search strategies * and OR are used to specify the results. To include inflection of words * are used. OR is used to include both English and Swedish words.*

Information about profitability calculations for renovation projects was found in publications regarding specific renovation projects and in research projects which evaluated or analysed one or more renovation projects. The question if a renovation project is profitably and how to determine whether it is or not, is widely treated. Table 2 present general reasoning on profitability from six renovation projects.

Table 2. Project information and data for profitability calculations gathered from research projects: 1(Byman & Jernelius 2012) 2(Brown et al. 2013) 3(Hastig & Tapper Jansson 2014) 4(Dalenbäck & Mjörnell 2011) 5(Lind & Lundström 2008).

	Hållbara Järva[1]	*Backa Röd*[1]	*Brogården*[1]	*Gårdsten*[1, 4]	*Two case studies*[2]	*Giganten 6*[3]
Calculation perspective	*Company and community*	*Company*	*Company and community*	*Company and community*[5]	*Company*	*Company*
Definition of profitability	*Future cash flow exceeds the investment cost*	*Future cash flow exceeds the investment cost*	*A positive result in 18 years was in this project considered profitable*	*A payback of below 20 years*	*Comparison is made with a base case (min. effort needed to keep the present function)*	*Decreased operational costs cover the investment cost*

In several cases information about method, definitions and input data are not specified. Table 3 present examples of specified information from six projects on renovations and specific conditions for profitability used in the BeBo methodology for comparison. The table organizes the required information for profitability calculations.

Table 3. Project information and data for profitability calculations gathered from research projects: 1(Byman & Jernelius 2012) 2(Brown et al. 2013) 3(Hastig & Tapper Jansson 2014) 4(Snygg et al. 2014). (– information missing)

	Hållbara Järva[1]	*Backa Röd*[1]	*Brogården*[1]	*Gårdsten*[1]	*Two case studies*[2]	*Giganten 6*[3]	*BeBo*[4]
Profitability calculation method	*Net present value (with a residual value)*	*Net present value (with a residual value)*	*Prediction of future return*	*Payback-time calculation*	*Life-cycle cost (LCC)*	*"Total cost"*	*Net present value*
Included costs	*Total project cost*	*Standard rising,* *energy efficient measures*	*Only investment (excl. maintenance and energy measures)*	*Energy efficient measures*	*Investment, operational, maintenance, re-investments (incl. end-of-life-costs), energy*	*Total project cost*	*Energy efficient measures*
Calculation period	*10 years*	*10 years*	*30 years*	-	*50 years*	-	-
Internal rate of return	*5% (incl. inflation)* *Real discount rate*	*6.25% (excl. inflation)*	*5,5%* *discount rate*	*20 years*	*5% (incl. inflation)* *Real discount rate*	*7% was stated initially but 5% and 5.25% was used*	*5%*
Inflation	-	*2%*	-	-	*1.2%*	-	*0%*
Lifespan	-	-	-	-	*Building: 50 years*	-	*HVAC: 15 years* *Building tech.: 40 years*
Energy prices	*Following the inflation*	*Unchanged from the prices when the calculation was performed (2009)*	*District heating: 3% Electricity: 5%*	*Unchanged*	*District heating: 1.4%/year (real price increase)* *Electricity: 2.5%/year (real price increase)*	*Current price for electricity and district heating in Halmstad at the time of the calculations (2011)*	*Electricity: 1.2 SEK/kWh 2%/year increase District heat: 0.8 SEK/kWh 1%/year increase*
Renovation and maintenance	-	-	-	-	*1.0%/year (real price increase)*	-	-
Profitable	*No*	*No*	*Yes*	*Yes*	*No for 3 out of 4*	*Yes*	-

In Hållbara Järva, Stockholm, the costs for maintenance that was performed during the renovation project was included with the rest of the investment costs even if these measures are not considered as investment. This was conducted in this way due to the complexity of separating them (Byman & Jernelius 2012). The performed profitability calculations in the renovation project Hållbara Järva, gave the result that the measures were not profitable. Some possible reasons for this are that the maintenance costs were included and that the assumed energy price was evolving in the same pace as the inflation but not more.

