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Summary

The overall objectives of the Nordic SURE research project (Sustainable Refurbishment — life cycle procurement and management by public clients, 2009-2011) are to build a Nordic network among industry, authorities and researchers to improve knowledge exchange on sustainable refurbishment procurement. Further, to summarize state-of-the-art on the interplay between life-cycle costing, environmental assessment of buildings and sustainable procurement, assess and classify various sustainable procurement strategies already being deployed by public clients on refurbishment of existing public buildings and analyse the experiences of public clients acting as sustainable change agents on the implementation of sustainable refurbishment in construction and real estate. And finally, to develop a Nordic guideline on sustainable refurbishment of buildings based on case studies and different client-specific and internal workshops/discussions. To develop a Nordic guideline on sustainable refurbishment, the SURE research project has investigated 10 different cases in the four countries, aiming to find out how the refurbishment projects are conducted and which possibilities and barriers there are to achieve a sustainable refurbishment. The guideline is divided into 6 phases; “Finance and procurement strategy”, “Requirement setting”, “Selecting the team”, “Managing the supply”, “Operation and maintenance” and “Monitoring, Enforcement and Evaluation”.

The first phase (strategy) is of most importance, being a tool for client change. The phase is divided into seven steps. First, the client (building owner) is encouraged to create a strategy for the refurbishment project. Second, the finances for the project must be set. Third, when the finance strategy is set, the client has to define sustainability based on approximately 60 different sustainable indicators. Fourth, the client has to choose level of ambition based on different parameters like energy consumption, technical standard, adaptability etc. Fifth, a condition survey of the building is highly recommended. When the condition survey is finalized, the client should create a performance profile of the building. Based on the profile, the level of ambition set in step four should be reviewed before finalizing a revised ambition level based on the performance of the building and the strategic analysis (sixth step). Finally, a list of priorities should be conducted for the specific refurbishment project (seventh step). Further, the second (of six) ***phase*** gives guidelines for setting requirements. The methodology is based on the 60 indicators of sustainability and a PDCA-model (Plan, Do, Check, Act) which also are of high relevance for phases 3-6 in the guideline. Further work on customizing country specific or even client based guidelines and analyzing experiences from implementation in multiple case studies is still to be done.
Keywords: Sustainable refurbishment, guideline, sustainable indicators, strategy, client

1. Introduction

Sustainable development of buildings and other construction works brings about the required performance and functionality with minimum adverse environmental impact, while encouraging improvements in economic and social (and cultural) aspects at local, regional and global levels [1]. In other words; to achieve a sustainable refurbishment, a lot of parameters, e.g. energy reduction (environmental), LCC-analysis (economic) and indoor climate (social) have to be simultaneously taken into account.

The latest years, global warming has become one of the main challenges for our future development of the society. The IPPC report (2007) [2] concludes that improving energy efficiency in buildings is one of the greatest potentials and most cost-efficient actions to reduce the climate changes. The building stock counts for a high amount of the total energy use, both in the Nordic countries and globally. Energy-efficient refurbishment of buildings is therefore extremely important both for reducing the amount of greenhouse gases and reducing the load on the energy distribution system. In the building sector, reducing energy demand and changing the energy sources from fossil fuel to renewable energy have been the main actions to reduce the environmental impact. This huge focus on energy reduction is important, but there are also a lot of other sustainable measures that have to be taken into account when aiming for sustainable refurbishment of buildings. Issues like e.g. waste management, material properties, area efficiency, lifetime, indoor climate, adaptability, building conservation, maintainability and building physics should not be forgotten. Furthermore, the measures must be done in the right way to avoid building defects and to ensure proper use of the building. The buildings also have to be refurbished according to the climate to come, not only the present climate.

