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Building design management – key success factors

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ABSTRACT

The architectural, engineering, and construction industry is facing challenges related to increased productivity and improved quality. Most of these challenges need to be dealt with early in the design phase of the projects. This requires an effective design process and increases the need for effective building design management (BDM). This paper explores the success factors for BDM by addressing the following research questions: (1) What are the key success factors in BDM according to literature? (2) Which of these key success factors are considered important by practitioners? Based on a literature review, a framework with 10 success factors for BDM is proposed. The success factors were then assessed with a case study. Afterwards, 22 design managers (DMs) have ranked these success factors according to importance. The case study shows that not all 10 success factors were equally dealt with, underlining the need for a broader perspective on successful BDM. The case study findings emphasize the design team and communication as the most important success factors, while the DMs rated communication and decision-making as most important. The proposed framework should enable building DMs to better handle the challenges of the design phase.

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Building design management (BDM); success factors; building design

Introduction

The architectural, engineering, and construction (AEC) industry needs to create more value through increased productivity and improved quality. Productivity and quality in the AEC industry have been debated for a long time (e.g. Andersen & Langlo, 2016; Bråthen, 2015; El. Reifi, Emmitt, & Ruikar, 2013; Love, Irani, & Edwards, 2003; Mejlænder-Larsen, 2015; Meland, 2000). The industry is fragmented, and the projects involve different actors. The work is carried out by both more permanent functional organizations and temporary organizations, and this creates challenges related to culture and communication (Dainty, Green, & Bagilhole, 2007; Kerosuo, 2015; Zidane, Stordal, Johansen, & Van Raalte, 2015). To summarize, the industry is characterized by project-based production with unique products and temporary organizations (Bølviken, 2012) that must deliver value through increased productivity and improved quality.

The design phase is crucial to achieve success in a project (Caixeta & Fabricio, 2013; El. Reifi et al., 2013; Emmitt, 2016). At the same time, building design management (BDM) is also highlighted as being challenging (e.g. Ballard & Koskela, 1998; El. Reifi et al., 2013; Hansen & Olsson, 2011). Compared to the field of project management, there is a lack of research in the field of BDM (El. Reifi et al., 2013; Emmitt, 2016; Gilbertson, 2006).

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Nonetheless, BDM is important for both productivity and quality. Sinclair (2011) stated: 'Design management is the discipline of planning, organizing and managing the design process to bring about the successful completion of specific project goals and objectives.' Emmitt and Ruikar (2013) simplified it further, stating that design managers (DMs) manage people and information. People have a specific knowledge, explicit or tacit, that they can transform into information needed by the project. From that we can elaborate that BDM involves planning, organizing, and managing people, their knowledge, and the flow of information to obtain specific project goals and objectives.

Since BDM is deemed important to AEC projects, it is necessary to investigate the success factors. This paper addresses the following research questions: (1) What are the key success factors in BDM according to literature? (2) Which of these key success factors are considered important by practitioners?

Research methods

The research was carried out in three steps. The first step was a literature search looking for success factors in BDM. The second step was an empirical study based on two case studies. The third step was a modest survey to rate the importance of the success factors. Although empirical research is not enough to validate the theoretical framework, case studies can contribute to new and valuable insights (Flyvbjerg, 2006; Ragin & Becker, 1992).

The literature search was based on the recommendations of Creswell (2003). A search in the databases Scopus (Sco) and Web of Science (WoS) with the search words 'success factors' and 'design management' gave 17 (Sco) and 12 (WoS) titles in the fields of engineering management. However, the search displayed a small number of BDM literature results dealing with success factors.

The creation of the framework was performed by going through several design management books, which are cited in Table 1. This led to a list of 63 elements directly or indirectly referred to as success factors in design management. These findings were coded and categorized through a process based on the recommendations of Creswell (2003). The 63 elements resulted in 10 categories or success factors. The 63 elements are summarized as keywords in Table 1.

The second step of the research was to look for the presence of these success factors through empirical research, using two qualitative case studies. The qualitative approach was chosen because it helps to gain an in-depth understanding of the human behavior with the perspectives and actions of the studied subjects (Alvesson & Sköldberg, 2009). The chosen strategy of inquiry was case studies since there is no need to control behavioral events and the focus is on contemporary events (Yin, 2014). First a pilot case study was carried out, then a larger case study. The pilot served as an independent study and verified the suitability of the case study methodology recommended by Yin (2014). The second case was chosen for availability, size, and complexity. The pilot case study focused on the role of the building DM and consisted of five interviews, namely, four interviews with building DM and one with an architect. The analysis resulted in the categories of team, meeting structure, DM, and power. The category of 'meetings structure' led to the use of observations in meetings as data collection in the second case. The second case study consisted of seven interviews, five observations, and a study of documentary evidence.

