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An open building approach to construction project management – a case study

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PAPER ABSTRACT The open building approach has recently received increasing attention from academics and practitioners in Finland. However, in practice the implementation of open building approach in construction projects has been problematic. For example, the designers are reluctant to implement the open building approach in design process because it requires substantial changes in the design process and competencies. This case study describes the implementation of open building approach in a real-life construction project and studies how the implementation is carried out in construction project management. The purpose of the study is to generate new knowledge on construction management practises that enable project stakeholders to utilize open building approach in construction projects. The case project is a new healthcare centre construction project located in Finland. A project management standard (A Guide to the Project Management Body of Knowledge - PMBOK) is used as a framework for the analyses. Interestingly open building implementation has an effect on eight out of nine analysed project management aspects. In addition, the case study shows that the training of key project stakeholders is essential for the implementation of open building in a construction project. The study suggests that the traditional project management needs extensive modification, particularly in the knowledge areas of scope management, quality management and procurement management, when implementing open building in construction projects. Therefore, the development of open-building-compatible project management system could be essential step to diffuse open building approach into the construction markets more rapidly.

KEYWORDS: open building, construction management, case study, healthcare facilities, project management

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Matti Sivunen studies construction and innovation management in the construction sector. His doctoral dissertation analyses how clients can benefit and manage innovations in construction process. He is a co-founder of Boost Brothers Ltd and has worked, concurrently with research activities, past five years in construction projects.

Juho-Kusti Kajander is an entrepreneur and researcher with a focus on managerial systems and technology commercialization in the construction sector. Kajander wants to accelerate the development and utilization of managerial systems that improve decision-making and management of construction investments and innovation in practice.

Juhani Kiiras is professor emeritus in construction management from Aalto University, Finland. During his long research and consultancy career he has developed new theories and methods for design management, target costing and project delivery.

Jari Toivo is CEO of KOY Järvenpään Terveystalo. Mr. Toivo is experienced and competent on running end-to-end solution development and Strategy & Business development with the ability to create measurable results. His background is in telecommunication industry. Currently, he is in responsible of a new Healthcare centre project located in Järvenpää, Finland.
1. Introduction

Traditional construction project management is based on the assumption that functions that a user performs in the facilities are fixed\(^1\). Paradoxically, the facility user’s functions change constantly. The open building approach has emerged to enhance the management of changes in user performs. The approach aims to produce user-oriented facilities, order efficient design tasks and manage changing user functions.

The basic idea in open building is to establish principles for dividing and combining building subsystems in a way that minimizes their interdependencies by transforming subsystems without redesigning or renewing the entire building.\(^2\) In the approach, a building is usually divided into a permanent base building (or “support” or “primary system”) and fit-out (or “infill”). Open building approach seeks to ensure that design decisions enable buildings to change and thus remain valuable in the future.\(^3\)

According the open building principles, a building is generally required to offer two quite different forms of flexibility: modifiability and service flexibility. Modifiability refers to the capacity of the building to be adapted to changes occurring in the future, such as changes of users. Service flexibility, also known as adaptability, refers to the capacity of the facilities to be operated and used in different ways without major renovations.\(^4\)

The open building approach has recently caught the attention of academics and practitioners in Finland.\(^5,6\) For example, it has been implemented in to the process standard scope of professional work of construction design tasks and process.\(^7\) However, in practise the implementation of open building approach in construction projects has been problematic. According to the authors experiences and understanding there seems to be at least three key factors that hinder the implementation of open building in practise. First, the clients are not familiar with the open building approach or the benefits it might have. Therefore, they typically do not require or utilize in construction management. Second, designers often refuse to the implement open building approach in the design process. They argue that it demands more work or does not generate benefits for the project. Third, if the client and designers decide to implement open building principles in a project, there is a lack of knowledge on the management and application of open building in practise, in particular how project stakeholders should develop their processes and how client should manage the project? This article focuses on studying the third hindering factor.