In BackaRöd, Göteborg the calculations did not result in the energy efficient measures being profitable (Byman & Jernelius 2012). If the energy efficient measures could count as raising the buildings value and therefore make it possible for the owner to increase the rent, the measures would had been profitable. However, this was not possible in negotiations with the tenant's association. Some of the reasons for the non-profit result are assumed to be the required high discount rate and the assumed energy price to stay at the level as when the calculations were performed.

In Brogården, Allingsås, the calculations showed that the energy efficient measures are profitable (Byman & Jernelius 2012). The owner of Brogården, Allingsåshem, considers the renovation profitable if investment costs and yearly costs, calculated for each year, will give a positive result within 18 years.

In Gårdsten, Göteborg, the energy efficient measures are considered profitable according to the owners, Gårdstensbostäder (Byman & Jernelius 2012). The calculations for profitability were made for a pay-back time which was considered positive with a pay-back of less than 20 years. The calculation was performed for the energy efficient measures purely with consideration on the cost for these investments and the yearly saving in operational costs. Deeper economic analyses of the renovation project, Gårdsten for Gårdstensbostäder were performed in the report “Affären Gårdsten” by H. Lind and S. Lundström 2008 and in “Affären Gårdsten en uppdatering” by H. Lind 2014. The reports present an economic evaluation first with an company perspective and secondly adding societal effects (Lind & Lundström 2008). The difference between the company’s market value with and without the effects from the renovation is compared with the renovation costs. The project was to be considered profitable if the difference of the company’s market value exceeded the costs for the renovation. This was not the case in the economic evaluation from a company perspective and the renovation was considered to be unprofitable in 2008. The calculation performed in 2014 showed an increased market value for Gårdstensbostäder (Lind 2014a). A new profitability calculation and reasoning of the uncertainties of market values and error margins result in the renovation no longer being considered unprofitable. For both studies the societal benefits where analysed and valued to be added in the corporative calculation. Decreased unemployment, welfare effects, less criminality, less use of natural resources and positive impact on the surrounding neighbourhood were treated and included in the analyses. For the evaluation performed in 2008 the societal benefits compensates for the corporative negative cost results and therefore the renovation is considered as

profitable (Lind & Lundström 2008). The updated evaluation of the societal benefits showed a development that these impacts have a longer lasting effect than earlier assumed (Lind 2014a).

The multi-story apartment building, Giganten 6 in Halmstad was renovated in 2012 (Hastig & Tapper Jansson 2014). The building was in need of maintenance but the costs made the project unprofitable to be performed. By including energy efficient measures, the investment for the renovation could be covered. The profitability calculation included the projects total costs, increased income for rent and decreased operational costs due to reduced energy need. A method for calculating the profitability, called "Total cost" was developed during the project where the total investment cost was compared to the decreased operational costs. The calculations were performed in the decision phase of the project but also as the project changed and developed. In the calculation no account for inflation, increased energy prices or calculation period is stated. Three renovation packages were evaluated from a profitability and energy saving perspective. The calculations resulted in all three suggested packages being both beneficial from energy and cost perspective. The "Total cost" method is not being used by the property owners anymore due to the company's ambition to have a more long-term perspective.

LCC calculations were performed for two case studies of multi-story apartment buildings with three suggested renovation packages (Brown et al. 2013). One of the packages being the base case, meaning the minimum effort needed to keep the present function of the building. Life-cycle costs were calculated with the net present value method over 50 years period-of-analysis and included investment costs for year one, operational and maintenance costs, re-investments (incl. end-of-life-costs), total bought energy costs but no end-of-life cost were assumed for the building. Conditions and data for the LCC calculation were as stated in Table 3. With two different multi-story apartment buildings as case studies, each with two suggested improvement packages, and from the total of four comparisons only one showed to be profitable from a LCC perspective. The calculations show up to 26% higher LCC than the base case. The assumptions and input data in the LCC calculation are presented in Table 4.