The interviews in both cases were carried out as face-to-face, semi-structured, open-ended interviews based on the recommendations by Denscombe (1998) and Kvale and Brinkmann (2009). The interview questions related to the execution and success factors of BDM. The interviews were audio recorded and transcribed before the material was analyzed. All 12 (five and seven) participants had more than five years of AEC experience and represented contractors, clients, and architects.

The observations done in the second case were made as a peripheral – member –researcher with a focused observation approach based on the recommendations of Adler and Adler (1994) as well as Postholm and Jacobsen (2011). The observations focused on the behavior of the DM and the team participants. The observations were made during design coordination meetings.

The collected data were analyzed using a constant comparative method based on Creswell (2012), with the methodical support suggested by Glaser and Strauss (1968), Corbin and Strauss (2008), and Savin-Baden and Major (2013). The analysis starts with an open-coding process, followed by a categorization of these codes. The codes are categorized in several steps, and the number of categories is reduced for each step. During the process, the categories are compared with the codes to see if they still make sense. In the pilot study, the analysis was done manually on paper. In the second case study, this was done using the computer program MAXQDA (VERBI, 2015).

The third step of the research was to conduct a survey, following the prescriptions of Fink (2009). The survey was sent to 31 DMs. All DMs are employed by the same contractor and have more than 5 years of AEC experience. They were asked to prioritize the importance of the 10 success factors from the study. In total, 22 out of 31 DMs responded.

Theoretical background

Jerrard, Ingram, and Hands (2002) mentioned design management skills as a success factor and that there is a need for strategic focus on design management to create a competitive advantage. This highlights the importance of DMs' experience, qualities, and their skills to manage the design process. A further step is to look at which success factors are described in the literature on BDM. Cooke-Davies (2002) defined the differences between project success, project management success, success factors, and success criteria. Project success is the link to the overall objectives of the project, and project management success is linked to the performance against time, cost, and quality. Success factors are factors that lead to success, while success criteria are criteria that are used to determine whether the project is a success. Several papers deal with success factors in AEC projects, but the number of papers specifically concerning key success factors of BDM seems limited. Research examining success factors in design teams might be relevant for a comparison. Koutsikouri, Austin, and Dainty (2008) studied the success factors with designers in multi-disciplinary projects. Oyedele (2010) studied the success factors of motivating architects and engineers in design companies. Kärnä and Junnonen (2017) described the success factors of design performance. Doğan,

Table 1. Success factors in BDM (sorted alphabetically).

Success factors the BDM handles	Keywords	Reference
Client	A good budget, brief, client team, understanding the clients need	Blyth and Worthington (2001), Boyle (2003), and Eynon (2013)
Communication	Communication, network, negotiation, meeting structure, coordination, flow of information, design solutions	Blyth and Worthington (2001), Gray and Hughes (2001), Jerrard et al. (2002), Boyle (2003), Sinclair (2011), and Eynon (2013)
Decision-making	Timely decision-making, client involvement, getting it right the first time, crucial points of decision	Gray (1994), Blyth and Worthington (2001), Gray and Hughes (2001), and Emmitt and Ruikar (2013)
HSE focus	Health, Safety and Environment focus	Eynon (2013)
Interface management	Design dependencies, control of interfaces	Boyle (2003) and Sinclair (2011)
Knowledge management	Feedback of experience, set of tools, stakeholders, knowledge organized and contracted	Gray (1994), Blyth and Worthington (2001), Gray and Hughes (2001), Jerrard et al. (2002), Boyle (2003), Sinclair (2011), and Eynon (2013)
Performance evaluation	Audit in design, measurements, benchmarking drawings, process measurements (social and performance)	Jerrard et al. (2002), Sinclair (2011), and Eynon (2013)
Planning	Defining the process, planning, cost plans, change control, quality plan, time, progress reports	Blyth and Worthington (2001), Gray and Hughes (2001), Jerrard et al. (2002), Boyle (2003), Sinclair (2011), and Eynon (2013)
Risk management	Managing risk	Sinclair (2011)
Team management	Relationships, management support, subcontractors, procurement, delegation of work, involvement, holistic working	Gray (1994), Blyth and Worthington (2001), Jerrard et al. (2002), Boyle (2003), Sinclair (2011), and Eynon (2013)

Kiliç Çalğici, Arditi, and Günaydin (2015) and Wang, Tang, Qi, Shen, and Huang (2016) examined success factors in design teams with partnering. The success factors are not always explicitly stated in the design management literature (e.g. Gray, 1994) but are implicitly mentioned. The success factors for design teams described in the literature have some overlap with the success factors identified in the case studies. In the following, the 10 factors derived from the literature study are presented in alphabetical order and summarized in Table 1.

