Reduced Footprints of Monumental structures, landscapes and buildings

A bright future for heritage buildings. How to promote energy efficient retrofitting measures?

Climate KIC pathfinder project

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Contents

1 INTRODUCTION

ReFoMo (Reduced Footprints of Monumental Structures, Landscapes and Buildings) is a project that has been responsive to the omission of heritage buildings in the EPBD. ReFoMo's objective is to reduce the footprint of unique heritage buildings by bridging the gap between the energy performance of heritage buildings and the potential energy savings. ReFoMo explores technical solutions that can be put in place to advancing the implementation of energy efficient retrofitting of heritage buildings (Rosales Carreón, 2015a). This is the third –and last- report prepared for the ReFoMo project. It focuses on the barriers that impede the execution of energy efficient retrofitting projects. The report is organized as follows. Section 1 offers a brief introduction. Section 2 gives the theoretical foundations in order to understand the barriers that impede the retrofitting of heritage buildings. After this, section 3 explains how knowledge regarding the factors that impede energy efficient retrofitting of heritage buildings was elicited within the different case studies (Rosales Carreón, 2015b). Section 4 explains the differences among the different case studies. Finally, recommendations are offered in the fifth section.

1.1 Knowledge gap

We argue that significant reduction of the energy usage of heritage buildings is highly desirable because energy costs and lack of comfort form the bottlenecks for a sustainable management and protection of these buildings. Another important aspect is that heritage buildings are not isolated. They are part of region, therefore, our approach asks for energetic and social inclusion of buildings at a city level. The idea of adapting heritage buildings for the future or climate-proofing heritage buildings is a growing trend that has been appreciated by many authors (Kohler and Hassler, 2002; Gallant and Blickle, 2005; Ball, 2002). Retrofitting heritage buildings aims at increasing energy performances while maintaining satisfactory service levels and indoor thermal comfort conditions that are applicable in contemporary lifestyles (Ma et al. 2013). EERHB provides attractive opportunities to reduce energy consumption of heritage buildings. In addition to the energy performance aspect of retrofitting, it also boosts the whole condition of the building. Examples include noise insulation conditions and exploitation opportunities, which extends the building life cycle and increase their value. In spite of the considerable advantages EERHB bring about, efforts have been gradual (Bulkeley and Kern, 2006). Successful experiences are oftentimes not applied on a larger scale, or in additional cities (Owen et al., 2013; Fabbri et al., 2012; Bullen and Love, 2010).

There is compelling need to advance the research on EERHB. Studies on the technical aspects regarding the construction design and retrofitting (URBACT Programme, 2014; 3ENCULT Project, 2010; EFFESUS, 2012; New4Old, 2008) are being carried out with the aim to bridge the gap between the conservation of historic buildings and climate protection, by means of furthering innovative solutions for conservation and energy-efficient retrofitting. However, systemic factors that influence this transition have not been thoroughly studied. The platform between current technical studies on retrofitting and the necessary arrangements to boost its implementation is still absent.

1.2 Research objectives and research scope

If it has been demonstrated that EERHB offers great potential to mitigating $C0_2$ emissions, why has the approach not reached a large scale implementation? If there are successful examples, what is exactly impeding the implementation of EERHB? This study attempts to provide answers to these intriguing interests. The present research aspires to fill in the existing gap between current technical studies on EERHB and implementation strategies that are needed to be enacted to support the advancement of these developments. It specifically aims at affording recommendations to advance the initiative on a European level. Further, it aims to contribute to the research conducted by ReFoMo on the system innovation aspects of EERHB. An ultimate aspiration of this study is to build up to the EERHB literature, through the provision of a comprehensive overview of the underlying barriers and incentives that influence the advancement of EERHB.

1.3 Research question and sub-questions

The research question of this study was:

- What potential solutions for implementation of climate-proof retrofitting of heritage buildings can be identified at European level?

The following sub-questions were elaborated to provide guidance throughout the research trajectory:

- What are the phases of a retrofitting project?
- What are the most common actors involved in the retrofitting project?
- What are the specific obstacles in different EERHB projects?

2 THEORETICAL FRAMEWORK

2.1 Energy Efficient Retrofitting for Heritage Buildings

With the purpose of understanding retrofitting of buildings, it is useful to provide a model that represents the different phases that can be distinguished in the retrofitting process distinguishes the different phases for the retrofitting process of buildings as follows (Rosales Carreón, 2015b):

• Phase 1: Problem Set-Up

In this phase awareness about problems concerning, among other; energy inefficiency, exploitation and comfort issues is created and the need for retrofitting is recognized.

• Phase 2: Search of Solutions

The search for solutions to the recognized problems takes place. By knowledge transfer and research enquiry, possible solutions will be developed. Technical, aesthetical, financial and other features of the solutions are explored. The feasibility of the solution is not yet taken into account in this phase.

• Phase 3: Decision-Making

Possible solutions are narrowed down by taking all the aspects of the solution, including the feasibility, into consideration. In this phase, all the regulations applicable to heritage buildings should be studied and financial institutions must grant the financial resources needed.

• Phase 4: Implementation

In this phase the actual retrofitting takes place.

• Phase 5: Verification

In this phase the direct and indirect benefits and/or drawbacks of the retrofitting are experienced. This is most often the longest phase. When the need for retrofitting is recognized again, the process moves back to phase 1.