The aim of the study is to analyse how open building implementation is carried out in the construction management. The purpose of the study is to generate new knowledge on construction management practises that support project stakeholders to utilize open building approach in construction projects. Construction management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements. Appropriate construction management process delivers the required result within scope, on

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\(^1\) Saari et al., Flexibuild – a systematic flexibility management procedure for building projects. Facilities 25(2007), 105


\(^3\) Kendall, S. Managing Change: the application of Open Building in the INO Bern Hospital, In Design & Health World Congress, 2005


time, and within budget\textsuperscript{8}. This case study analyses the implementation of open building approach in a real life construction project.

The research method is a case study. The study utilizes the project management Body of Knowledge (A Guide to the Project Management Body of Knowledge – PMBOK) as a framework for the analysis. The Project Management Body of Knowledge is the synthesis of knowledge within the profession of project management. The PMBOK was selected as a framework for the study because it is generally accepted definition for good project management practises. Moreover, it is aimed for researchers analysing project management\textsuperscript{9}.

In construction management literature it is discussed that the open building approach differs from the conventional way of construction project management in terms of scope management, procurements and schedule management. The main difference in scope management is that in open building brief, the functional requirements are not described on a single space program that determines every room that should be implemented in the design. A single room program does not satisfy versatile needs and preferences as well as the requirements of future users.\textsuperscript{10} In the procurements the role of the user should be highlighted. The open building approach acknowledges that building design is a collaborative process, which involves many participants with diverse backgrounds. Thus, the management in ordering design tasks is of utmost importance to reduce building design complexities and to balance divergent interests of the related parties. Involving the users in the decision-making process is a priority in open building.\textsuperscript{11} From a schedule management point of view, the advantage of open building is in the postponement of the decisions of facility users regarding the interior of the building. In other words, it offers a valuable option to delay user decisions on facilities. In contrast, the traditional construction management practices force users to make decisions about the premises before the start of construction, for example in the Scandinavian countries, the dominant project delivery methods involve preparation of all final design documents before actual construction.\textsuperscript{12} The open building approach also provides service flexibility and modifiability for the remaining life cycle of the building so that users can reconfigure the space as their needs change.\textsuperscript{13}

The structure of the paper is as follows. Following the introduction, the research design is presented. Thereafter, the results of the case study are summarized. Finally, there is a discussion and conclusion.

2 Research design

The research design is based on descriptive embedded single case study\textsuperscript{14}. The research aims to describe how open building is implemented in the construction project management system in a case project. The study utilizes the PMBOK as a framework for the analysis.

The analysis is executed according to the principles of project management plan recommended in PMBOK. Therefore, the consequences of implementation the open building approach to the project management procedure is analysed in following nine aspects: Project scope management, Schedule management, Cost

\textsuperscript{10} Saari et al., Flexibuild – a systematic flexibility management procedure for building projects. Facilities 25 (2007), pp. 108
\textsuperscript{12} Saari et al., Flexibuild – a systematic flexibility management procedure for building projects. Facilities 25 (2007), pp. 105
\textsuperscript{13} R. Vrijhoef & L. Koskela The four roles of supply chain management in construction. European journal of purchasing & supply management, 6(3): 2000 Pp. 172
\textsuperscript{14} Yin, R. Case study Research, Designs and Methods (3rd Ed.) 2003 pp. 12
management, Quality management, Process improvement, Staffing management, Communication management, Risk management, and Procurement management.

The analysis is conducted by comparing the traditional construction management approach to case project’s open building based project management approach. The main used data is project documentation, interviews, and direct observation by the authors. As a result, the main differences between the approaches are presented. The comparison is carried out as follows. First, we analyse the key sections of the case project’s management plan. The aim of the analysis is to identify how the open building approach is accounted for in the project management plan by comparing it to the traditional project management process. The analysis is conducted from the client, architect’s and contractors perspectives. Following that, the results of the comparative analysis are reviewed in an industry expert workshop. Finally, we analyse how the results converge with different PMBOK aspects.

The study analyses a real-life construction project, which has strategic importance in relation to the research aim as the project been implemented through open building approach. The case project is a new healthcare centre, which will offer the basic health and social services for 35 000 inhabitants of the city of Järvenpää, Finland. The project scope is about 14,000 sqm (5 floors). The contractor constructs both the primary (base building) and fit-out. The timeline for construction is from October 2014 to October 2016.