There are number of tools available for sustainable planning for both new and existing buildings. Existing commercial rating schemes, such as BREEAM, HQE, DGNB or LEED give guidance on how to plan and build sustainable buildings using their indicator set. These systems are one step in the work towards a more sustainable building stock, but they also have disadvantages. Obtaining a certificate for marketing purposes using indicator sets not fitting well with local context don`t always improve sustainability. Furthermore, the certification comes with a fee. These tools usually focus on the planning process, given that the client has chosen to do a sustainable refurbishment. But this is not always the case. The need of construction or renovation often starts when the space in use doesn`t meet user needs.. And at this stage the client might not even be aware of the meaning of sustainability. He also might not have a strategy for the project, and the condition and performance of the building(s) might not be known. Therefore, focusing on the client as a change agent is of high importance if the refurbishment should get a high character of sustainability.

This paper describes a Nordic Guideline on sustainable refurbishment of buildings developed in the Nordic SURE research project (2009-2011) by building researchers from Denmark, Finland, Norway and Iceland. The project title is “SURE - SUstainable REfurbishment – life-cycle procurement and management by public clients”. The overall objectives of the SURE project have been to build a Nordic network among industry, authorities and researchers to improve knowledge exchange on sustainable procurement, summarize state-of-the-art on the interplay between life-cycle costing, environmental assessment of buildings and sustainable procurement, assess and classify various sustainable procurement strategies already being deployed by public clients on refurbishment of existing public buildings, analyse the experiences of public clients acting as sustainable change agents on the implementation of sustainable refurbishment in construction and real estate, develop guidelines for sustainable refurbishment of existing buildings by public clients and finally develop a Nordic guideline on sustainable refurbishment based on the case studies and different client-specific and internal workshops/discussions [3]. The 10 different case studies in Norway, Denmark, Finland and Iceland are described in [4], and some of the main conclusions from the case studies, as a basis for developing a Nordic guideline, are summarized in the following.

First, the client has to go through a process of defining sustainability. The content of sustainability could differ for each project and client. What is sustainable for the specific refurbishment project in

the specific location with the given assumptions, limitations and possibilities? Is the client aware of the meaning of sustainability? When the sustainability is defined, a strategy and ambition level for the project is needed. But the strategy and ambition level cannot be set before the client has a performance profile of the building. Therefore, a condition survey is of high importance in a very early stage of the project. A condition survey must be carried out by highly qualified personnel, and should give alternative concepts for the refurbishment as outputs, highlighting the economical, social and environmental consequences of the different concepts.

One of the questions which often arise is weather to refurbish or tear down the building. In a guideline on sustainable refurbishment of buildings, a helpful tool to make the client reflect and hopefully conclude on this question should be implemented. Also, a list of sustainable indicators should be presented. The indicators should be sorted in three main groups; social, environmental and economical, and should be mostly quantitative so that they can be measured and benchmarked in the operation phase. The lack of measuring, monitoring and benchmarking of important sustainable indicators is one of the main challenges to achieve the goal of a sustainable building. Therefore, the guideline should both help the client to plan how to implement these indicators into the project, and give guidance on how to check the indicators both during planning, building and operation phase.

2. Methodology

Figure 1 shows an outline of the methodology used in this study. 10 different case studies in Denmark, Finland, Norway and Iceland are investigated in order to find sustainable solutions for refurbishment. Further, thorough discussions with the clients regarding ambitions, strategy, energy reduction, future use and a lot of other parameters have been conducted. For several of the case studies, a condition survey has been carried out to get an overview of the performance of the building(s). Thereafter, discussions on recommended measures, overall client strategies, procurement strategies, client as a change agent and the use of guidelines in the specific refurbishment project are summarized in a case study report. The guideline on early phase planning here described has been created based on findings and conclusions in the case studies, internal and client-specific discussions/workshops combined with the researcher`s theoretical and practical former experiences and knowledge in refurbishment of buildings. The guideline contents and structure is created through internal discussions and brainstorming in workshops in the SURE research project.