Client

The client as a person, organization, or representative is an important success factor. The client is responsible for the available time, budget, and scope of the project. 'A key to successful design rests with the client and not the designers' Boyle (2003). This is highlighted through the focus and importance of the brief, aligning the client's needs to the project's execution (Blyth & Worthington, 2001; Boyle, 2003; Eynon, 2013).

Communication

Communication is often highlighted as an important success factor in design (e.g. Gray & Hughes, 2001; Otter & Emmitt, 2008; Sinclair, 2011). This could be interpersonal communication through coordination and integration (Sinclair, 2011) or the importance of the meeting structures and the network of communication (Gray & Hughes, 2001; Sinclair, 2011). Eynon (2013) highlighted the efficient flow of design information as a key success factor.

Otter and Emmitt (2008) defined terms of communication as synchronous or asynchronous and stated that the design process contains both. Synchronous communication is described as an information flow between two or more people directly using hearing, sight, and talking (e.g. meetings and telephone). Asynchronous communication is a remote flow of information, which is delayed in time (e.g. emails, drawings, models, etc.). The more complex the process is, the higher need for synchronous communication. Flager, Welle, Bansal, Soremekun, and Haymaker (2009) showed that as much as 58% of the time in the design phase is spent on managing information. With more efficient information management, more time can be spent on value-creation activities. Integrated concurrent engineering (ICE) – for example – is an approach with synchronous communication where key stakeholders work together at the same time with the same topic. Moreover, ICE was developed by NASA to help extreme collaboration in design (Mark, 2001). Rapid decisions, a clear work scope, and well-prepared stakeholders are preconditions for the full benefit of ICE.

Decision-making

The importance of decisions in design is highlighted by several authors (e.g. Blyth & Worthington, 2001; Snowden & Boone, 2007) and is acknowledged as a challenging part of design. Design is dependent on decision-making throughout the process. 'Decision making is a phase connecting the creation phase with the production phase of design. On the other hand, decision-making is also an integral part of each of the two other phases' (Bølviken, Gullbrekken, & Nyseth, 2010). Decisions must be made in time to facilitate the flow of work (Blyth & Worthington, 2001), and they must be right the first time to reduce waste (Emmitt & Ruikar, 2013). Still, to let the design process evolve, there must be flexibility on when to decide and when to let the design process evolve (Olsson, 2009).

Health, Safety and Environment focus

Health, Safety and Environment (HSE) is not often referred to in the literature about the design process. A notable exception is Eynon (2013). However, to meet the expectations for HSE from the workforce, politicians, society, etc. might be one of the AEC industry's greatest challenges in the years to come. Typically, HSE is connected to the production phase, but key decisions made in the design process can be crucial for the production phase, thus the increased HSE focus by the DM is important. Choices made in the design of windows, ventilation, etc., influence the working environment of the users, and at the same time influence the production method. Environmental issues are getting more focus in governmental standards and certification standards (e.g. BREEAM). Overall, this helps to evolve the industry and create better products.

Interface management

The interfaces between the disciplines in construction are getting complex with more specialized equipment, technical infrastructure, and cross-disciplinary topics to be solved (Gray & Hughes, 2001). The interfaces are interdependent of the different disciplines in different ways in the different phases of the design (Sinclair, 2011). Thompson (1967) introduced three types of interdependencies: pooled, sequential, and reciprocal. Bell and Kozlowski (2002) added intensive. All these interdependencies are present in the building design processes and require coordination. Coordination of these multi-disciplinary interfaces is one of the most challenging parts of BDM (Knotten, Svalestuen, Hansen, & Lædre, 2015a).

Knowledge management

Knowledge may be the most important commodity of designers. Previous experience from design and feedback from users can contribute to better solutions and briefs (Blyth & Worthington, 2001). The knowledge of the designers needs to be adapted to the design tasks (Gray, 1994). Knowledge not only concerns the design issues but also the knowledge of the design process (Boyle, 2003). An important part of designing is knowledge sharing. Ghobadi and D'Ambra (2012) discussed the challenges with cross-functional knowledge sharing. They pointed out two major factors, namely, cooperation and competition. Their study shows that competition affects cooperation and thereby knowledge sharing. Ding, Ng, and Li (2014) emphasized team spirit instead of individualism to promote knowledge sharing. To have efficient knowledge sharing, one needs cooperative task orientation, communication, and interpersonal relationships (Ghobadi & D'Ambra, 2012).