3 Results

This section summarizes the results from the comparative analysis of open building and traditional project management plan.

3.1 Project scope management

The main document in project scope management is the project brief. In traditional construction project management approach buildings have been programmed for specific purposes using a fixed detailed room program. In the case project the scope management approach differs from traditional construction management approach in terms of room program and target setting. Moreover, it was observed that the capacity management of the base building is a central part of the scope management.

In the case project, the brief sets measurable targets for fit-out and base building. The brief utilizes flexible room program originally presented by Saari et al.15. The targets in the brief were formulated based on several information sources, particularly on feasibility studies, scenario work, and benchmark data. The flexible room program is described in Table 1.

Each row in the flexible room program has two targets i.e., the range of values in where the designers can manage the functional change during the design process and the type of spaces the base building and fit-out must enable in use.

The main requirements for the base building in the case project are:

- The gross floor area of the building cannot exceed 14 000 sqm2 and it must enable fit-out for 8000 sqm2 as described in the fit-out requirements.
- The capacity of the base building must enable the variance described in the flexible room program
- The building must reach the LEED Gold level standards
- The target cost for the building is 41.150 000 € (including fit-out 10 800 000 €) and the maintenance costs of the building must not exceed 1 190 000 € per year

The project scope management approach utilized in the project has a big effect on the processes of client, architect and the contractor. First, the client and architect can give more time for the users of the building to develop their functions as the there is no need for fixed room program before the design process begins. From the contractor point of view the scope management approach increases uncertainty, as the contractor does not know the design solution of the fit-out during the point of agreement. However, the budget of the project is fixed and the design solution of the fit-out is managed and controlled to fit to the budget during the construction phase of the base building. Finally, it was observed that during the design of the base building and the fit out a number of meetings and workshops were needed to clarify and exchange information on how the flexible room program should be understood and utilized in the practice. The information exchange focused on the base building, fit-out and flexible room program interfaces of heating, ventilation and air conditioning (HVAC) systems.

The project management team decided that the HVAC systems are divided in design phase into "HVAC base building system" and "HVAC fit-out system." This was due to the fact that the capacity of the HVAC system is relatively fixed after installation. Therefore the capacity of the HVAC system needs to fulfill the same capacity requirements as the base building's other structures. However, the client has not yet decided if the HVAC base building system in "full capacity" will be completed or not. The project management team has reserved sufficient space for the system in "full capacity," but it is possible that the initial HVAC base building system will be constructed with a capacity that matches with the fit-out’s first users requirements. In this case, it is possible to expand the capacity of the HVAC base building system later, as there is space reserved for that. The agreement drawings for contractor are made in “full capacity”. If client decides, however, to build HVAC system for only first user’s requirements, the system design will be updated and the set-aside space can be demonstrated by comparing the designs.

The capacity management and calculations were essential part of scope management process in the project. During the design process, the designers conducted an analysis to demonstrate how the base building fulfills the targets set in the flexible room program as presented in the figure 1.
3.2 Schedule management

In traditional construction management approach the schedule management is, as Kendall et al.\textsuperscript{16} describes it, based on conventional one-step or “all-at-once” process. In this process the base building and fit out is first designed in detail and then the contractor is procured to carry out the construction work. In the case project the schedule management approach differs from conventional approach in design and construction phases of the project as the base building and fit out were mainly managed separately.

The project had three main phases. First, there was a preparatory phase, in which the main task was the development of the brief. The second phase was the design phase. The main tasks of the design phase were scheme design of the base building and concept design of the fit-out. The third phase of the project was construction. The main tasks of the construction phase were to generate detailed designs of base building and fit-out, construct the base building and the fit-out, and commissioning the building.

The design of the building extensively utilized building information modeling (BIM). The effect that BIM modeling had for open building implementation was a key topic in project management meetings. Finally, it was decided that in the case project the base building and fit-out are designed in different BIM models. To schedule the design work, following BIM deliverables were defined for base building and fit-out as presented in tables 2 and 3.