Table 4. Source of the input data in the profitability calculation (Brown et al. 2013).

Calculation period	*Was assumed as a reasonable lifetime that was of interest for decision makers when the study was performed.*
Internal rate of return	*Together with the inflation the real discount rate were calculated with the assumed nominal discount rate. Analyses were made on 10-year government bonds for long-term nominal interest rates for the assumption of nominal discount rate.*
Inflation	*A general rate of inflation was calculated from the needed merchandise*
Energy prices	*The increase was assumed from previous performed study on past trends of charges for electricity and district heating*
Renovation and maintenance	*Building costs were based on Swedish standards. Real price increase for renovation and maintenance were taken from Swedish statistic factor price index. Technical lifespans were assumed from earlier performed studies for Swedish cost for renovation and maintenances.*

5. Discussion

Gathered information from analyses of renovation projects' profitability calculations shows variation in presented input data, as summarized in Table 5. With different calculation methods the needed data varies and the interpretation of the used method can lead to misunderstandings if this is not clearly presented. To learn from the experiences on the performed renovations, all input data with origin and method should be showed in a transparent way for a fair comparison. As stated in Table 5 some data is not specified for all projects. Table 5 also shows the variation of which data is given in the projects. When looking at the internal rate of return a span from 5% to 7% were stated in the projects. It was also expressed as the discount rate or the real discount rate. There were methods found that are dependent on e.g. inflation but this input data is not mentioned in the study. When analysing performed renovation projects, not only the found information should be considered but also the lack of information.

Table 5. Summarized data from table 3.

Profitability calculation method	*Net present value, Prediction of future return, Payback-time calculation, LCC, "Total cost"*
Included costs	*Total project cost, Standard rising, energy efficient measures, only investment, operational, maintenance, re-investments (incl. end-of-life-costs)*
Calculation period	*10 years, 30 years, 50 years*
Internal rate of return	*Real discount rate/discount rate, 5-7%*
Inflation	*Not specified, 0-2%*
Lifespan	*Not specified, building, HVAC, building technical*
Energy prices	*Following the inflation, specified prices in SEK, specified increase in % real or nominal*
Renovation and maintenance	*Not specified, real price increase, 1 %*
Profitable	*No, yes*

The gathered information in this study is mainly from academic reports specifying only a few aspects of the total renovation process. To clearly benefit from the knowledge of performed renovations all relevant information needs to be easier to access. By collecting information spread in different studies, the holistic approach could be lost. Found publications on renovation projects often lack information regarding origin of input data and method descriptions.

6. Conclusion

Information from profitability calculations for renovation projects is dependent on all project information being accessible to prevent the risk of misinterpretation. A description of the used calculation method and origin for used input data are essential for assessing the project. For the information to be manageable it needs to be structured and a common vocabulary should be used.

A standard of how to structure the methodology and input data used when calculating profitability would contribute to the process of disseminated renovation projects. More research is needed within this field to achieve a transparent calculation method that shows a realistic picture of the profitability of a renovation project with sustainable aspects taken into consideration. The need is clearly shown by the renovation project Gårdsten that has been analysed in different projects with a variation of outcomes of the investment profitability. Analyses have been performed with different methods and assumptions, which makes it difficult to judge if the question of Gårdsten´s investment was effectively answered.

This study shows some of the inconsistencies relevant when presenting a profitability calculation for a renovation project. These are some of the aspects for National Renovation Centre to consider and treat in the process of develop a tool for optimizing the renovation process in an interdisciplinary manner.

The presented renovation projects were chosen due to the found information about their profitability calculations. Where stated in this report that information was missing/not found no conclusion of this not existing is taken, only that the information was not accessible for this study. For deeper knowledge of the full process of profitability calculations in these projects a more extended investigation should be performed.