Performance evaluation

There is a need to control the process and the product through performance evaluation. The importance of performance evaluation and measurement is highlighted by several researchers (e.g. Drucker, 2008; Kaplan & Norton, 1996). This could be evaluations of the design by third parties (Gray & Hughes, 2001; Jerrard et al., 2002; Sinclair, 2011), or measurement of the design team through benchmarking or KPIs (Eynon, 2013; Kristensen, 2013).

Planning

'The *planning* of the design activity is fundamental to design management. A different approach must be considered for each stage of the design' (Gray & Hughes, 2001). The plans make progress reporting and change control easier. Two factors influence the planning of design. First, it is the nature of design with its interdependencies. Traditional production management literature suggests planning for sequential interdependences, but these plans work poorly with reciprocal or intensive interdependencies (Knotten, Svalestuen, Hansen, & Lædre, 2015b). Second, it is the way we plan. The last planner thinking – described by Ballard (2000) – is letting the people closest to the execution do their own planning. Another approach is collaborative planning in design (Fundli & Drevland, 2014). However, a plan needs to be followed up and must allow for re-planning to get back on track.

Risk management

Risk management in the design process is not covered much in the building design literature. However, exceptions from this exist, such as the work by Sinclair (2011). 'The objectives of project risk management are to increase the probability and impact of the positive events and decrease the probability and impact of events adverse to the project' (PMBOK, 2004). Samset (2010) pointed out that the uncertainties in a project can be transformed into a negative risk or an opportunity (positive risk). The DM can address risk management in two ways. The first is to address the uncertainties of the design process. This could be done by ensuring contracts with the actors detailing their deliverables, a detailed planning of the scope, or ensuring a common briefing document. The second way is to ensure that the design team acknowledge the negative and positive risks. The design team must use the opportunities to develop the project. Essentially all success factors are reducing the negative risk in the design process.

Team management

The team, creating a team or managing a team, might be one of the most important success factors. Depending on how the project is organized and procured, there is usually a need to transform a group of people into a team. Eynon (2013) emphasized the importance of all the disciplines working together holistically. There is a benefit if the design team has a good, long-term relationship based on respect and trust (Gray, 1994; Gray & Hughes, 2001; Jerrard et al., 2002) To have a collaborative working team, involving the designers and designing subcontractors is important (Fundli & Drevland, 2014; Sinclair, 2011; Svalestuen et al., 2015). Mohammed, Hamilton, Tesler, Mancuso, and McNeese (2015) discussed the importance of the team mental model (TMM) in aligning the team and introduced temporal TMM. A temporal TMM is an agreement in a group concerning the deadline of task completion, the speed of the activities, and the sequence of the actives, to improve team performance.

Findings from the case study

This project consisted of five major parts: an office block, a hotel, housing apartments, commercial space, and a common parking garage, with a total of approximately 55,000 m^2, and a cost of approximately $94 million. The project is in Norway, and the client is a large professional property developer.

Figure 1 shows the organization breakdown structure (OBS) of the project and which actors were participating in the design meetings. Of the designers, only the architect and the structural engineer are directly subordinate to the contractor. The technical consultants are subcontractors to the technical subcontractors, basically creating a design-build relationship between the contractor and the major subcontractors.

As the contractor took the lead of the BDM process, they divided the project in three parts: the office (O), the hotel (H), and the apartment, commercial, and garage (ACG). Each of these parts had separate site managers (SM) and DM, with separate design processes. This meant that the OBS in Figure 1 was similar in the O, H, and ACG part. The different consultants and subcontractors had the opportunity to choose whether they wanted different persons responsible for the various parts or if they wanted to use the same persons. The architect, client, contractor, and most subcontractors were clear about dividing the responsibilities, but the electrical subcontractor had the same persons covering all three parts of the project.

As previously described, the case study was first analyzed using the constant comparative method. The main categories emerging from the analysis were *team, prerequisites*, *designing*, and *communication*. This is presented in Figure 2 together with some of the subcategories. The category *team* included every member of the design team, their competence and behavior, and the abilities of