### Table 2 Base building and BIM Model

<table>
<thead>
<tr>
<th>Phase of the design</th>
<th>BIM Model</th>
<th>Main content</th>
<th>Readiness of design work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing</td>
<td>Requirement model</td>
<td>Requirements for the base building</td>
<td>0 %</td>
</tr>
<tr>
<td>Concept design</td>
<td>Draft building element model</td>
<td>The model contains the main fit-out and base building partition building elements such as facades, shafts and roof. The model does not have product structures.</td>
<td>20 %</td>
</tr>
<tr>
<td>Scheme design</td>
<td>Building element model</td>
<td>The model contains the main base building elements (e.g. amounts, locations and dimensions) without product structures.</td>
<td>40 %</td>
</tr>
<tr>
<td>Detailed design</td>
<td>Construction element model</td>
<td>The model contains base building’s elements and the actual product structures to implement the corresponding building element.</td>
<td>95 %</td>
</tr>
<tr>
<td>Handover</td>
<td>As Built</td>
<td>The model contains the information on how the base building designs were actually implemented in construction.</td>
<td>100 %</td>
</tr>
</tbody>
</table>

### Table 3 Fit-out and BIM Model

<table>
<thead>
<tr>
<th>Phase of the design</th>
<th>BIM Model</th>
<th>Main content</th>
<th>Readiness of design work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing</td>
<td>Requirement model</td>
<td>Requirements for the fit-out</td>
<td>0 %</td>
</tr>
<tr>
<td>Concept design</td>
<td>Type room models</td>
<td>The models contains basic information of type rooms (e.g. measures, furniture settings)</td>
<td>20 %</td>
</tr>
<tr>
<td>Scheme design</td>
<td>Building element models for different facility concepts</td>
<td>The models contains’ the main areas of fit-out and building elements (e.g. amounts, locations and dimensions) without product structures</td>
<td>40 %</td>
</tr>
<tr>
<td>Detailed design</td>
<td>Construction element model</td>
<td>The model contains fit-out’s building elements and the actual product structures to implement the corresponding building element.</td>
<td>95 %</td>
</tr>
<tr>
<td>Handover</td>
<td>As Built</td>
<td>The model contains the information on how the fit-out designs and areas were actually implemented in construction.</td>
<td>100 %</td>
</tr>
</tbody>
</table>

The timing of the fit-out design solution decisions and construction work was reviewed several times during the project by project management team. For example, the client’s argument was that the whole secondary system should not be “locked” in one decision but rather the fit out should be designed, design solution should
be accepted by the user and construction work should be planned in parts (e.g. one user unit at the time). With this approach some of the users or different units of a user organization have more time to make their decisions related to fit out.

3.3 Cost management

In traditional construction project management procedure the cost management process is usually build so that the client will tender the design and contracting work separately and a fixed lump sum contract is made according the tendering results. In contrast to the traditional approach, the project used a target cost method, “open book” approach and financial incentives.

The main principle of target costing is to make cost and value drive the design process instead of calculating the cost after the design is complete. A target cost for the project is an outcome of the feasibility studies and a design-to-target for the project team. In the project, the base building and fit-out had separate budgets. The contractor or cost expert calculates the costs of the design solutions of base building and fit-out during the design work. If the costs of the design solutions seem to exceed the budget, the contractor consults the design team, users and client and responsibility to make a new design solution that is line with the budget is shared. The main feature of the “open book” approach is that the contractor and designers must present the actual costs of project work to the client to justify the bills.

Financial incentives are an important part of the cost management approach in the project. In effect, approximately 40 % of the compensation of the designers and contractor are based on reaching targets in each project’s 6 milestones. The following key factors are analysed in each milestone:

- Quality: Does the design solution meet the functional, quality and capacity requirements set on the fit-out and base building in the brief and is the quality management of the construction work appropriate?
- Costs: Is the design solution and construction work in line with the investment and maintenance budget set on the brief?
- Time: Have designers generated alternative solutions and are all designs produced on time?
- Collaboration: Are users and owners satisfied with the collaboration with designers?
- Innovation: Have contractor and designer innovated design solutions?
- Safety: Is the safety of the site managed properly?