2.2 The innovation system

The building sector can be approached through the innovation systems perspective in general (Rosales Carreón and García Díaz, 2015). There are several innovation system approaches that emphasize the systemic characteristics of innovation but with a focus on different levels of the economy. The national innovation system (NIS) brings understanding of the process of innovation on a national level (Lundvall, 2007). The technological innovation system (TIS) examines the system of innovation in several areas of technology (Carlsson, 1995). The Regional Innovation System examines the system of innovation on the geographic area larger than a city, but smaller than a nation (ONRIS, 2006). The sectoral innovation system (SIS) is a systemic approach that provides a multidimensional, integrated and dynamic view of sectors. The sectoral system is proposed as a set of products and the set of actors carrying out market and non-market interactions for the creation, production and sale of those products (Malerba, 2002). Therefore, we take this approach in order to identify the presence of barriers that impede the EERHB.

2.3 Actors

The actors composing the SIS are organizations (firms, non-firms, institutions and government agencies) and individuals (consumers, entrepreneurs etc.). The actors are characterized by specific learning processes, beliefs and competencies which interact through different processes of communication shaped by institutions. The relevant actors that take part during the EERHB are:

1. Owners. The owners of heritage buildings can be private entrepreneurs or government agencies. These owners can also be active as the operator of the building, but usually leave the exploitation of the building to the operator.

2. Operators. The operator uses the building as a platform for a certain business. This can be a restaurant, meeting facilities, party venue or other catering activities. The operator is thus concerned with the day-to-day management of the building and to a large extent the energy use within the building.

3. Users. The user is a client of the operator, a tourist or a member of the community surrounding the heritage building. Users visit the building to partake in the activities provided by the operator. The users experience is crucial to the successful exploitation of the building by the operator.

4. Government. The government acts on the national, provincial and municipal level. It provides the legislation that prevents or encourages the possible retrofitting and it determines the possibilities for exploitation by the operator. Although governmental organizations can also own heritage buildings, the two actors should be viewed as separate at all times.

5. Designers/architects. The designers/architects figure out how the retrofitting options that are selected by the owners and operators are to be implemented in the building by the contractors.

6. Contractors. The contractors execute the actual retrofitting. They are the construction workers that fit the energy saving technologies into the heritage building. Contractors and designers/architects often work closely together, and are sometimes even a part of the same large diversified firm. The distinction between contractors and designers/architects is sometimes hard to make, because of their actions sometimes overlap. The energy saving technologies that the contractors use for the retrofitting are provided by subcontractors. These are the firms that develop and produce the technologies that make the retrofitting possible.

7. Financial institutions. Banks and investment agencies that are willing to lend money to the owner or operator to finance the retrofitting. They can directly block the retrofitting if they do not see the retrofitting as a profitable action.

8. NGO's. Any non-profit, citizens' group which is organized on a local level. In this particular case, their tasks are driven by an interest in preserving the cultural heritage of a city. If there is not a particular interest in preserving the cultural heritage ,at least they have the intention of improving the sustainability of the city where they are located.

Table 1 depicts the different actors within the different phases of an EERHB project. This table shows that different actors that are expected to be involved in each of the phases of retrofitting process.

Table 1 Main actors involved in the EERHB

<table>
<tr><th>Actors\Phase</th><th>Set-Up</th><th>Search of Solutions</th><th>Decision Making</th><th>Implementation</th><th>Verification</th></tr>
<tr><th>Owner</th><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td></tr>
<tr><th>Operator</th><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td></tr>
<tr><th>Designer/Architect</th><td></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td bgcolor="#4F81BD"></td><td></td></tr>
<tr><th>Contractor</th><td></td><td bgcolor="#4F81BD"></td><td></td><td bgcolor="#4F81BD"></td><td></td></tr>
<tr><th>Government</th><td bgcolor="#4F81BD"></td><td></td><td bgcolor="#4F81BD"></td><td></td><td></td></tr>
<tr><th>Final User</th><td></td><td></td><td></td><td></td><td bgcolor="#4F81BD"></td></tr>
<tr><th>Financial Institution</th><td></td><td></td><td bgcolor="#4F81BD"></td><td></td><td bgcolor="#4F81BD"></td></tr>
<tr><th>NGO’s</th><td></td><td></td><td bgcolor="#4F81BD"></td><td></td><td bgcolor="#4F81BD"></td></tr>
</table>

2.4 Barriers for EERHB

The SIS provided the necessary structure to examine and describe the actors and their interactions. However, in the description of the SIS approach, Malerba (2002) does not distinguish barriers explicitly. Therefore, an adequate framework about existing barriers that prevent energy efficiency investments is needed. Klein-Woolthuis et al. (2005) summarize failures or barriers—as we called them—into four basic categories: i) infrastructural (i.e. physical infrastructure), ii) institutional (i.e. norms), iii) interaction (i.e. relations in networks), and iv) capability (i.e. lack of non-physical resources). This classification allows identifying causes that hinder innovation. This framework is appropriate to identify the main barriers that hinder the EERHB.

3 METHOD

ReFoMo considers the need to understand the factors that block energy efficient retrofitting of historical buildings. This project analyzed these factors based on 3 case studies. The case studies are related to historical buildings located in Hungary, Italy and the Netherlands. Each case study has been already described in Rosales Carreón (2015b). The first step was to establish a database base of information on specific actors. The second step consisted in developing an instrument that allowed us to elicit the knowledge that different actors have regarding the barriers that hamper EERHB. A Semi-structured interview was proposed in order to allow actors to make an elaborated explanation of their opinions. The interview consisted of two parts. In the first part, demographic data was gathered. In the second part, the interviewees were asked several questions regarding the process of retrofitting heritage buildings. However, the interviewees were not asked directly for the systemic barriers. Questions aimed at providing indications of the four basic barriers a system can have (see previous section). For the sake of understanding perceptions related to infrastructural barriers, the interviewees were invited to elaborate their thoughts on inputs and technologies needed to retrofit a heritage building. In order to get information about institutional barriers, we enquired about viewpoints related to legislation. Asking interviewees about desired changes in the heritage building environment allowed inspection of their insights about interaction barriers. Finally, capability barriers were identified by enquiring about the sources of information used by the interviewee and his/her particular knowledge with regard to heritage buildings. However, since one of the aims of the ReFoMo project was to share best practices. It was decided to use this interview guide only as a reference. Each team designed its own method in order to elicit knowledge.

