

Learning From SamBIM - A Norwegian Innovation Project About BIM-driven Collaboration in Ambitious Building Projects

Anita Moum,

SINTEF Building and Infrastructure, Norway

(email: anita.moum@sintef.no)

Ketil Bråthen,

Faculty of Architecture and Fine Art,

Norwegian University of Science and Technology

& Fafo, Norway

(email: ketil.braathen@fafo.no)

Cecilie Flyen,

SINTEF Building and Infrastructure, Norway

(email: cecilie.flyen@sintef.no)

Tore Haugen,

Faculty of Architecture and Fine Art,

Norwegian University of Science and Technology, Norway

(email: tore.haugen@ntnu.no)

Abstract

This paper reports and discusses the status in a Norwegian research-based innovation project called "SamBIM – BIM-driven collaboration in the building process". The overall aim of SamBIM is to develop BIM-driven processes and collaborative models that boost value creation in construction projects, the AEC-industry and in the SamBIM-companies. SamBIM is funded by the Norwegian Research Council. The project partners are leading and R&D active companies in the Norwegian AEC-industry, representing various parts of the building process value-chain. SamBIM focuses in particular on the interface between programming, design, and the production phase. Important characteristics of the project is the holistic and interdisciplinary approach to phenomena studied in five ambitious real-life projects, the action research inspired methodology, and the use of change-agents as the "innovation gear" between research and practice. The SamBIM project concludes in 2016.

In this paper, we present preliminary results of the case studies. We furthermore investigate different foci, implementation angles, practice, and development of BIM-driven collaboration, both in the individual case project and in the SamBIM project in general. The paper discusses possibilities and challenges related to the research design and methodological approach of the innovation project. Knowledge development and learning across maturity levels, formal and informal implementation strategies, collaboration across scales (multidisciplinary dimensions,

life-cycle perspectives), process models for collaboration, and measures to obtain high quality BIM-driven collaboration in the building process are among the subjects appraised. The multidisciplinary profile of the research team has been fruitful in order to grasp the complexity of the observed phenomena. The broad approach has made it possible to view SamBIM topics from different traditions, both practically and theoretically. The research has contributed to increase the industry partner's knowledge, as it has contributed to the scholarly literature (particularly through the two embedded Ph.d-studies).

We gratefully acknowledge the collaboration with and contributions from the partners in SamBIM:

- Industry partners: Skanska Norway (project owner), Statsbygg (The Norwegian government's key advisor in construction and property affairs, building commissioner, property manager and property developer), Multiconsult and LINK Architecture;
- Interdisciplinary research group; SINTEF Building and Infrastructure, Fafo and NTNU (The Norwegian University of Science and Technology).

Keywords: BIM, Building process, Collaboration, Case study, Implementation.

1. Introduction

In this explorative paper, we present and discuss the first lessons learned in a Norwegian ongoing research-based innovation project called "SamBIM – BIM-driven collaboration in the building process" (2012-2016). We address two main questions:

- How can we identify main drivers for successful BIM-driven collaboration?
- How can in-depth case studies of the building process in real-life projects reveal such drivers?

Implementing new technology alone does not necessarily improve the way we work and interact in building projects. Improvement seems to require an understanding of the interrelationship between technological, processual and people-related factors (Moum 2008, Owen et al. 2010). To manage and implement change and innovation processes is epically challenging in the AEC-industry (Architecture, Engineering, and Construction). The industry has some particular characteristics (Dubois and Gadde 2002, Eccles 1981), making innovations challenging to deploy (Harty 2005). Harty (2005) points out five factors central to understand how innovations are deployed in the AEC-industry: 1) Tasks are often conducted as collaboration between several firms, with own resources, practices and goals. 2) The work is project-based, and there are often large numbers of people and companies involved. 3) The work is dependent on information sharing across organizations. 4) The tasks intersect organizational boundaries. 5) Each involved firm influences on the project by own practices and expectations.

Inter-organizational collaboration, complex interdependencies, and the absence of a single actor who can ensure a unitary implementation and use of BIM for the whole project characterize the context of the SamBIM-project. In the following, we describe the SamBIM scope, objectives and the methodological approach. We furthermore present the case studies and some first tentative findings, before we explore on the two questions above. We wrap up the paper with some concluding remarks.

2. SamBIM's scope and objectives

The successful collaboration and interaction between the people involved in the programming, design and production of building projects is a key to value-creation. This has traditionally been a challenging quest in temporary and non-continuous project teams. Such teams are typically comprised of companies who have never worked together before, who are representing different roles, interests and disciplines, and who are responsible for different parts of the process. The implementation and use of BIM (Building Information Modelling) is expected to improve collaboration and enable new and more efficient ways of working. Around fifteen years ago, the first companies in the Norwegian AEC-industry started implementing and using various BIM-tools. The implementation of the first generation of BIM demonstrated positive effects on design team coordination. Still, the industry is yet not enhancing the full potential of BIM beyond the goals and achievements of individual participants and phases. An initial state-of-the-art review in SamBIM identified a need for more holistic knowledge on BIM-driven

cooperation across phases and actors. SamBIMs multidisciplinary approach relates to architecture, technology and construction management as well as organizational studies and sociology.