The contractor, architect and client observed that the selected cost management approach is a valuable part of project management procedure. It has significantly contributed to the generation of common targets for all parties of the project and increased trust between parties. Moreover, the client perceived that financial incentives and systematic feedback for project stakeholders are highly valuable methods to control the project. Client observed that the financial incentives have motivated the project team to implement open building approach in practise.

3.4 Quality management

In traditional construction project management procedure it is assumed that the contractor inspects the quality of the design documents during the contractor tendering process. Moreover, it is assumed that the client inspects and accepts the building as a whole after the construction work.

In the case project, traditional quality management approach was revised according open building principles in two ways. First, the design solution and construction work of the fit-out of the building is mainly inspected and commissioned by the users of the buildings. The users first inspect and accept the designs of the fit-out by utilizing 1:1 3d CAVE technology. Following that, the most frequently used type rooms of the fit-out are constructed near the site to be tested, inspected and accepted by the users. Figure 2 illustrates the structures of a test room. Finally, the users inspect and accept the fit-out in parts. Second, the client inspect and accepts the base building and fit-out separately – including HVAC systems. The aim of the inspection of the base building is to ensure that the capacity of the base building matches the requirements set in the brief.

In spite of the systematic quality management approach several project challenges emerged during the project. In particular, the questions on how users should be included to the design process, how the test rooms should be constructed and analyzed and how actually the base building should be inspected were necessary to
address and tackle. All of these questions needed education for project members and development work during the construction phase.

3.5 Process improvement plan

In traditional construction project management procedure the process improvement actions are usually individual responsible for each party of the project. However, in the case project it was observed that open building approach affects the project’s process improvement plan in three different ways. First, the financial incentives in each project milestones described in the section 4.3 generated exchange of information of the project progress and improvement actions needed during the project. Second, the client has procured industry experts to educate open building approach for project members and to evaluate the success of implementing open building to the project. Finally, as the implementation of the open building approach has been problematic in previous construction project, and thus, the designers and contractors were selected to the projects by evaluating also their propositions on how they would implement open building approach for this project.

During the design phase of the project, there were problems to collect and analyse feedback related to process improvement. Most of the project parties considered the feedback as an issue. A lot of reviews were needed to find a common understanding that the feedback was intended to improve the project organizations productivity – not criticise individual parties.

3.6 Staffing management

In traditional construction project management it is common that the requirements for the staff executing the base building and fit-out are the same. In this project, the staffing management plan was in general well aligned with the traditional project management. However, the main difference was that the base building and fit-out had separate designers: architects and engineers. The architect responsible for the fit-out was selected due to the special talent and experience on the execution of user-oriented design processes. However, the partition of the architects work into these two main responsible areas needed training and discussion between parties, as the architects were not familiar with the open building approach.
3.7 Communication management

In traditional construction project management procedure the communication is usually operated so that the communication contains information of the whole building. In this project, the main difference in the communication plan in comparison to the traditional procedure is that a special attention is given on the communication from project parties to users of the building. In effect, open building approach enabled this as the communication to users is focused on questions related to fit-out – not the whole building.

In practise, this approach was problematic to execute. The users observed that the communication focusing on factors related to fit-out was a positive thing. However, the users also frequently provided feedback that they felt that they were not fully informed all aspects related to project progress. Therefore, it was critical to reach a common understanding in project management team meetings on what should be informed to users and when. However, project management team felt that open building approach enabled an uncut communication process to the users and thus helped the project team to collaborate with users.

3.8 Risk management

In traditional construction project management procedure the risk management approach is usually the responsible of the contractor. However, in this project the preliminary risk analysis was conducted before the brief was generated. The preliminary risk analysis identified the delays the design progress due to changes in user functions as a major risk for the project. The client developed an open building approach as a risk prevention action, and thus the open building approach was implemented to the project principles. Interestingly during the project two new risk categories emerged: base building and fit-out. In this project, open building was an important response to risks.

