The potential for implementing a decision support system for energy efficiency in the historic district of Visby

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Abstract
A prototype for a decision support system (DSS) for energy efficient historic districts has been developed within the European project EFFESUS (ENERGY EFFICIENCY FOR EU HISTORIC DISTRICTS). The DSS is an expert system that aims to identify and priorities retrofit measures to improve the energy performance of a specific historic district. This paper will discuss the possible implementation and assessment of the DSS in the historic district of Visby, Sweden. The objective is to investigate how the DSS could work in planning and management of the small world heritage city seen from a stakeholder perspective. The study is conducted through a workshop and interviews. An outcome is the division between the presumed direct and indirect use of the DSS depending on the stakeholder position or profession.

Keywords – Decision support system; Energy efficiency; Historic urban districts; Stakeholder perspective

1. INTRODUCTION

Research within the multidisciplinary field of decision support, energy efficiency, heritage significance and historic urban districts is not common. The 7th European framework project EFFESUS (Energy efficiency for EU historic districts’ sustainability) aims to find solutions to the complex problem of managing energy saving and safeguarding historic urban districts. The objective of this paper is to investigate how a decision support system (DSS) developed within the project works in relation to the local planning and management of a small world heritage city.

In the field of energy efficiency in historic buildings a considerable amount of research has been carried out with focus on single buildings, retrofit solutions, energy performance, climate control, management, legislation, often in the form of case studies.[1][2][3] The need for well informed and balanced decisions taking into account both energy efficiency and cultural heritage has been in focus for several research projects on a European level summarized in Vieites et al [4]. So far, less attention have been paid to historic urban districts and building stocks. An attempt to approach this matter is
done by Arumägi et al [5]. Modelling of building categories to serve as a support for optimizing different scenarios for energy saving actions and their affect on building stocks has been developed in a Swedish national context. [6] The attitude towards change within the heritage sector as one of the principles of conservation has been a focus for research and discussions both in theory and in practise. The values of the built heritage need to be assessed and evaluated together with other aspects such as energy, use, function, economy etc. [7]

In the EFFESUS project, a step is taken towards a more holistic and multiscale approach to sustainable energy strategies for historic urban districts. A web based tool has been developed to work as support when making decisions where many parameters need to be taken into account and where analogical tools is not sufficient for handling many different systems of data. [8]

The intended users of the DSS are municipalities, property owner and organisations developing strategies and policies for historic urban districts or bigger groups of buildings. Differences between countries regarding legislation is affecting how the use of the DSS can be integrated in future planning for energy efficiency and sustainable development of historic urban districts. The present case study will show the possible use of the DSS in a Swedish context. The study is based on interviews and workshop with three main groups of stakeholders; experts representing the municipality, property owners and consultant experts in the fields of architecture, energy and heritage. The main questions are;

- What are the perceived needs to improve energy and heritage management and what is the potential of implementing a multiscale decision support system (DSS)?
- The DSS as a tool for decision making: Is it manageable on the district level from a stakeholder point of view?

2. THE EFFESUS DECISION SUPPORT SYSTEM FOR ENERGY EFFICIENT MEASURES IN HISTORIC URBAN DISTRICTS

The DSS is the main outcome of the EFFESUS project. The software tool is an expert system that aids users to identify and prioritise retrofit measures to improve the energy performance of a specific historic district. This selection process requires, on one hand, data about the district’s characteristics. At low levels of decision making (LoDM I) this information is introduced by the user, but at higher levels (LoDM II and III) this location-specific information is stored in a multiscale data model. In order to work in medium levels of information availability (LoDM III) a Categorization Tool has been developed as a web application that is used to categorize the building stock and select typical buildings as representatives for the whole district.[9] On the other hand, it is necessary to characterize the possible retrofit measures regarding their impact in the different decision making criteria such as heritage significance, energy saving or thermal comfort. These data are structured and stored in a technical solutions repository. The inputs from the data model and the repository are used by the DSS to produce.
- A current state regarding energy demand and carbon emission
- A list of possible solutions classified by their applicability
- A priority list of packages of retrofit measures which are likely to be suitable in the context of a specific historic district and their impact at district level.

3. THE VISBY CASE STUDY

The case study of the Swedish Unesco world heritage city of Visby is conducted to clarify the stakeholder needs and the potential of implementing a multiscale decision support system within the managerial system connected to energy efficiency and built heritage. Visby is an originated medieval city surrounded by a city wall and situated on the island Gotland in the Baltic Sea. Based on an inventory made in the Effesus project there are 1235 built properties and 314 listed buildings within the city wall. The character of the historic district is connected to the medieval influences but also to the 18th and 19th century periods.

![Image of Visby cityscape](image)

Figure 1. The cityscape of the world heritage city of Visby

The case study consisted of one workshop and seven interviews. The workshop was conducted in a way where the participants were divided into discussion groups for short intensive discussions and then asked to give individual written feedback as well as in an open discussion. In the next stage semi structured qualitative interviews were carried out in order to get a deeper understanding of the results from the workshop. The stakeholder input was divided into two parts; the first part deals with the perceived general needs of knowledge, support, guidance etc. within the multidisciplinary field of energy efficiency and historic urban districts, the second part (in the context of the EFFESUS project and the DSS) is on how the implementation of the DSS could fill fill the perceived needs. In total 19 different stakeholders participated in the study. The interviewees were representing different expert fields; architecture, heritage, energy, politics and engineering. There is a division in responsibility between different areas of interest within the municipality such as architecture, cultural heritage, environment and energy and building survey. This division is a result of how work is organised in relation to the national planning and building act.
Local policies and guidelines concerning energy measures in the historic urban district of Visby are provided by the building regulations for the city that gives a brief guidance to what kind of measures are acceptable regarding the heritage values of the building stock. This building regulation was developed as part of the planning instrument for the historic centre of Visby. In short the building regulations contain de facto restrictions on exterior changes related to energy retrofits. There is also a higher requirement concerning building permits than for the normal building stock which gives the municipality a possibility to control and minimize the visual/exterior changes of the built environment within the historic district.