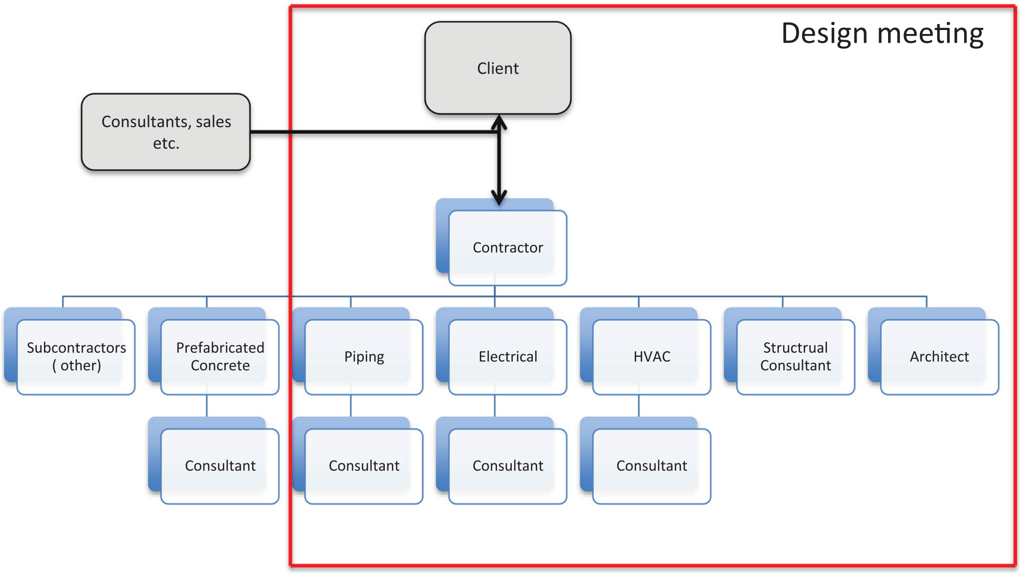

Figure 1. OBS of the case with the design meeting participants.

the building DM. This was the most dominant category from the analysis. The team and DM were the main categories from the pilot study. The *prerequisites* category includes the parts that need to be present to execute the project. The prerequisites were topics that the DM could not influence but needed to adapt to, which includes the contract form, public permits, BREEAM certification, etc. The category *designing* refers to the actual designing process – the processes which the DM is trying to lead and manage. The last category *communication* is how the interaction and communication was planned, set up, and executed during the project. The design meeting structure was also a main category from the pilot study. Figure 2 also shows the link between the case study categories and the success factors from the literature review. As the figure shows, most of the categories from the case study can be linked to the success factors, even though they might have different emphases in the two different research approaches. An example is *team*, which, in the analysis, consists of the subcategories of client and DM, but, in the literature review, both team and client were listed as separate success factors.

The following presents the case study findings organized according to the 10 success factors. Since the project was divided in three parts, the discrepancy between the three parts is mentioned when relevant.

The DM (O) had 15 years of AEC experience, mainly as a constructor and as a DM. The DM (ACG) has 9 years of AEC experience, mainly as a designer, and this was his first project as a DM. The DM (H) has 25+ years of AEC experience, mainly as a constructor and was combining the role of DM and SM. The different parts were in different phases. The O and H were still developing solutions, while the ACG was in detail design and the construction had commenced.

Client

The client was an active participant of the design process and the design meetings. Because of the diversity of the project, the 'client' was actually several people from the client's company or hired consultants. Their task was not only to contribute to the design of the project but also to get commercial actors to rent space, oversee the sales of the apartments, etc. Each of the client representatives had their responsibilities clearly defined. The clients were present at the design meetings; they were well