3.9 Procurement management

In traditional construction project management the client usually executes six main procurements i.e., architect, structure engineer, HVAC engineer, electricity engineer, project manager, and contractor. In the case project, the client executed three main procurements: design team, contractor and audit team. The open building approach has an effect on each procurement. One of the main quality criteria in each procurement was to evaluate how the tender would implement open building approach to this project. Moreover, the tasks described in the procurement documentation were divided to tasks related to base building and tasks related to fit-out.

Interestingly the tenders seemed to have a need for basic information of open building approach during the tendering process. Many of the tenders were not familiar with the approach and only a few of the tenders were successful to implement open building approach to their offers. After the selection of the service provider an education event of open building approach was needed.

4 Discussion and conclusion

The purpose of the study was to generate new knowledge on construction management practises that help project stakeholder to utilize open building approach in construction projects. The study analysed how open building implementation is carried out in a case project in terms of a construction project management procedure. According to the authors experience this is one of the first studies that investigates the link between open building approach and construction project management approach.

The main finding of the paper is that open building implementation has a radical and strong effect on project management. In the case study, the open building approach had an effect on eight out of nine analysed project management aspects as summarized in table 4. Open building approach did not have a strong effect on risk management approach but open building approach was a major risk management action itself.

In addition, the case study shows why the training of key project stakeholders is essential when implementing open building in a construction project (table 4). In the case study, all of the construction project management aspects that were modified needed additional training for project parties. In particular, most extensive training was needed for implementing open building to project scope management and quality management.
### Table 4 Summary of the findings

<table>
<thead>
<tr>
<th>Aspect</th>
<th>The main differences comparing to traditional procedure</th>
<th>Aspects that needed additional training to project parties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project scope management</td>
<td>The project brief has targets for base building, fit-out and flexibility (capacity). Scope management has a new task: capacity management.</td>
<td>The use of flexible room program, interfaces between fit-out and base building, capacity calculations</td>
</tr>
<tr>
<td>Schedule management</td>
<td>Schedule is based on tasks related to base building and tasks related to fit-out. Schedule control is based on Milestone analyses. BIM modelling is based on open building approach.</td>
<td>BIM in open building approach, the timing of the fit-out design solution decisions</td>
</tr>
<tr>
<td>Cost management</td>
<td>Financial incentives to improve the process, target cost method, “open book”</td>
<td>How to generate and use budget for base building and fit-out?</td>
</tr>
<tr>
<td>Quality management</td>
<td>Fit-out of the building is mainly commissioned and accepted by the users of the buildings; the client (owner) commissions and accepts the base building.</td>
<td>User implementation to design process, use of test rooms; commissioning of the base building</td>
</tr>
<tr>
<td>Process improvement</td>
<td>Milestone analyses, industry experts as evaluators</td>
<td>Utilizing feedback to improve productivity</td>
</tr>
<tr>
<td>Staffing management</td>
<td>Separate architect for base building and fit-out</td>
<td>Design tasks related to base building and fit-out</td>
</tr>
<tr>
<td>Communication management</td>
<td>Focus user communication to questions related to fit-out</td>
<td>Timing and content of communication to building users</td>
</tr>
<tr>
<td>Risk management</td>
<td>No major difference, but open building was a major risk management action itself</td>
<td>No significant educational need</td>
</tr>
<tr>
<td>Procurement management</td>
<td>Open building motivation and competence as an evaluation criteria, task divided to tasks related to base building and tasks related to fit-out</td>
<td>Open building principles</td>
</tr>
</tbody>
</table>

The study suggests that the traditional project management needs extensive modification, particularly in the knowledge areas of scope management, quality management and procurement management, when implementing open building in construction projects. Therefore, the development of open-building-compatible project management system could be essential step to diffuse open building approach into the construction markets more rapidly. The findings are supported from the construction innovation perspective. For example Winch\(^{17}\) has suggested that construction innovation should be implemented to the construction project level.

\(^{17}\) Winch, G. Zephyrs of creative destruction: understanding the management of innovation in construction pp. 273
to make a difference. Therefore it is essential to study more deeply how open building approach is executed in actual construction projects.

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