4. ENERGY AND HERITAGE MANAGEMENT IN VISBY

The need for advice, best practice, information and specifically advice and information concerning energy and cultural heritage were topics that all stakeholders addressed in different ways. A common knowledge base, both in the sense of understanding each other’s field of expertise and also a need for developing better guidelines, in the multidisciplinary field of architecture, conservation and energy was addressed as one important need mainly from the stakeholders representing the experts at the municipality. The idea was that a common knowledge base would reduce the barriers between different fields of expertise, which was seen as an obstacle for introducing a strategical work on energy efficiency in the historic centre of Visby. Access to information about solutions applicable to historic buildings is needed by consultants and property owners. Stakeholders not representing the municipality, mainly consultants, found it difficult to get information and guidance on how to interpret what heritage values means in reality and how it is connected to the possibility to make alterations to a building. The stakeholders representing the municipality could see a need for information about best practice as guidance for sounder decisions and in the communication with residents. Understanding and respect between different fields of knowledge was discussed as a challenge by mixed group of stakeholder in the workshop.

Modern solutions and traditional building constructions are far from compatible and this is a challenge that needs to be taken seriously according to the majority of the stakeholders from the municipality. These statements are connected to the existing and future demand on existing buildings to perform as close as possible to the near-zero objectives. The house owners in the historic city of Visby have the possibility to use district heating as a 100% renewable energy supply. In spite of this, heat pumps, with both visual and acoustic impact, have been increasing in popularity. The installation of ground source heat pumps can be made in most cases without building permission since the visual impact is almost none. The energy expert saw this as a problem regarding conflicting strategies of the systems for energy supply to the historic district.

The awareness of energy efficiency as a way of reaching the complex objectives of the overall climate challenge is not common knowledge among property owner and residents living inside the historic district of Visby according to one of the heritage experts, neither is the knowledge about life cycle costs and analysis in order to relate the small pieces of achievement to a bigger picture. The
4.1 IMPLEMENTATION OF THE DECISION SUPPORT SYSTEM IN VISBY

The DSS works on different levels of detail as described above. On a general level there is a possibility to use the system for strategical support for decisions as well as for guidance. On the next level the user of the DSS is asked to answer twelve questions that will limit the possible applicable solutions due to the active choices that are made. The user of the tool need for example to have knowledge about the legal situation of the district, if there are specific restrictions concerning changes to the buildings and whether the district is characterised by stone or wooden buildings. The input to the twelve questions will generate a list of suggested energy measures that would be a first step towards a strategy for energy improvements. On the more advanced level the DSS is provided with more detailed building stock data and the user also need to decide on weighing factors between for example cost, energy saving, low impact solutions, indoor air quality etc.

The Visby stakeholders from all expert fields could see the decision support system to be a useful tool supporting complex decisions about strategies and retrofitting solutions for energy efficiency in historic buildings and districts. Representatives from the municipality could see the tool as a support for development of local guidelines more than a tool for supporting decisions on specific energy efficient retrofits. This could in turn support the actual decisions made by the individual house owners. Consultants found the tool potentially useful in their business relation with private property owners. Doubts and questions about the future management of the tool and the flexibility to new data were raised both in the workshop and in the interviews.

5. DISCUSSION

This study aimed at to investigate a decision support system for energy efficient strategies in historic urban districts would apply to the preconditions of the historic city of Visby. The expressed uncertainty among all stakeholders about possible and acceptable energy retrofits in historic district according to national and local regulations shows that a tool like the DSS addresses a fundamental need among all stakeholders.

The expressed need for decision support among stakeholders could be sorted into three main themes; information and knowledge, technical solutions and an environmental life cycle perspective on the topic. There were differences in focus among stakeholders between the three themes depending on their professional background. Energy experts were more occupied by how technical solutions were compatible with existing material and architectonic character of the historic environment. Heritage experts saw a need for relating to bigger issues of management for sustainable development and especially in relation to the new planned management plan for the world heritage site. Stakeholders representing the municipality addressed issues about knowledge and information both within the
municipality between expert groups but also as citizen service. The overall most raised issue during the workshop and the interviews was the need for applicable information and knowledge. The DSS could serve as a guide to fill the perceived knowledge gap.

The municipal responsibility of questions concerning energy efficiency, environment and climate are divided on many fields of expertise (heritage, planning, permission, building regulations and technical demands etc) and also on different levels in society from user level to the political level. The communication between different fields of expertise is expressed through the stakeholder interviews as inadequate which can result in non-optimized decisions on energy efficiency. In relation to the current situation where different matters of the same issue are divided between different professionals, on different levels and also with different interests to watch over, the decision support system could work as an intersectional knowledge breaker and a platform for dialogue towards sounder decision processes.

Finally there is a line between the direct and indirect presumed use of the DSS. Representatives from the municipality expressed that it would be helpful to use the DSS outputs for producing policies and guidelines that would benefit the improvement of buildings to become more energy efficient. This is an indirect advantage of the decision support system. The direct advantages of the system were estimated for the property owners and consultants; this is mainly due to the Swedish legal context.

6. REFERENCES