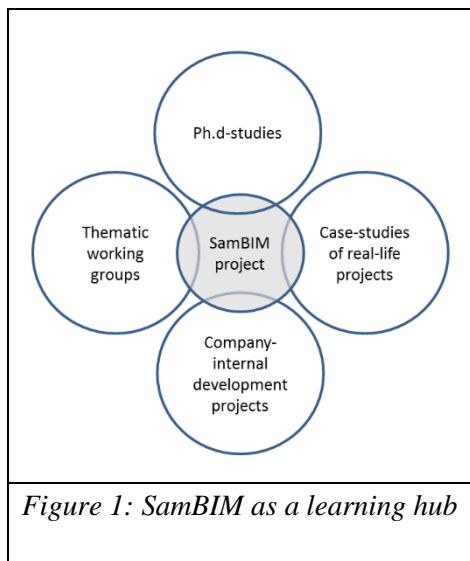
The overall aim of SamBIM is to develop BIM-driven processes and collaborative models that boost value creation in the SamBIM partners, in the building projects, and in the AEC-industry. This is to be obtained by processes that are more efficient, customized end-products, better use of resources, reduced costs, less process-related building defects, and less waste. In SamBIM, leading Norwegian AEC-companies and research environments are together identifying and developing knowledge. Experiences are gained from exploring collaborative models and processes in real-life building projects with high BIM-ambitions. The partners expect research outcomes and innovations with positive impact on the planning and production of buildings, such as:

- Successful adaption of new working methods, for instance Lean Construction principles, ICE (integrated concurrent engineering) and more;
- Improved competence of the client, consultants and contractors when it comes to purchasing and supplying services in BIM-supported building projects;
- Improved information flow and coordination – with particular focus on the interface between programming (client requirements), design and production of building projects
- Better understanding of roles, responsibility and tasks – and of management and organizational drivers and barriers in BIM-ambitious building projects.
- Less errors and better buildings.

3. Methodological approach

SamBIM is an Innovation Project for the Industrial Sector funded by User-driven Research based Innovation (BIA), a programme of The Research Council of Norway (RCN). The BIA programme aims to promote value creation in Norwegian trade and industry through research-based innovation in companies and the R&D environments with which they cooperate (RCN 2015). Innovation Projects are owned by a company or an organization. They include research activities and knowledge development needed for implementing innovations and value-creating renewals. These projects call for a research methodology enabling a high degree of interaction between the industrial partners and the involved R&D environments. A successful implementation enabling a subsequent value-creating effect in the companies is crucial.

The SamBIM methodology addresses the premises of RCN in several ways (Fig.1). Firstly, action-research inspired case studies of real-life building projects serve as an arena for both data collection and interactive knowledge development. Important criteria for selecting the real life projects were: 1) High ambitions of BIM-use and collaboration, and 2) Participation of a SamBIM company in the project. The research group has carried out open-ended and semi-structured interviews (individuals and groups) at different levels in the companies: at strategic level (management, client), tactical level (project management), and operative level (architects, consultants, BIM advisers). The group has furthermore observed project meetings and other project process related activities as well as relevant documents. The questions are targeting processes, people involved, technologies used, and the interrelationship between these. This



paper primarily presents findings from these case studies. Secondly, based on the data from the first case studies, thematic working groups were established to elaborate on cross-case challenges. Thirdly, the industry partners have kicked off company-internal development projects. Fourth, Ph.D-students are digging deeply into core issues of SamBIM. SamBIM is a learning hub, interconnecting and boosting knowledge development and implementation across the arenas in Figure 1. An important measure for ensuring a close interaction between the different learning arenas, and between the industry- and research partners, has been the so called "change agents". Each of the companies involved have appointed an employee to this role. The change agents support SamBIM as "innovation-gears" and gate-

openers, acting as two-way contact points between research and practice. They assist the research activities by driving necessary internal coordination, mobilisation, and information work in their companies. They are giving access to case studies, driving forward some of the thematic working groups, and they are active participants in workshops and SamBIM project meetings.