Figure 1: Outline of the methodology

3. The guideline

The two main focus areas for developing the guideline have been contents (themes) and structure. The contents (themes) are carefully considered and put into context to give the user of the guideline the best insight in what to focus on to achieve a sustainable refurbishment of building(s). The structure of the guideline has also shown to be of high importance. One of the objectives of the guideline is to change the client into thinking sustainability. We had to ask ourselves: How can the guideline be easy to use and still point out the most important topics for a sustainable refurbishment? And how can the structure itself help the project to succeed?

The Nordic Guideline on Sustainable Refurbishment (SURE) of buildings is built upon the principals shown in figure 2. The figure shows the different phases during the lifetime of a building, starting from left. The vertical axis shows the quality standard of the building during time (horizontal

axis). First, the planning of the building starts with an early design phase, thereafter a more detailed design phase followed by the construction phase. When approaching the handover phase, the building has reached its highest quality standard. Then, the operational phase starts, and the quality of the building will decrease, depending on maintenance intervals and replacement of building parts. When the quality or usability of the building has decreased to a certain point, there is a need for a major renovation (figure 2, far right, visualized with the sign “You are here”). Now the building owner has three choices; tear down the building, refurbish the building according to present quality standards and requirements, or raise the quality standard of the building into a sustainable standard, a SURE standard. The SURE guideline will help the client to take the right choice, and should be used from this point.

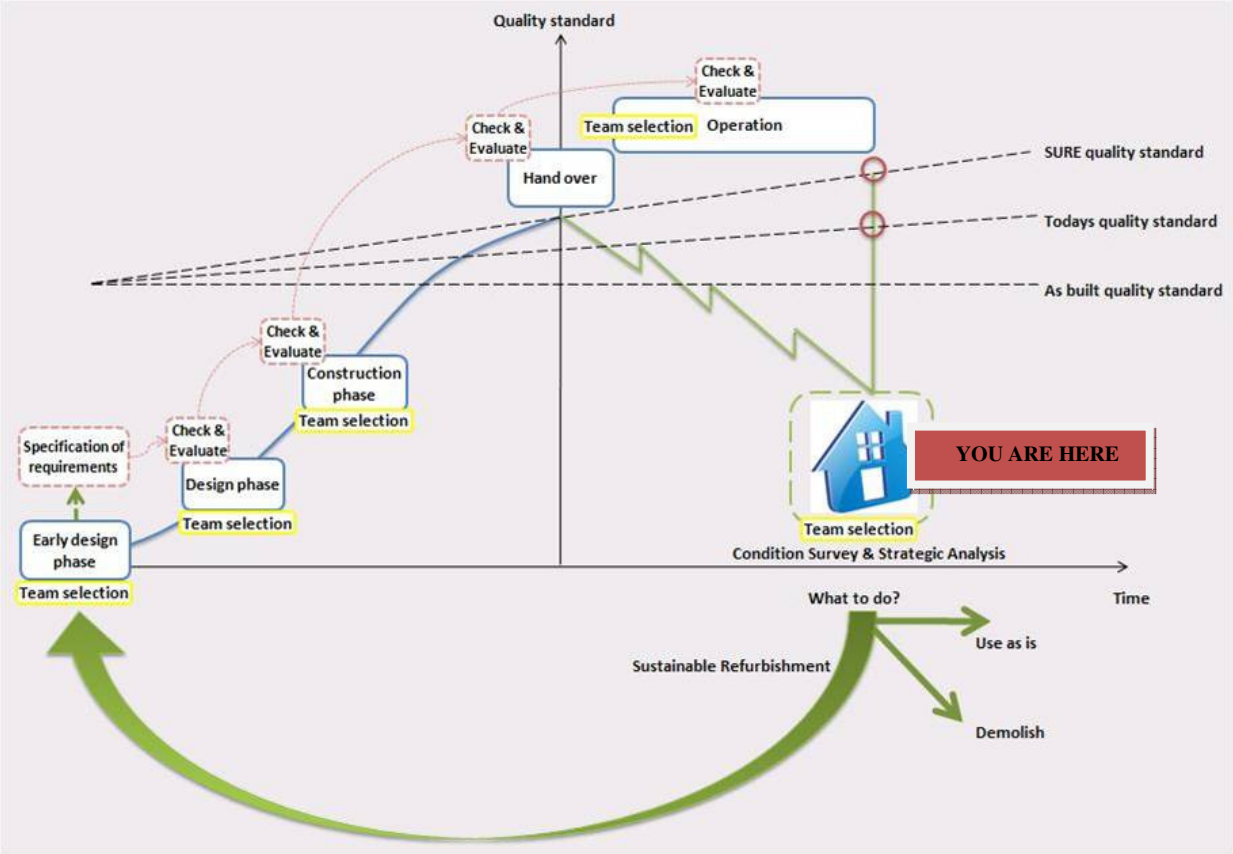
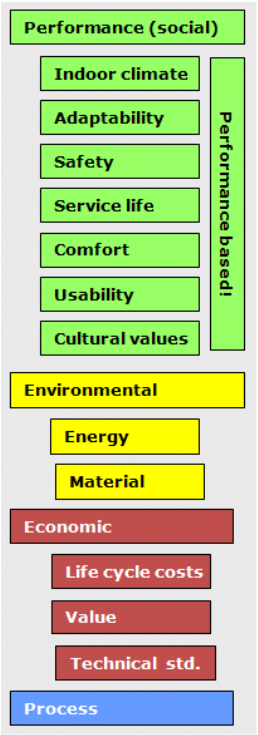