Acknowledgements

In 2014 a strong research environment was granted by Formas in Sweden called SIRen, Sustainable Integrated Renovation. The research project is connected to the Swedish National Renovation Centre.

References

Alingsåshem & Skanska, *Brogården – med fokus på framtiden*, Allingsås. Available at: http://www.alingsashem.se/uploads/pdf/Brogarden_mars13_webbx.pdf [Accessed January 30, 2015].

Bonakdar, F., Dodoo, A. & Gustavsson, L., 2014. Cost-optimum analysis of building fabric renovation in a Swedish multi-story residential building. *Energy and Buildings*, 84, pp.662–673. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0378778814006926 [Accessed November 1, 2014].

Brown, N.W.O. et al., 2013. Sustainability assessment of renovation packages for increased energy efficiency for multi-family buildings in Sweden. *Building and Environment*, 61, pp.140–148. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0360132312003174 [Accessed November 3, 2014].

Byman, K. & Jernelius, S., 2012. *Ekonomi vid ombyggnader med energisatsningar*, Stockholm: Miljöförvaltningen Energicentrum. Available at: http://www.stockholm.se/energicentrum [Accessed January 30, 2015].

Cetiner, I. & Edis, E., 2014. An environmental and economic sustainability assessment method for the retrofitting of residential buildings. *Energy and Buildings*, 74, pp.132–140. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0378778814000589 [Accessed August 26, 2014].

Dalenbäck, J. & Mjörnell, K., 2011. Milparena – A Network Project for Knowledge Enhancement Regarding Energy Renovation of Multi-family Buildings in Sweden. In *Ökosan*. pp. 1–10.

Hastig, S. & Tapper Jansson, S., 2014. *Val av energieffektiviserande åtgärder*, Lund: Lunds Universitet.

Högdal, K., 2013. *Halvera Mera - Slutrapport*, Stockholm: BeBo. Available at: http://www.bebostad.se/wp-content/uploads/2013/11/2013_30-Halvera-Mera-slutrapport.pdf [Accessed January 30, 2015].

Kreiner, H. et al., 2014. Sustainable building optimization – A systemic approach. In *World Sustainable Building*. pp. 1–9.

Lind, H., 2014a. *Affären Gårdsten en uppdatering*, Stockholm: KTH.

Lind, H., 2014b. *Ekonomiska aspekter på renoveringar av bostäder*, Stockholm: KTH.

Lind, H. & Lundström, S., 2008. *Affären Gårdsten*, Stockholm: KTH. Available at: http://www.diva-portal.org/smash/get/diva2:473770/FULLTEXT01.pdf [Accessed January 30, 2015].

Ouyang, J., Ge, J. & Hokao, K., 2009. Economic analysis of energy-saving renovation measures for urban existing residential buildings in China based on thermal simulation and site investigation. *Energy Policy*, 37(1), pp.140–149. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0301421508004023 [Accessed November 12, 2014].

Papadopoulos, A.M., Theodosiou, T.G. & Karatzas, K.D., 2002. Feasibility of energy saving renovation measures in urban buildings: The impact of energy prices and the acceptable pay back time criterion. *Energy and Buildings*, 34(5), pp.455–466. Available at: http://www.sciencedirect.com/science/article/pii/S0378778801001293.

Snygg, J., Levin, P. & Falkelius, C., 2014. *Rekorderlig Renovering Demonstrationsprojekt för energieffektivisering i befintliga flerbostadshus. Slurapport för Klackvägen - Stockholmshem AB*, Stockholm: BeBo. Available at: http://www.bebostad.se/wp-content/uploads/2014/08/RR_Klackv%C3%A4gen-slutrapport-140704.pdf [Accessed February 6, 2015].

United Nations, 1987. *Report of the Commission on Environment and development Our Common Future*, Available at: http://www.un-documents.net/wced-ocf.htm [Accessed January 30, 2015].