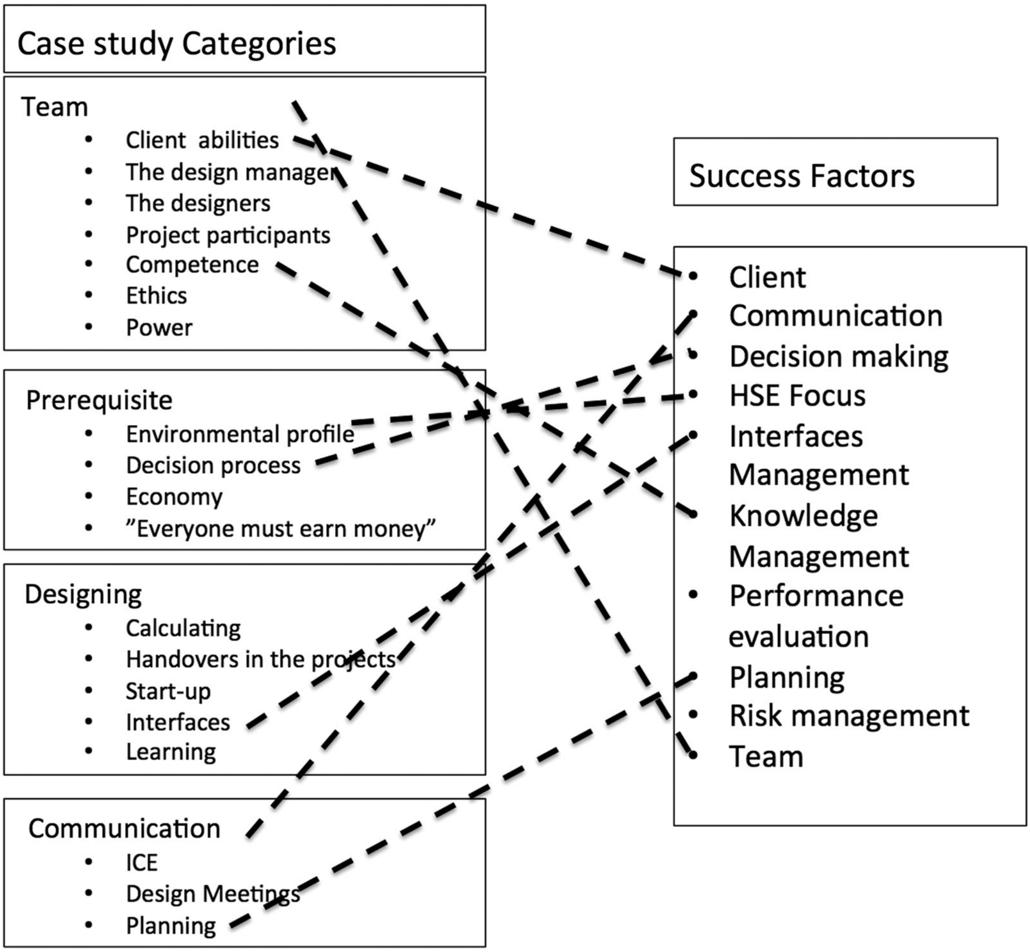

Figure 2. Findings from the second case study aligned with the success factors from literature.

prepared, contributing as valuable assets. However, they did not want to make any decisions in the design meetings and had separate decision meetings with the contractor. Still, all the DMs said there was a good relationship with the client.

Communication

The main source of collaborative communication in the project was through the design meetings. The contractor wanted to organize the design meetings as ICE sessions. The project was partly co-located and had bi-weekly ICE sessions. The ICE sessions were not that successful, as the client had decided that they did not want to make decisions in the design meetings but in a separate meeting with the contractor. The agenda of the session was sent out in advance, and all the DMs were well prepared. However, observations showed that not all the participants met prepared, thus leading to longer lead-time and unsolved issues. After a short while of ICE, however, the DM (H) reverted to traditional design meetings because his design team were more comfortable with this method of working.

The common method to communicate the project was through a building information model (BIM) and drawings organized through a web-portal. The drawings pass through many steps of development before they are finished, and the other trades need the information to develop their design.

In a meeting, one of the design team participants asked the others to be much more precise in describing the quality and layout of their requested input. By a more precise requirement, they could achieve two things, first the designer in need of input was sure to get what he/she needed, and the designer providing the input could produce only what was needed.

Decision-making

Since the client wanted separate decision meetings, the design meeting (ICE) did not conclude in a decision, but merely created propositions. Even though this only concerned the client's decision, this affected the culture of the sessions, leading to few or no decisions observed in the ICE. Decisions were acknowledged as important, and there was a decision plan where all the project's important decisions were listed. A log was kept to track all decisions. Not all the office (O) and commercial (ACG) areas had tenants, which also created problems with decisions. This meant that some decisions had to be postponed or the client made presumptions of the solutions, knowing that a change would most likely come. There was also an observation that not all the design team members were familiar with their scope in the design meetings, creating uncertainty and delayed decisions. For the DM to ensure the right decision at the right time is challenging, and the informants mentioned this.

The HSE focus

The HSE focus in construction is often connected to the production phase, but not so much to the design phase. All Norwegian AEC projects are regulated by the Construction Client Regulation (CCR). The CCR is a part of the Working Environment Act and describes the different parties' responsibilities in an AEC project. Even though the designers have a responsibility to design solutions that are safe to build and use, this is seldom a prioritized topic by the designers. Moreover, HSE was a part of the design process in diverse ways. In one meeting (H), the client's representative started asking about the status of HSE in the design process. In another meeting, HSE was a part of the general agenda of the meeting (O), asking whether there were any issues concerning HSE in the design process. Once this led to a response from the HVAC consultant that the constructor should plan the ventilation shafts so no one could fall between the ducts during maintenance and operations. However, an impression was that the DMs treated HSE focus as an 'ad-hoc issue.'

Interface management

Interfaces between the trades contribute to the complexity of the projects, especially in the design phase. The project had interfaces both between the trades within the various parts of the project and between the various parts of the project. The parts of the project were also in distinct phases. In the ACG part, piling and excavating had started, which needed production drawings, while there was still a creative phase of developing solutions in the O and ACG parts. There were also separated sessions in the ICE for the technical trades (MEP) and for the constructive trades (O and ACG), letting the two groups solve many of their own interfaces.