Figure 2: The SURE Guideline structure.

A number of procurement guidelines already exist, e.g. those by ISO [5] and UN [6] but none of them seemed to provide a framework for SURE applicable as such. Therefore, the SURE guideline is divided into six phases: “Finance and procurement strategy”, “Requirement settings”, “Selecting the team”, “Managing the supply” “Operation and maintenance” and “Monitoring, Enforcement and “Evaluation”. Some of the phases may need to be revisited several times during the process, but they have been picked out because of their importance. In this way the actual refurbishment process “Managing the supply” represents only one phase out of six.

The first phase is definitely the most important phase - the strategic phase. This phase is divided into seven main steps. First, the client (building owner) has to create a strategy for the refurbishment project. If the client already has an overall strategy, it should be reviewed and specified to suit the specific project. Secondly, the finances for the project must be set. Which finance models should be used, and which are the finance boundaries? These are most important questions, as ambitious refurbishment projects often are put on hold because funding is not clarified in advance. Third, when the finance strategy is set, the client has to define sustainability and answer the question; what is sustainable for this specific refurbishment project? The analysis on sustainability will be based on a lot of different parameters as shown in appendix 1 and figure 3. At this point the overriding criteria for sustainability is defined, and the client is now (fourth step) encouraged to choose the level of ambition for the project based on different parameters like

energy quality, technical standard, adaptability etc. Fifth, a condition survey of the building is highly recommended. Findings and analysis in the condition survey could reveal specific obstacles making the defined ambition level hard, or even impossible, to reach. The condition survey should focus on the building component`s technical standard and provide answers on which components / damages will make the upgrade especially costly. Further it should focus on building physics, cultural values, technical equipment and the other sustainable indicators shown in appendix 1. The survey should be summarized in a report showing the performance profile of the building. It should also give different recommended refurbishment concepts based on the performance profile and the client`s ambitions and finance strategy. A well documented condition survey has shown to provide a high efficient planning process.



The condition survey or the following strategic analysis should also focus on weather to tear down or refurbish the building. The SURE Guideline methodology for this purpose is based on a four quadrant figure where the client has to place the building in one of the quadrants. The figure is built upon a three-grade scale for both adaptability and quality standard. If the building has both very low adaptability and quality standard, the client should consider either to tear down, sell or change the use of the building. More about the methodology can be seen in the guideline.

