Towards sustainable design

Integrating data from operation of buildings in design practices

Saridaki, Maria; Haugbølle, Kim

Published in:
Conference Proceedings

DOI (link to publication from Publisher):
10.1088/1755-1315/588/5/052051

Publication date:
2020

Document Version
Publisher's PDF, also known as Version of record

Towards sustainable design: Integrating data from operation of buildings in design practices

Towards sustainable design: Integrating data from operation of buildings in design practices.

Maria Saridaki[1,2] and Kim Haugbølle[1]

[1]Danish Building Research Institute, Aalborg University Copenhagen, A.C. Meyers Vaenge 15, 2450 Copenhagen, Denmark
[2]Vandkunsten Architects, Krudtløbsvej 14, 1439 Copenhagen, Denmark

E-mail: msa@sbi.aau.dk

Abstract. In recent years, the Danish Architecture, Engineering and Construction industry has shown increased interest in sustainability in contributing to the achievement of the UN 17 sustainable development goals. Sustainable design is, however, hampered by lack of information and weak data integration especially in the early design stages of building projects. In order to overcome these challenges, research has proposed transferring information from operation to the design of new buildings. By conducting a case study analysis in a Danish architecture firm, this research aims to explore the form of collaboration between architects and building client, and how this collaboration can support or inhibit the calculations of life cycle costing as an essential part of sustainable design practices. The data, for this exploratory research, are gathered through direct observations, surveys and semi-structured interviews. Structured analysis is used as the theoretical methodology to map the flow of data in a paradigmatic building project of the case company and recognize existing forms of knowledge transfer and areas of improvement. The results indicate that there are significant potentials of collaboration, however, several actions should be taken from both sides in order to enable information and data exchange. By improving the collaboration with building clients, architects will gain access to information from operation of buildings, which can be effectively used in architecture design improving the sustainability of buildings and contributing to SDG-9: Industry, Innovation and Infrastructure.

1. Introduction

In recent years, the Architecture, Engineering and Construction (AEC) industry has shown increased interest in sustainability in contributing to the achievement of the UN 17 sustainable developments goals. The main topic of SDG-9: Industry, Innovation and Infrastructure includes the adoption of sustainable technologies in buildings and targets on developing quality, reliable, sustainable and resilient infrastructures. Sustainable design takes into consideration not only environmental and social performance of buildings, but also economic assessment in long term perspective. Thus, the concept of Life Cycle Costing (LCC) is used by architects and engineers as a decision-making tool for assessing alternative design solutions based on several key factors such as costs, quality and comfort over the entire life cycle of a building [1].

The last few years, the Danish AEC industry has increased the application of LCC in design practices due to significant new initiatives, including, among else, LCC adoption by governmental regulations, European procurement policies and various certification schemes (see [2]). However, there are various real-word challenges that hamper the fully integration of the concept. In the recent study of Saridaki and

Haugbølle, the authors conducted a case study analysis in a Danish architecture firm and identified several contradictions of integrating LCC in the Danish design practices [3].

Although the challenges, currently, design teams timidly apply LCC in late design stages of building projects in order to comply with regulations and obtain certifications. However, the inclusion of LCC is proven more valuable in early design stages, where the ability to impact the cost and performance of a building is significant. Specifically, Bogenstätter U. identified that decisions that are made early in the design determine up to 80% of building operational and maintenance costs [4]. Nevertheless, the implementation of LCC in early stages is even more challenging due to lack of available information and data.

Recently, researchers and practitioners have shown increased interest on transferring knowledge from operation of existing building to design of new buildings. Although the wide recognition of this approach (a literature review is made by [5]) and various proposed typologies of transfer mechanisms (like [6]), currently, necessary initiatives are lacking, and the concept faces resistance in practices [7].

The aim of this research is to examine the collaboration between architects and building clients of social housing projects, and investigate how this collaboration can support or inhibit the transferring of information from operation of existing buildings in the design of new building in regard to LCC calculations as an essential part of sustainable design practices, contributing to SDG-9. By conducting a case study analysis in a Danish architecture firm, the author uses structured analysis (SA) to map the flow of data in a paradigmatic building project of the case company and recognize existing forms of knowledge transfer and areas of improvement.