Miles and Huberman (1994) argue that qualitative case studies may suffer from limitations. Specially in a project like RefoMo where the diferent teams used a different method to elicit knowledge, albeit based on the same interview guide. In order to guarantee the validity of the answers we obtained, each team followed the directives proposed by Wolcott (1990) during the knowledge elicitation process: i) elaborate an interview guide, ii) pre-test the interview guide, iii) avoid the modification of the interview guide structure during the interviews, iv) refrain from talking but rather listen carefully, v) produce annotations that are as precise as possible, vi) write in an early way, vii) employ a unique format to transcript the interview, and viii) corroborate the information with the interviewee.

3.1 Data Analysis

Once knowledge was elicited, the different answers were interviews are finished, copied, and authorized by the participants, the data derived from the interviews was analyzed. For that, we used qualitative content analysis, which is one of the procedures for analyzing textual material (Bauer & Gaskell 2000). According to Flick (2006), qualitative analysis looks for understanding of new situations and supports the discovery of new information. Qualitative methods are appropriate in contexts where it is necessary to first identify the variables that might later be tested quantitatively. In each response key ideas were identified. These ideas were merged into core themes. Below, we present the results by case study.

4 RESULTS

The results are divided in two sections for each case study. In the first section, the particular eliciting knowledge method that each team used. In the second section, the each one of the systemic barriers are discussed.

4.1 Utrecht

4.1.1 Method Utrecht

The Utrecht team decided to follow the interview guide prepared for ReFoMo. Key actors involved in the retrofitting of Fort de Gagel and Fort aan de Klop were identified and interviewed. The province of Utrecht manages both fortresses. Therefore, a representative for each fortress was interviewed. Also, among the interviewees were: four architects, two policy makers working at the municipality of Utrecht, two members of the Cultural Heritage Agency of the Netherlands, two NGO's engaged with sustainability, two practitioners specialized in refurbishing heritage buildings and the future operator of Fort de Gagel was also interviewed. Fort aan de Klop was not in operation when this study was conducted. Therefore, no operator from this fort was included. The interviews were conducted face-to-face with an approximate duration of one hour. Appendix A contains the interview guide used in the Utrecht case.

4.1.2 Results Utrecht

<u>Interaction Barriers</u>

The interview analysis revealed that the main issues relate to interaction barriers. The public needs to become better informed about the different possibilities and pitfalls that are associated with undertaking energy efficient monumental retrofitting. More specific, actors have shared their thoughts on the missing public information in the area of communication tools regarding to financial possibilities, laws and regulation, technological possibilities and their energy efficiency and the importance of sustainability and international awareness creation. A civil servant argued that "there are real chances in informing the actors about what can be done and is allowed in restoration and retrofitting of a monumental building." This is also supported by the operator: "[We deal] with different legislation. This makes the process diffuse and difficult to discover what can be done and what can't." When information on these aspects is missing, in the example of financial possibilities, this will unnecessarily block the whole execution, because actors cannot find the financial aid they need.

Poor communication between the different actors at all stages of the renovation process was also mentioned: "I think that especially the communication should be improved", a civil servant stated. The actors have indicated that inefficiencies often are caused by preliminary investigations which were not complete or absent. Even when the preliminary investigation was successful, a change in plans can surprise other actors and cause inefficiencies, on the short term as well as the long term. Next to the need of increased communication, an increase in collaboration is mentioned as a requirement for more widespread successful energy efficient monument retrofitting. This means that some actors do not see the current levels of collaboration sufficient. Mainly the poor collaboration and internal communication between the different departments of the government are indicated as a barrier. Furthermore, another barrier derived from the interviews is the lack of clarity in law and regulations as well on national level as on municipal level. The laws and regulations are not specified for energy supply and historic buildings. This corresponds to the EPBD, in which monuments are not taken into account in the sustainability goals (Directive 2010/31/EU).

Capability Barriers

Most respondents argued that financial resources are always a decisive factor, and that this is a difficult time to obtain credit from a bank or other financial institutions. The economic dimension also has a strong link with the social dimension: many people are not aware of different opportunities to raise a budget. An NGO concerned with sustainability also stated that people tend to be focused solely on the cash in- and outflows of the project itself: “In some forts you have entrepreneurs and companies who use rooms for business purposes; if those rooms get more comfortable, the possibility to rent the premises is likely to increase along with its price. This is an example of how retrofitting can increase the returns on the investment [which people tend to overlook]”. Furthermore, each municipality has their own way of financing the retrofitting for heritage buildings, providing different subsidies with a finite amount. As an NGO in sustainability mentioned: “[There is a limit to the budget], so you have to be quick to get such a subsidy” speed seems to be a decisive factor for obtaining a subsidy, rather than actual importance and necessity. However, it seems that –in the Netherlands- there is a mechanism that may help to diminish the impact of this barrier. A project which makes a historic building more sustainable can apply for a loan which has a lower interest rate than regular loans.

A second aspect related to this barrier was the lack of public technological knowledge in this area could create a situation where renovations do not achieve their full energy efficiency potential. As the owner of Fort de Gagel noted: “I really don’t think I know everything about what’s possible in a fort like this.”