When the condition survey and performance profile is finalized, the client should review the level of ambition set in step four, and make a revised version of the ambition level based on the condition survey and the strategic analysis (6th step). Finally, a list of priorities should be conducted (7th step).

Figure 3: The sub-categories of the sustainable indicators used in the SURE Guideline.

When the strategic phase is finalized, the client is ready to set the requirements for the refurbishment project. “Requirement setting” is the second **phase** (of six) in the SURE guideline structure. Here, the client has to set quantitative values or choose between different alternatives for sustainable refurbishment indicators, e.g. delivered energy (kWh/m^{2}y), indoor climate (CO_2-ppm), percentage reuse of building materials etc. The SURE indicators (approximately 60) are sorted in the three categories Social (performance), Environmental and Economic as shown in figure 3. Also, a fourth category is added, named Process. Here, indicators related to project management are found. As they often are difficult to place in one of the three traditional sustainable categories, they are here united in a Process-category. Efforts on setting the requirements will also give important inputs to the procurement documents and for setting the criteria when selecting teams (cf. “Selecting the team”).

In the SURE guideline, the indicators and requirements are chosen to be mostly quantitative. This will help the client to set measurable values for the project. As often happens, the requirements for the refurbishment are qualitative and cannot be measured in the operational phase. Then, the users and the building owner have too few figures in the operation phase to benchmark from the planning process. This is of high relevance, especially for indicators like energy use, CO_2-concentration and day light factor. To try to give a helpful tool for planning, setting requirements, measuring and to form procurement documents, the SURE guideline is using the principle of PDCA; Plan, Do, Check, Act (figure 4). PDCA is an iterative four-step management process typically used in business. It is also known as the Deming circle/cycle/wheel, Shewhart cycle, control circle/cycle, or plan–do–study–act (PDSA). The concept of PDCA is based on the scientific method, as developed from the work of Francis Bacon [7]. The scientific method can be written as "hypothesis"–"experiment"–"evaluation" or plan, do and check. The four steps could be described as in the following:

Figure 4: The PDCA-principle

Plan: Here, the client should establish the objectives and processes necessary to deliver results in accordance with the expected output. By making the expected output the focus, it differs from other techniques in that the completeness and accuracy of the specification is also part of the improvement.

Do: Here, the client is encouraged to implement the new processes, often on a small scale if possible. Setting the requirements for the refurbishment project and actions in the construction phase are examples of processes in the “Do”-category.

Check: Here, the client should measure the new processes and compare the results against the expected results to ascertain any differences.

Act: Here, the building owner or the user of the building should analyze the differences in planned and checked values to determine their cause. The client should determine where to apply changes that will include improvement. When a pass through these four steps does not result in the need to improve, one should refine the scope to which PDCA is applied until there is a plan that involves improvement [7].

The PDCA-model should be used on each of the sustainable indicators. Approximately 60 sustainable indicators are included in the Nordic SURE guideline. Appendix 1 shows the different indicators sorted by sub category (cf. figure 3).

When the requirements are set, the client is ready to start the third phase of the SURE Guideline; “Selecting the team”. In fact, this phase is more dynamic than the other phases, in terms of actually being relevant for all phases. To achieve a successful sustainable refurbishment, a high qualified and competent team is needed for both for the strategic analysis, the condition survey, the design, the construction and the operation. The PDCA-methodology is also used in the “Selecting the team” phase. The first team to select is the early phase strategic team. Here, the client should first *plan* how to reach and engage the right personnel. Thereafter, the procurement documents should be created for the tendering process, and relevant companies should be contacted (*do*). When the bids are received, the references, competence, description of deliverance etc. should be carefully *checked*. Further, the deliverance should be checked according to the procurement documents. Finally, if there are differences in planned and checked deliverance, the client should determine the cause and apply changes that will include improvement, e.g. more focus on specific building components in the condition survey report (*act*). The principles are the same also for the other team-selection-processes.