Knowledge management

Knowledge may be the designer's key commodity, and knowledge management is important. Knowledge is gathered through education, work experience, and previous project teams, and the design team consisted generally of experienced professionals. Making sure that the required knowledge is present for the problems to be solved is a challenging task for the DM. The DMs handled this by sending out the meeting agenda in advance, clarifying what topics were to be solved in the meeting.

Creating a culture for knowledge sharing is important, and so is the way we communicate the knowledge. In a design process, there is a lot of focus on the production material (i.e. producing the drawings). However, the DM (ACG) highlighted the necessity to let the designers work thoroughly through the design issues, and not rush them. The main technical subcontractors were also present in the design meetings, contributing with valuable knowledge of the products to be used and thus reducing the need for assumptions by the designers.

One of the questions in the interview was about the key skills of a DM, and the answers varied according to the respondents' background and experience. Interviewees with long contractor experience highlighted the understanding of planning, project economy, build-ability, and the delivery of information to the construction site. Others with experience from designing highlighted the DM's ability to understand the design process and allow room for changes and creativity.

Performance evaluation

Performance evaluation was recognized by one DM as important. The only assessment done was to look at the design plan and determine whether the tasks were done. Measuring the performance of the design team by a PPC (for example) was mentioned in one interview, but the actual DM did not prioritize the implementation of an evaluation system.

Planning

The different DMs of the project had different approaches of handling the planning. The DM (O) had made the design plan by himself and let the design team members confirm that it was viable. The DM (ACG) made the design plan collaboratively with the design team through a session with sticky-notes, and then recorded the plan. To make a complete design plan was regarded as impossible since, in design, one only presents one possible solution of many to the problem, but by planning one could increase the possibilities of delivering on time. The plan was used to look at what issues needed to be addressed in the following period, but there was no re-planning of the plan when the activities failed to be delivered on time. All the DMs commented that they should have focused more on using and updating the plan.

Risk management

What risk does one encounter in the design phase? This could be the risk of not keeping time, not solving interfaces in the design, solutions not satisfying the brief, the lack of decisions, not having the right competence or capacity, etc. The DM (ACG) pointed out that, by investing some more resources in the preliminary stages of the design (pre-contract), one could reduce the risk of not keeping the plan later in the project. The project had a decision plan to reduce the risk of not having the decisions made at the right time. The mention of risk was always to reduce the negative risk and not to pursue the opportunities of positive risk.

Team management

The design team comprises the people of the project contributing to the design process. They all belong to different companies; some had met for the first time in this project. They all had their perception of the project's problems and solutions, and all had a perception of the others' contributions in the project. This varied with the experience of the people, making this an extra challenge to manage. The DM (O) said, 'things were better after a start-up session' relating this to better interpersonal relations among the team members, creating a common culture, understanding, and ownership for the project. Common themes concerning team were the challenges of

Table 2. Success factors rated by DMs with a comparison of case study findings.

	Survey ($n = 22$)		Case study	
Success factor	Average	s	Interview	Observation
Communication	2.18	1.53	yes	yes
Decision-making	3.55	1.63	yes	no
Planning	3.91	2.29	yes	yes
Client	4.05	1.62	yes	yes
Interface management	4.36	2.06	no	yes
Team management	5.05	2.28	yes	yes
Risk management	7.55	2.65	yes	no
Knowledge management	7.77	2.07	yes	yes
HSE focus	8.09	1.63	no	yes
Performance evaluation	8.50	1.41	(yes)1*	no

Note: 1* was mentioned in the interviews but not handled in the process.

communicating, building the team, and when to stop the design process and decide that this is the solution needed.

Findings from the survey

To get an indicator of the importance of the success factors, a small survey was sent out to 31 DM. They were asked to rate the importance of the 10 success factors, where 1 is the most important and 10 the least important. In total, 22 of 31 DMs answered. The result is presented in Table 2. The DMs rated communication as the most important success factor, with an average of 2.18. Second was decision-making, with an average of 3.55. The next was planning, client, and interface management. They have a slightly different average but have basically changed places through the survey, rating them equally important. The same applies for HSE focus, knowledge management, and performance evaluation at the bottom of the list. An interesting notion is that none of the 22 DMs rated the 10 success factors identically.

Discussion

The AEC industry needs to create more value through increased productivity and improved quality, thus providing a new aim of project success. The design phase is crucial to achieve success in a project (Caixeta & Fabricio, 2013; El. Reifi et al., 2013; Emmitt, 2016). To handle the different challenges in design projects, the DM needs to address the success factors.