This barrier also relates to the availability of innovative and energy saving technologies. These technologies are often expensive and require high research and development input (Vanegas et al., 1995). Multiple actors in the case study on Fort de Gagel indicated that financing the most innovative technologies might be problematic. For example, the operator states:” Use of more innovative techniques requires higher investments.” Another mentioned barrier is that implementing new and innovative technologies require testing, especially in the heritage building sector. This also entails follow-up research to track eventual errors or inefficiencies, suggests the operator: “Besides the costs, the risks of not fully tested innovative technologies are higher.”

Institutional Barriers

Institutional barriers were also mentioned. Many of the barriers that arise in the process of energy efficient retrofitting in heritage buildings have their origin in the legislation concerning preservation of this cultural heritage. Dutch law prescribes that the retrofitting of heritage buildings requires a license which will be granted on municipal level. Municipal government considers the interests of the owner and the building to form an optimal balance (Monumentenwet 1988). If this would not be the case, monuments could be in danger of losing their cultural heritage due to excessive retrofitting or rezoning. The municipal department that grants licenses contacts government on a national level (RCE) for advice and an inventarization of the cultural heritage of the concerning building (Cultureel

Erfgoed, 2012b). The decision to grant or refuse the license will be made partly on the basis of this advice and partly on governmental research, depending on the size and amount of officials of the municipality. A subsequent barrier arises when the national government on cultural heritage (RCE) considers the preservation of cultural heritage to be more important than the relatively large ecological footprint and the corresponding financial costs. As one architect stated: “It is almost as if the RCE would like to see that each brick is preserved”. In the case of Fort aan de Klop an unexpected failure came up during the execution phase. An operator acknowledged this: “Due to some bats in the basement of the Fortress, a complete climate control system (€100.000) was needed to build, because bats are protected animals.” His opinion about this situation is clear: “The building process delayed and costs of the 10 bats were €10.000 each. In my opinion this is not realistic, but because of a rigid legalization we ought to. A meaningful balance should be fund instead of this”. An owner confirms the fact of unexpected failures in other cases: “after the permit is given, in 90% of the cases the building process will delayed due to undiscovered valuable object in the building. A suspended ceiling is removed and thereunder beautiful 17th century beams appear”. In the retrofitting process of heritage buildings unexpected failures are inherent to the process and should therefore be taken into account, as far as possible. A contractor explained that the actual state of heritage buildings should not be over overestimated: ‘The actual state of the monument is not always very clear, and there for a budget for unexpected costs should be taken into account’. This barrier is of high importance, however it was not in our questionnaire.

Another aspect lies in the uniqueness of the heritage buildings, which causes the legislation to vary. This in turn leads to a variable ease of obtaining a permit per municipality, according to one of the national civil servants: “Some municipalities are stricter than others”. When an owner of a monument previously received a license for refurbishing a heritage building, he might not be able replicate the same retrofitting for another building in another municipality, since different municipalities may have different views. When refurbishing a monumental building to suit a new function, there can be conflicts in legislation. For example, when legislation demands a fire exit somewhere, creating this exit can compromise the buildings cultural value, conflicting with the monument preservation laws, this matter is mentioned by a member of the municipal government: “We get a lot of contradictions with the fire permits, which tell us to wrap the thick wooden beams for fire safety, while they are part of the cultural heritage“.

Furthermore, another problem with legislation can be the application of innovative technologies, because legislation can limit the application of these technologies, thereby reducing their effects. This is the case when applying solar panels in places on the monument where they cannot be seen. The owner of a monument has experience with this issue: “The visibility of solar cells intervenes with the architectural aspect. I have to request a monument licenses and such (…) I can’t put solar cells on the roof without the permission of the ‘Rijksdienst voor Cultureel Erfgoed’ (RCE)”. This specific placement can reduce the effectiveness of the panels to a point where they are no longer useful to implement.

<u>Infrastructural Barriers</u>

Infrastructural aspects were also mentioned but not regarded as relevant. The majority of the aspects derived relate to the architectural dimension. They are concerned with the compatibility of the technologies in heritage buildings. This is evident from, inter alia, a statement of a consultant of the Cultural Heritage Agency of the Netherlands: “There are many technological possibilities available, but these cannot simply be used in heritage buildings. These buildings are built in a whole different way and are constructed differently.” Innovative technological methods are often not applicable with the architecture in these buildings. This can be attributed to the lack of knowledge of the construction. Moreover, some sustainable technologies are associated with certain problems. For example, isolation in a heritage building can cause decay in the form of rotting and vapor formation (Perfectbouw, 2014). Lastly, the standards for comfort have been adjusted since the initial construction of the monument. Due to this change, the current composition of the buildings is not always suited for the present requirements.

The uniqueness of heritage buildings spawns another aspect of this barrier, namely that it impedes usage of all technologies that are available in the construction sector as a whole. The use of solar panels for example, would contribute to a more sustainable energy management, as is applied in many new constructions. However, preserving the cultural and architectural significance of a heritage building would require that the sustainable innovations would be invisible for the bystander. This in turn requires specific research and development for solutions for the heritage buildings, according one of the civil servants of the national government: “not nearly all of the available technologies in the construction sector can be put to use in the retrofitting of heritage buildings.” Furthermore, new and sustainable technologies often occur as a replacement of current installations or insulations, which also contradicts with the preservation of cultural and architectural significance.

4.2 Bologna

4.2.1 Methods Bologna

The Bologna team decided to interview three stake holders involved in EERHB. The first interviewee was a policy maker working at a regional level. The second stakeholder was an executive working in the private sector in the area of facility management. The third interviewee was an executive working in the technical department of a construction firm. The questions were based in the interview guide developed by UU. However, some of the questions were modified according to the needs of the team. Appendix B shows the interview guide used in Bologna.