2. Methodology

In this research, the authors conduct a single case study analysis in a Danish architecture firm, in order to explore the form of collaboration between architects and building clients and use SA as theoretical approach to map the dataflow of a social housing project of the case company.

2.1. Research approach: Case study analysis

The case company that is selected for the analysis is an architecture firm located in Copenhagen, Denmark, and it is a frontrunner in the field of sustainable design and constructions including LCC. The company is continuously working on social housing projects that demand significant collaboration with building clients of social housing organizations.

The project that is selected for the analysis is a paradigmatic social housing project that is completed in January 2019. The research data are collected through direct observations, participant observations and semi-structured interviews. More specifically, three semi-structured interviews were conducted in the case company during November 2019. The interviewees were architects that are working in social housing projects and have increased overview of building projects and processes.

2.2. Theoretical approach: Structured analysis

In order to map the dataflow of the project under examination, structured analysis is applied as the theoretical approach in this case study research. SA was developed in late 1960s by Ross and his colleagues, who use it as a methodology to describe complex IT systems such as the US Air Force Computer-Aided Manufacturing Project [8]. The methodology was commercially introduced in 1973, and since then, it has been applied in various project in diverse industries [9].

SA is successfully used for analysing complex IT systems and business requirements by describing a system of activities from a perspective of data flowing through it. Congram and Epelman [9] stated that SA is helpful to understand what happens in delivering of a service, and it is a well suited methodology to structurally providing significant attributes of service description, such as: (i) who and what performs the activity (mechanism), and (ii) what guides or limits the activity (controls).

Thereby, SA is identified highly useful in this research project, and it is used to understand the flow of data on a selected project of the case company, to map the actors and the tools as significant

mechanism of the project activity, and finally identify what guides and what limits the activity in relation to LCC analysis.

3. Findings

The results of using SA in the selected case project of the Danish architectural firm are presented in figure 1.

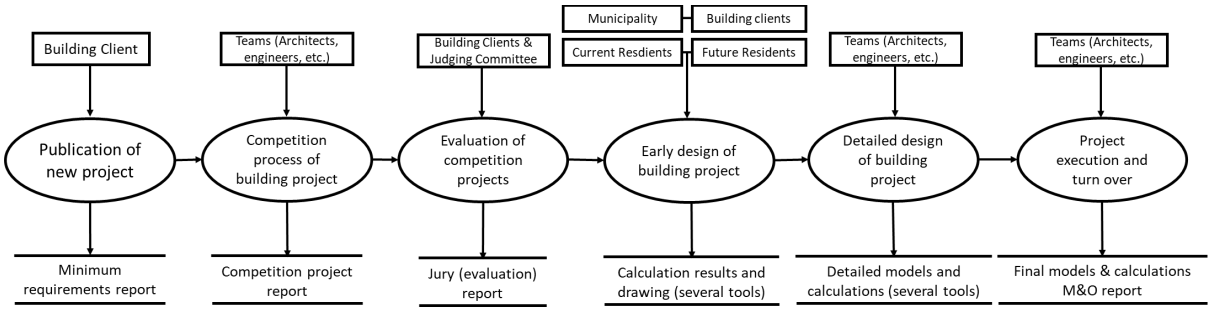

Figure 1. Flow of data in the case project by using SA.

As it is illustrated in the Figure, the processes that are taken place in a building project are: (a) public announcement of a new project, (b) competition process of the project, (c) evaluation of submitted projects, (d) early design of building project, (e) detailed design of building project, and (f) project execution and turn over.

When a new project begins, the building client publishes the project announcement along with a report that includes detailed requirements for the project submission. The report includes among else, requirements for housing size, architecture quality, energy class calculations, indoor climate, etc. Requirements in relation to LCC are also reported, including expected lifetime of building components, maintainability of materials and low operational costs. In addition, a detailed schedule of maintenance activities and expected expenditures for the upcoming 30 years is offered by the building client. Those requirements indicate the desire of building clients to consider long-term cost in the building project.

When the new project is published, pre-qualified teams work on the competition of the project. In this step, architects develop design proposals that satisfy the requirements of the project and submit their report. The report includes case analysis, drawings and various calculation results. In this step of the process, it is observed that the case project does not include sufficient LCC information to support the design proposals in the competition report.