The fourth phase of the SURE guideline is “Managing the Supply”. Here, the client is encouraged to follow up the requirements set in phase nr. 2. Design, construction and hand over are all included in this phase, and the “check” and “act” categories are used in particular. The client or project manager should keep eye on procurement requirements and carefully *check* the execution of the construction work or the documentation delivered at hand over. If there are differences in requirements set and execution/documentation, the client should *act* in forms of e.g. holding back money or set specific deadlines for rectification.

The fifth and sixth phases of the SURE guideline are “Operation and Maintenance” and “Monitoring, Enforcement and Evaluation”. Also here, the “check” and “act” categories are most relevant. If the operation of the building is not as intended, or the measured values in the monitoring process do not correlate with the values from the requirement setting, the client or building operator should determine the cause and apply changes. E.g. if the measured energy consumption is higher than expected, a review of a detailed energy account should be conducted. When the source of error is found, changes in use or operation of the building should be carried out as soon as possible.

4. Discussions and Conclusions

The main reason for creating such a guideline is to give building owners (clients) a helpful tool to take the right choices when aiming for a sustainable refurbishment. Very often, the clients have

high ambitions, but not as high finances. In addition to finances, both the quality standard of the building and the possibilities and restrictions have to be highlighted before finalizing the ambition level. By going through the guideline, a performance profile of the building(s) will be set. This profile should improve the awareness of sustainability with the help of indicators. The guideline can also be used as a checklist. One of the biggest challenges in developing a common Nordic guideline has been the differences in defining sustainability and the national requirements, building codes, climates, building practice etc. in different countries. Reducing the energy consumption in buildings is of high priority in most of the countries, but because of the use of geothermal energy, this is not as important in Iceland. It has shown, though, through investigations of the different case studies in Denmark, Finland, Iceland and Norway that the most challenging part is the need for client changes. Therefore, the SURE guideline is focusing on the client as a change agent in a six phase process, starting with the two most important phases "Procurement and finance strategies" and "Requirement settings". Further, the guideline focuses on sustainable indicators to help the client to be aware of important parameters to achieve sustainable refurbishment of buildings. The methodology is based on a well established PDCA-model (Plan, Do, Check, Act).

5. Further work

This is the first version of the SURE Guideline. Further work on customizing country specific, or even client based guidelines, and analyzing experiences from implementation in multiple case studies is still to be done.

6. Acknowledgements

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Appendix 1 – The sustainable indicators used in the SURE guideline

Economical		Environmental		Social	
LCC	Paybacktime	Energy	Delivered energy	Indoor Climate	Room temperature
	Annual costs		Primary energy		Design air flow
Value	Plot opportunities		Electrical		Air velocity
	Meeting owner`s/user`s strategy		Heating		Noise level
	Branding/certification	Material	Life time		Formaldehyde concentration
Technical standard	Ground, foundations and grid systems		Product documentation		Air quality
	Windows, exterior doors		Waste management		Acoustics
	Exterior cladding and surface				Lightening intensity
	Roof, gutters, drains				Thermal comfort
	Interior surfaces (floor, wall, ceiling)				Radon
	Fixtures				CO2-concentration
	Water and sanitation				Emission from materials
	Heating				Cleanness of air-handling components
	Cooling			Adaptability	Flexibility
	Fire				Generality
	Air treatment / ventilation				Elasticity
	Electricity: general construction / distribution				Climate change
	Electrical: lighting, electric heating, opera-tional technology			Safety and accessibility	Number of accidents/deaths
	Telecom and auto: general construction, electrical and electronics systems				Structural safety
	Elevators				Fire safety
	Waste				Accessibility
	Outdoor technical facilities				Safety in use
	Drainage, terrain management				Feeling of safety
				Comfort	View to outside
					Architectural design
					Support spaces
					Visual stimulation
				Usability	Functions (core activity)
					Support functions
					Capacity
					Logistics
				Cultural values	Protection level
					Cultural heritage
					Community acceptance