4.2.2 Results Bologna

Infrastructural Barriers

The three interviewees focused mostly in infrastructural. The architectural constrains were mentioned as the main issue within this barrier.

“In historic buildings, however, interventions are often not feasible due to architectural constraints.”

However, not doing an intervention was considered a paradox by the policy maker: “However sometimes the owner are worried about the architectural limitation of the intervention of historical buildings and they call this limitation architectural constrain. This world does not represent correctly the activity of the Ministry of Cultural Heritage and Landscape which has the mission to protect the cultural heritage and not to make constrains."

Capability Barriers

Most of the comments that suggested this barrier were related to financial aspects. It is interesting to see the perspectives that each one of the interviewees has in this aspect. The executive of the construction firm expressed this clearly: "but they [owners of the building] demand low-cost efficient solutions that are often not achievable."

However, the policy maker seems to know a possible solution for this issue:

"The answer is very simple, because making such interventions for improving the energy efficiency of the building the government finances the 65 % over the entire cost."

Once again, the construction executive presented an argument: "government promote and reward development [in heritage buildings], but often underestimates the costs of implementation. The following claim –by the facility management executive- seems to propose another view on the required investments for retrofitting: "interventions on production and control systems [within heritage buildings] pays off in a few years"

Interaction Barriers

It was clear from the claims analyzed for the capability barriers that interaction among actors in this system needs to be increased both in quantity and quality. Regarding this aspect, the executive of the facility management firm mentioned: "the energy retrofitting is not a necessity. It is a choice for which evaluation of opportunities must be carried."

Or as the policy maker noted: "the dissemination at different level could be the key to make the retrofitting process more well-organized and widespread. In particular for the monumental building it is necessary to understand the construction technique used in specific case because also century ago a building was built taking into account the indoor comfort of the users." This statement shows that the responsibility of an EERHB does not lie in one single actor but on a team which is able to communicate through the different phases of an EERHB project.

Institutional Barriers

Institutional barriers were just mentioned once. This mention related to the evaluation if a certain technique is compatible with the building to be retrofitted.

4.3 Budapest

4.3.1 Methods Budapest

Since there was no ongoing retrofitting of the Budapest case study -just plans. The Budapest team decided to do a round table in order to investigate the barriers that are present in the Hungarian sector. The round table had duration of 90 min. During the meeting the Climate-KIC framework and the background of ReFoMo were presented. Afterwards, the case study was explained to the different actors. After that a discussion -based on the interview guide developed for ReFoMo, was facilitated. The minute from the round table is shown in Appendix C.

4.3.2 Results Budapest

Capability Barrier

The outcomes of the Budapest team were mainly focused in capability barriers directly linked with the financing of an EERHB project. In fact, each one of the barriers shows a direct connection with financial aspects. From the aspects of financing the function after retrofitting has utmost importance: its usefulness secures return of investments. The heritage quality is not necessarily relevant in this aspect, but often can be a problem since the wished function can be installed easier and cheaper in a new build. Before investment it should be assessed whether it is worth to bring the function into that certain area.

Interaction Barrier

The retrofitting of a heritage building should be included into the development plan of the district hence raising the value of the building and the whole area. This secures that the owner of the whole district has a vision and that incorporate the utilization of heritage buildings too. A vision can secure the societal aspects and returns too, which needed for EU funding but in alone not sufficient. However, is also fundamental to direct the focus towards the non-economic benefits of heritage buildings. A heritage building is not attractive from energetic aspect (no obligation to meet), but the heritage value makes it attractive that creates emotional bonds. This bond can even result in lively cultural life, however, location, neighborhood and environment matter too. In case of the Gasworks the proximity of Danube river could be beneficial once a direct connection has been established. At the current moment there are no infrastructural advantages of the location. The charm could be quantified by the number of visitors (as indicator for the culture) and also describing the utilization rate than can be enhanced by adding office functions. Monitoring after retrofitting can underpin the assumptions of the projects and the findings. In Hungary, there is a building cadaster under preparation containing which public building should be refurbished and how. This work should include heritage buildings (not planned considering that no obligations apply).

The future user should be consulted and must be committed to that function. In case the function is rather determined by public use and culture (not market utilization but public good). However, once again, financial aspects were mentioned. It can be hard to incorporate market funding and should check the opportunity to involve EU funds. In case of private (market based) funding the incomes arising from function and location are the decisive aspects, since the investors will only finance if it provides return and feasible. In order to promote EERHB it was suggested to consider this projects as "pilot/reference project" or operate only seasonally (when there is no heating cost) considering that a higher utilization rate should secure the return on investment.

Institutional Barriers

The funding at EU level was also discussed. Basically, If EU funds are planned then the added value should be proved. There was a consensus acknowledging that the energy scenarios for heritage buildings do not provide enough added value and not sufficient to apply for EU funds. Besides, there are no EU obligations for heritage buildings. Hence, EU Governments do not dedicate for them from

Cohesion Policy because meeting the obligations is the priority when designing national Operative Programmes.

Infrastructural Barrier

Novel materials/solutions are expensive and in turn provide only low savings. Proper subsidy constructions considering the novelty factor could alleviate this insufficient cost-benefit indicator.

4.4 Comparison among Case Studies

We have discussed several aspects regarding the different barriers found in each city. Table 2 depicts a representation of the barriers that should be tackled first. The green color indicates that a specific barrier did not represent a concern for the interviewees. The yellow color indicates that the barrier is present but –nevertheless- it is possible to work with it and/or there are some possible alternatives to diminish its impact. The red color indicates a barrier that is seen impedes EERHB.