When the competition projects are submitted, the building clients together with a judging committee evaluate all submitted competition projects. In the case project, the award criterion is the most economically advantageous tender, however, a number of sub -criteria are used for evaluation: (1) The building system: Architecture idea, building technology and quality, variety of options and flexibility; (2) Price: compliance with given price per m2, unit price, price of advices; (3) Cooperation: the contract team and their organization. However, there is not any criterion that evaluates the consideration of long-term economical design solutions.

In the following process, the winning team works in the early design of the project. Through the early design, the team conducts several meetings with different stakeholders, including meetings with current residents of similar existing building projects. In those meeting, the team has the opportunity to discuss with the residents about the performance of the building and unexpected operational and maintenance issues. Following the early design, a detailed design is performed where detailed models of the building project and calculation are developed. Through the case analysis was noticed that LCC is not considered in those processes.

Building execution and turn-over is the last process of the building project. In this process, the architects submit the final models, all the detailed calculations of the project, as well as a M&O

(maintenance and operation) report. This report contains many information about the building materials, however, not enough information about any maintenance and operation strategy.

Through the analysis, it is observed that there are initial actions for transferring knowledge from operation to design in process (a), through the availability of the 30-year maintenance expected budget, which is calculated based on existing buildings; and process (d), through the meetings with residents of existing buildings. However, it is concluded that there is limited use of the given information by the architect, who do not consider LCC in their processes.

4. Conclusion

In order to meet the UN 17 sustainable development goals, the AEC industry focuses on sustainable design, considering, among else, LCC as a decision-making tool for sustainable design of new buildings. However, LCC analysis requires data that are rarely available, especially in early design. Nonetheless, researchers have recently shown increased interest on transferring data and knowledge from operation of existing building in the design of new buildings.

This study used SA analysis to map the flow of data on a paradigmatic project of a Danish Architectural firm in order to recognize existing forms of collaboration and information transfer between architects and building clients that support or inhibit LCC calculation. The results exhibited very little attempt to use LCC in current practices. However there are significant potentials of collaboration, since there are initiatives of LCC related information sharing in both processes of publication of a new project and in early design of building project in the SA system. Nevertheless, several actions should be taken in all processes and from both sides in order to enable information and data exchange. In future research, the authors will give a more elaborate insight in the design process and identify the processes where enabler or inhibitors may occur when adopting LCC.

By improving the collaboration with building clients, architects will gain access to information from operation of buildings that can be effectively used in architecture design, improving the sustainability of buildings and contributing to SDG-9: Industry, Innovation and Infrastructure.

References

[1] Haugbølle K and Raffnsøe L M 2019 Rethinking life cycle cost drivers for sustainable office buildings in Denmark *Facilities* **37** 624–38
[2] Saridaki M, Psarra M and Haugbølle K 2019 Implementing Life-Cycle Costing: Data Integration Between Design Models and Cost Calculations *J. Inf. Technol. Constr.* **24** 14–32
[3] Saridaki M and Haugbølle K 2019 Identifying Contradictions of Integrating Life-Cycle Costing in Design Practices *10th Nordic Conference on Construction Economics and Organization. Published online: 26 Apr 2019* pp 33–9
[4] Bogenstätter U 2000 Prediction and optimization of life-cycle costs in early design *Build. Res. Inf.* **28** 376–86
[5] Rasmussen H L, Jensen P A and Gregg J S 2017 Transferring Knowledge From Building Operation To Design - a Literature Review *CIB World Congress 2017 - University of Salford, Salford, United Kingdom*
[6] Jensen P A 2012 Knowledge transfer from facilities management to building projects: A typology of transfer mechanisms Knowledge transfer from facilities management to building projects: A typology of transfer mechanisms *Archit. Eng. Des. Manag.* **8** 170–9
[7] Meng X 2013 Involvement of Facilities Management Specialists in Building Design: United Kingdom Experience *J. Perform. Constr. Facil.* **27** 500–7
[8] Ross D T 1977 Structured Analysis (SA): A Language for Communicating Ideas *IEEE Trans. Softw. Eng.* **SE-3** 16–34
[9] Congram C and Epelman M 1995 How to describe your service An invitation to the structured analysis and design technique *Int. J. Serv. Ind. Manag.* **6** 6–23