From the literature concerning success factors related to design, Sanvido and Parfitt (1993), Chan, Scott, and Chan (2004), Koutsikouri et al. (2008), and Oyedele (2010) highlighted team-related issues as a success factor. Gray (1994), Koutsikouri et al. (2008), Wang et al. (2016), and Kärnä and Junnonen (2017) focused on scheduling and planning of design activities as important factors to achieve success. Doğan et al. (2015) concluded that successful partnering in building design requires effective coordination by encouraging collaborators to voluntarily share information and establish common goals. This could be linked to the success factors of knowledge management and communication in our study. Koutsikouri et al. (2008) also mentioned communication as an important part of achieving design efficacy.

The factors are so far presented only in alphabetical order without any regard to the success factor's importance. Are any of these success factors more important for the DMs than others? Koutsikouri et al. (2008) pointed out that it is relevant to identify success factors that make sense to the team, instead of identifying a general list. Kärnä and Junnonen (2017) stated, 'The success of a project is party-specific, which is affected by the size of the project, as large projects appear to be more complex than the small ones.' This indicates that the importance of the success factors will vary from project to project.

The main categories from analyzing the two cases were in the pilot study team and meeting structure, and in the second case: team and communication. The three DMs' responses to what they characterized as the most important success factor were: 'To work as a team' DM (O), 'To get to know each other' DM (H), and 'To do as promised' DM (ACG). The first two DMs responses can be linked to the success factor of team, while the last can be linked to communication or planning. The three different DMs prioritized, organized, and carried out the BDM differently, even though they were organized similarly in the same project. The result of the survey (presented in Table 2) shows that the most important success factors were communication and decision-making. When comparing the results of the survey with the second case study findings (see Table 2), there are some issues to highlight. Decision-making was rated important by the survey, but decision-making related to major client requirements were not observed in the case. This was mainly to do with the arrangement between the client and contractor. Interface management is also rated high by the survey, but was barely discussed in the interviews. However, through their use of ICE sessions and inclusion of the subcontractors, they had enabled a strong interface handling.

This leads to an assumption that the prioritization and relevance of the success factors is not only dependent on project (Kärnä & Junnonen, 2017) and team (Koutsikouri et al., 2008) but is also directly affected by the DM. The DM's experience and skills will affect the prioritization and handling of the success factors in the BDM process. How can the DM address these success factors to achieve project management success and project success? A look at these factors constitutes a proactive handling for the DM. The DM should have a strategy to handle and implement the issues raised by the factors in advance but also have a contingency plan when disruptions appear. According to Gray (1994), a success factor is to understand the complexity of the project and the design process.

The members in the case made a strategy of how they wanted to communicate and manage information through structuring their design coordination process with the use of ICE; however, the clients wished to make decisions in separate meetings, which made the ICE sessions less effective and the decision process slower. The planning process was done differently in the three parts, but two DMs used collaborative planning as a tool for planning and to follow up on the plan. Even though the planning was not re-planned, new activities were added and completed, giving the DM some sort of 'progress control.' Interfaces were dealt with in the ICE sessions, and since the client, designers, and contractors were present, the interfaces could at least be discussed properly. The broad representation in the ICE session also provided the right knowledge. However, in one session, a junior engineer stepped in for the MEP designer. Even though the junior engineer was well prepared before attending the session, she could not answer all the questions that arose in the meeting and had to take those back to the senior MEP designer, leaving them unanswered. A help to the DM to address challenges during the process is to have some sort of performance evaluation. Is the project going as predicted or has something changed? How will this affect the project? Will the delays of decisions by the client affect the plan? Will the inexperienced junior engineer's lack of knowledge affect the design process? With some sort of measurement, the DM can assess the situation and act accordingly. Team was highlighted in the cases – not only that it should consist of the right competence and enough resources but that the DMs also focused on respect for each other, recognizing the individuals in the team. They also emphasized the importance of building a team to solve the project tasks.

Conclusion

The BDM process involves planning, organizing and managing people, managing knowledge and managing the flow of information to obtain specific project goals and objectives. This work has identified 10 key success factors for BDM. The 10 success factors were present in the case study and acknowledged by the practitioners, but they were not equally prioritized or equally dealt with by the practitioners. A rather obvious conclusion is that the importance and relevance of the success factors depend on the project, the design team, and the DM. Taking this a little further the implication is that the 10 success factors might not be entirely relevant for all BDM process. However, the authors believe that highlighting these factors and assessing the implications will have a positive benefit on the BDM process. By addressing these success factors in a proactive manner the DM should be better positioned to plan and execute the design process and thus contribute to the successful management of the project and the project success. A natural next step is to conduct further research to further understand the importance of these success factors.

Disclosure statement

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