Table 2. Presence of systemic barriers within the case studies

Barrier\City	Bologna	Budapest	Utrecht
Infrastructural			
Interaction			
Institutional			
Capability			

The infrastructural barrier referred mostly about the architectural constraints. These constraints can appear in several forms: historical value, materials, structural aspects, etc. However, actors involved in EERHB acknowledge this as an inherent factor that will always be the case with this type of buildings. Furthermore, ReFoMo has already given some –technical- suggestions to deal with these constraints (Rosales Carreón, 2015a). The most relevant result in terms of a possible intervention within the system in order to boost the EERHB is the revelation of the interaction barrier as the barrier that seems to have the biggest contribution in hindering EERHB. Section 3.3 depicted the decision making of an EERHB project as the phase where more actors are involved. Decision making involves an open dialogue and communication among actors to find an optimum solution. Therefore, this barrier should be found first.

The analysis of the results suggest that the institutional barrier is only relevant in Utrecht. From the other two case studies it seems that as long as the government offers a financing mechanism (such as subsidies in the Italian case) there is no need for norms and/or regulations. This is an interesting finding because these are one of the main elements of a SIS. The capability barrier was related to the (lack) of financial mechanisms that allow an EERHB project. Bologna mentioned subsidies as one possible solution that contributes to diminish the effects of this barrier. Utrecht, did not put emphasis to this barrier albeit it was mentioned.

5 RECOMMENDATIONS

The barriers discussed in sections 2.4 and 4.4, do not occur in a vacuum. They are interlinked, meaning that solving or reducing the impact of one barrier could start a chain process in the other barriers. The barrier that needs to be solved first is the interaction barrier. Below, there are some elements that indicate specific areas of intervention. In exemplification, when communication between actors is increased, this can also mean that technological knowhow is better spread amongst actors. An increase in communication also offers chances for increased collaboration. However, we believe that involving all the actors in the solution of this barrier will result in higher benefits for ReFoMo. Therefore, this section concludes with the recommendation of the creation of a community of practice.

5.1 Public Awareness

The lack of information regarding to undertaking energy efficient retrofitting is one of the biggest barriers. This can lead to indistinctness among the different actors, which can retain the actual execution of the retrofitting. Initiators of retrofitting projects, which are most often owners of the monuments, do not have all the information and connections. This results into a lack of incentive to start, or an inefficient execution of the project. To counter this barrier, communication tools should be developed that inform owners and operators about the energy their monument is using and what options for energy retrofitting are available. Calculations can be based on an example monument, a representative fortress. Each one of the five main themes (isolation, water, power, heat and saving tips) show options for making buildings more environmentally friendly and efficient. Each option comes with a tool which shows data such as the expected change in emissions, yearly savings and the payback period (De Groene Grachten, 2014a). Such concrete information might be a good stimulus for owners or operators to refurbish. Besides this, these tools could also help them to find parties that can help them perform the actual retrofitting. And by providing for example knowledge about the guidelines for monuments and the possible financial arrangements a realistic view on the retrofitting can be created. An example of this is 'De Groene Menukaart' or the 'Green Menu', a tool that was designed specifically for owners of canal houses in Amsterdam (De Groene Grachten, 2014b).

Another aspect influencing the lack of awareness is the lack of consciousness among the different actors involved. Next to better informing the actors with better communication tools, the solution for this barrier could be educating the future generation about the importance of sustainability. This could break the vicious cycle of continuously trying to solve the matters at hand, by preventing the problems to begin with. As an example, the government can give 'Greendeals' to organisations to involve interns and graduates at running projects (Rijksoverheid, 2014b). Practice shows that contractors are willing to be more sustainable, but their lack of knowledge is an inhibiting factor. Preparing the future generation with the required knowledge can overcome this barrier.

5.2 Communication between Actors

The first stage of the renovation process lacks efficient communication between the different actors involved. The main situation that indicates poor communication between the different actors is the preliminary investigation. In this stage it has been reported that actors, such as operators, often change their plans last minute. Some actors believe this can be solved with thoroughly identifying all needs and requirements for the process. Another cause for this can be found in the barrier stated above this one; public awareness. When public awareness about preliminary investigations is not adequate, this could lead to a completely missing preliminary investigation. When this investigation is missing, communication between actors is decreased significantly. In turn his leads to last minute changes in license applications and other inefficiencies. Some actors argue that also during the later stages communication needs to be increased.

5.3 Collaboration

Some actors see the current collaborations as insufficient. Actors mentioned lack of or incomplete preliminary research impeding the process of retrofitting. The level of collaboration between actors should increase to combat this. A way of achieving more collaboration can come from increasing the inter-actor communication. For example by organizing information-events for energy retrofitting, where actors could meet and discuss in person. This could increase actors understanding of each other's situation which in turn leads to better quality of collaborations. Increased quality of collaborations directly improves the quality and reduces the time of the preliminary research because actors are already in contact with each other.

5.4 Community of Practice

The foundation of ReFoMo is the creation of a multicultural and multidisciplinary team in order to address an issue where several actors and factors are involved. As discussed in section 5, there are several areas of opportunity in order to improve the interaction among actors of the heritage building sector. Furthermore, ReFoMo highlights the need of a better interaction among the ReFoMo team members (Rosales Carreon, 2015b). During the realization of the ReFoMo project a website was launched. Also web based management project management software was available to share information. Nevertheless, the inefficient use of both tools, albeit well intentioned, resulted in a burden for the different team members. To guide RefoMo in the development of a strategy to promote EERHB, the building a Community of Practice is recommended.

The concept of Community of Practice has been implemented in several organizations and it might be one of the important vehicles of knowledge management in the 21st century. A community of Practice (CoP) is defined by Wenger and Snyder (2005) as "groups of people informally bound together by shared expertise and passion for a joint enterprise". The focus of a CoP is often the same: the sharing of best practices among the members of the community and the creation of new knowledge to advance a specific domain (Cambridge et al, 2005).

5.4.1 Why to start a CoP?

CoP's are important for eight reasons. Due to ReFoMo's idea about bringing users and technology nerds together in a format where they improve the product and exchange knowledge and questions, can be derived that four specific reasons are relevant.

- Provide a shared context for people to communicate and share information, stories, and personal experiences in a way that builds understanding and insight.
- Enable dialogue between people who come together to explore new possibilities, solve challenging problems, and create new, mutually beneficial opportunities.
- Capture and diffuse existing knowledge to help people improve their practice by providing a forum to identify solutions to common problems and a process to collect and evaluate best practices.

- Generate new knowledge to help people transform their practice to accommodate changes in needs and technologies.

5.4.2 How to build a CoP?

CoPs are dynamic social structures that are fundamentally informal and mostly self-organizing, but they emerge and grow by cultivation. Building such a community can be achieved through a series of steps: "individuals can design the community's environment, foster the formalization and plan activities to help grow and sustain the community". Cambridge et al. (2005) identify several life cycles of a community that need to be understood for successful facilitation of a CoP. Each lifecycle requests a different approach in order for the community to develop to the next phase in the life cycle. Because ReFoMo has not started his community the first three phases are further elaborated.

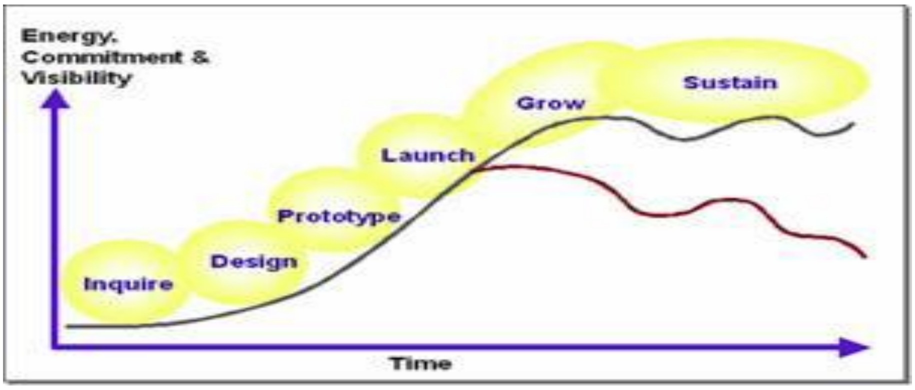

Figure 1: Life cycle of a community (Cambridge et al., 2005)

<u>Inquire</u>

In this first stage the audience, purpose, goals, and vision for the community should be identified. The involvement of the right audience is of great importance for the development of the community and the adoption of the product. The audience includes the people wherefore the community is build and its stakeholders, special emphasis is put on lead users which will be elaborated below. After identifying the audience, the key issues and nature of learning should be determined. The primary focus of the community, benefits for the audience and which needs should be fulfilled are aspects which should be regarded before ascending to the next stage.

1. Conduct a needs assessment through informal discussions, formal interviews, surveys, and/or focus groups. At first, ReFoMo could set up a discussion meeting with everybody who wants to participate as a member to identify their needs, interview important suppliers for possibilities and set up a technology focus group with his product designers.

2. Define the benefits of the community for all stakeholders, including individual sponsors, individual community members, defined subgroups (technology focus group), the community as a whole, and the sponsoring organization.

3. Create a mission and vision statement for the community, tying these into the sponsoring organization's mission and vision if appropriate.

4. Identify the major topic areas for community content and exploration. For the technology these are: CFL light, drip systems, infrastructure around these systems, combining components and, nutrient system.

5. Create an estimate of the cost for community technology, special technical development, facilitation, and support.

6. Begin the recruitment of a core team of individuals (lead users) who represent the community audience. We recommend that the project manager of ReFoMO to be the coordinator/facilitator of this core team.

<u>Design</u>

The second stage includes defining the activities, technologies, group processes and roles that will support the community's goals. In order to accomplish the community's primary purpose, ways of communication should be determined. It also should be thought of what kind of interactions within the community generate engagement. In the same way, the answer to the question which external resources should be used in order to create a learning aspect and optimal knowledge sharing is important to acquire.

1. Identify tasks that community members are likely want to carry out in the community.

2. Identify face-to-face meeting opportunities for community members and define how these will be incorporated into the community experience (conferences, etc.). ReFoMo could set up a first interactive event for his community members, for example a workshop where his lead users and technology manufacturers come together to create a new vision on product improvement. If successful and liked by the members it could be repeated in the future with more participants.

1. 3. Set up a tentative schedule for the community, we recommend a bi-monthly meeting as a starting point.

3. Create a timeline for the community's development to show its development and successes, Facebook and/or the ReFoMo website can be a good platform to present this. However, it must be clear who the manager of such website is

4. Create a directory or folder structure for organizing discussions, documents, and resources. This is important for the transparency and it improves efficiency because it avoids duplication.

5. Determine facilitator roles and recruit the first 'EERHB' community users. It would be very useful and constructive to recruit people with lead user's characteristics and also the product developers should take part.

<u>Prototype</u>

In the prototype stage a pilot should be started with a select group of key stakeholders to gain commitment, test assumptions refine the strategy and establish a success story. How to create a viable and valuable entity should be taken into consideration at this moment. Also which technologies facilitate best the social structure and the community's core activities should be determined. In addition, in this stage will the strategy concerning the forming of the community's identity be determined.

1. Design the EERHB community and use a test panel to test the functionality through case scenarios.

2. Decide on the community metaphor and how it will be represented in the community's organization and appearance.

3. Facilitate events and activities to exercise the EERHB, focusing on achieving short-term value-added goals. Make sure valuable feedback can be expressed and evaluated.

4. Ensure that roles are clear and that support structures are in place.

5. Measure success and report on the results of the prototype to sponsors and stakeholders. This includes ReFoMo's his core team, including –possible- lead users and manufacturers.

6 CONCLUSIONS

Heritage buildings represent a challenge regarding energy use and comfort. In this report the obstacles for energy efficient retrofitting of these buildings were studied. This research was based on the Sectoral Innovation System approach complemented with different dimensions that represent the different retrofitting phases. In chapter 5 several areas of improvement were presented. Nevertheless, we believe that given the nature of the ReFoMo project, the main recommendation is to create a Community of Practice in order to consider a holistic view in the retrofitting of the buildings under the scope of the project. If the guidelines offered in this report contribute – or at least make it evident- to the creation of a CoP, our efforts would be entirely rewarded. Furthermore, the fact that institutional barriers are relevant in the Dutch case, opens new research avenues that we hope to transit in the future.

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APPENDICES

Appendix A. Interview Guide Utrecht Team

General Data

Name:
Contact Information: (e-mail, telephone, address)
Age:
Background (profession):
Position (and years in this position):
Introduction

Good day Mr./Mrs. as a part of a European Project (ReFoMo) currently we try to understand the factors involved around the energy retrofitting of heritage buildings. We know that you are involved in project(s) which aim at the retrofitting of a historical building in your city. Therefore, we would like to learn from you so others can benefit from your knowledge and your experience. This interview is confidential and your name will only be known by the researchers to assure the validity of the study. The interview consists of 15 questions and it will take 1 hour 15 min approximately. Please, feel free to express any thought you may have. Before starting the interview, may I ask your permission to record the conversation?. Is there anything else you would like to know before starting the interview. If not, then we start.

Questions

1. Please, describe your actual position?
2. As we understand, nowadays you are involved on an energy efficient retrofitting project of the following building: (mention appropriate building). Please, elaborate on the origin and characteristics of this project.
3. In your opinion, what are the conditions that make the energy efficient retrofitting of a building to take place?
4. What elements are required in order to complete the retrofitting of your building?
5. What would you change if you could do it?
6. With which different institutions/companies have you been in contact with the retrofitting of your building?
7. How do these actors have influenced the retrofitting project?
8. What knowledge has been essential to carry out the retrofitting of your building?
9. How does the financing of energy efficient retrofitting look like?
10. How does legislation (national or regional) have influenced the renovation process of your building?
11. What are the consequences (in any aspect you may think of) that this energy efficient retrofitting of your building will have?
12. How do you acquire information on the implication of energy retrofitting projects?

13. If participate in another retrofitting project what would you do different (in comparison with the actual project)?

14. What changes in the retrofitting system are necessary?

15. Based on the knowledge you have acquired in this project, in which circumstances would you recommend the application of an energy retrofitting project

This was the last question. We appreciate your enthusiast participation. In case of some need of clarification, is it possible to contact you?. Also, if you are interested, we can provide you with the final report where the findings of our project will be disseminated. Thank you for your collaboration!

Appendix B. Round Table Budapest Team

Minutes

ReFoMo project workshop

Budapest, 17 June, 2014

Agenda

- 10:00 – 10:20 Introduction to Climate-KIC and ReFoMo, Miklós Gyalai-Korpos, Climate-KIC Central Hungary innovation manager
- 10:20 – 10:40 Findings of the Hungarian ReFoMo case study: Óbuda Gasworks, Donát Rabb, minusplus architect office
- 10:40 – 10:50 Q&A
- 10:50 – Discussion based on the questions provided by Utrecht

Participants

Function[1]	**Organization**
Owner	Municipality of Budapest
Authority	Gyula Forster National Centre for Cultural Heritage Management
Designer	minusplus architect office
Designer	mindspace
Financing	OTP Hungaro Projekt
Project partner	Negos Zrt.

There are no user and contractor currently for the building of the case study, since the future function has not been determined yet.

There are no user and contractor currently for the building of the case study, since the future function has not been determined yet.

[1] general function, participants are not necessarily involved in the Gasworks project

Appendix C. Interview Guide Bologna Team

Questions

1. What is the main difference in facility management of historic buildings in comparison with recent buildings?
2. Which costs differentiate management of historical monumental buildings from recent buildings?
3. For historic buildings, with high consumption, could we anticipate retrofitting intervention types which costs can be balanced by reduction in operating costs?
4. Which types of interventions are more frequent for improving energy efficiency of historic buildings?
5. Are constraints for monuments protection an obstacle for upgrading the energy efficiency of assets? Is it just a questions of cost or in some cases interventions are unfeasible?
6. Is it possible to improve the quality of historical heritage through ordinary or extraordinary maintenance, or is it necessary intervention with significant changes on buildings' plant system?
7. In percentage, how many interventions are performed on redevelopment of energy at historical heritage?
8. Is it performed more often on the casing or on the plants?
9. In tendering for restoration, is improving energy efficiency element of evaluation? What is its weight compared to other evaluation elements?
10. Which intervention is more frequent, transformation of fixtures or opaque surfaces?
11. Are there any materials or technologies for improving energy efficiency specifications for historic buildings or the technical solutions "borrowed" from work on new construction?