4. SamBIM as a learning hub

4.1 The SamBIM consortium

The project owner of SamBIM is Skanska Norway, one of the biggest contractors in Norway. Skanska's industry partners are Statsbygg (building commissioner), Multiconsult (an interdisciplinary consultant company) and LINK Architecture. All of them are R&D active and linked to international sister companies or equivalent organizations in other countries. They are front-runners in BIM implementation, and are involved in networks and joint initiatives such as BuildingSMART, Lean Construction Norway and more. Together these companies represent the stages of the building process crucial to SamBIM: programming, design and production. The industry partners have committed a multidisciplinary research group as required by the complex and broad objectives of SamBIM. The R&D partners are SINTEF Building and Infrastructure, Fafo, and The Norwegian University of Science and Technology (NTNU). Around five researchers and two Ph.D-students are involved in the project on a continuous basis, with expertise from architectural and engineering sciences, technology implementation, process-related research and social sciences.

4.2 Thematic focus areas

Both researchers and industry partners contribute in the thematic working groups, established by the need to dig deeper into specific topics:

- *Barriers and drivers for collaboration*; aims to identify barriers and drivers for co-location/integrated concurrent engineering in the design phase of constructions projects, opportunities and obstacles for mutual adaptation of technology, and organization and process among actors in the design phase. *Ambition*: to publish a publicly available *collaboration guide*.
- *Lean Construction*; aims to facilitate arenas where topics related to Lean Construction are discussed and further developed, and to obtain a more unambiguously perceived term, both by researchers and industry partners. *Ambition*: to collaborate with the Lean Construction Norway network to spread the results of the SamBIM project.
- *A common process model*; aims to develop a common process model for the building process, from cradle to grave. The SamBIM findings have been communicated to a national initiative on a new norm for describing the stages of a building process, inspired by the RIBAs plan of work in the UK.

4.3 The case studies – tentative findings

The SamBIM-team has carried out five case studies of real-life building projects (Table 1). Two of them are still ongoing (spring 2016). This section briefly presents tentative findings from each of these case studies.

Table 1: Overview of the SamBIM case studies.

<i>Case Characteristics</i>	<i>Risløkka</i>	<i>Veitvet</i>	<i>Deichmanske</i>	<i>Urbygningen</i>	<i>Eikefjord</i>
<i>Function</i>	<i>Road authority building (refurbishment)</i>	<i>School building (new)</i>	<i>Public library (new)</i>	<i>University building (refurbishment)</i>	<i>School building (new)</i>
<i>Phase/when case-study</i>	<i>Design (Oct. 12- april 13)</i>	<i>Design, 2013</i>	<i>Design, 2013-2014</i>	<i>Design & construction, oct. 2013 -</i>	<i>Design & construction 2014 -</i>
<i>Project delivery method</i>	<i>D-B</i>	<i>PPP</i>	<i>D-B-B</i>	<i>D-B-B</i>	<i>D-B with user participation</i>
<i>SamBIM actor involved</i>	<i>Statsbygg</i>	<i>Skanska & LINK arkitektur</i>	<i>Multiconsult</i>	<i>Statsbygg & Skanska</i>	<i>Skanska</i>
<i>SamBIM focus/initiativ</i>	<i>BIM, ICE</i>	<i>BIM, PPP</i>	<i>BIM, process model</i>	<i>BIM, ICE, Lean, "BIM kiosks" (on-site)</i>	<i>Procurement, BIM, collab. model, lean, big-room.</i>

4.3.1 Risløkka

The case deals with the refurbishment of a medium-sized office building located in Oslo, for the Public Roads Administration. Statsbygg acted as building commissioner. Already in the pre-design phase, Statsbygg appointed this project to become a SamBIM case study. Because of the connection to SamBIM, Statsbygg and the design team agreed on testing out the following Lean Construction-inspired work principles in the design phase:

- Co-location of the design team and Statsbygg twice a week;
- Working principles inspired by *Integrated concurrent engineering*;
- The use of a so-called planning matrix and *action items*.

Bråthen et al. (2014) and Bråthen and Moum (2015a) identify driving and restraining forces affecting the BIM implementation in this case study. Rather than just studying its effects, the actual implementation was also in focus. The analysis displays that a successful implementation of BIM largely depends upon a participative and co-operative process at the ground level. At this, the significant project participants must be involved in the development of a BIM-implementation-plan. This plan should reflect interests and goals of the involved parties. The analysis points out that related discussions and negotiations can ensure ownership and the design team participants' commitment to an innovative and, for some, unfamiliar BIM-process. The study also shows that working principles based on Lean Construction contributed to a more dynamic design team. Especially the combination of BIM and co-location opened up for working in a new and more efficient way. When working co-located the designers used BIM to show each other possible solutions and problems and could make clarifications and decisions “there and then”. According to our informants this implied faster decisions and better interdisciplinary working compared to a “traditional design process” (Bråthen et al. 2014). However, such a way of working requires that all participants are present and have decision-making authority.

4.3.2 Veitvet

The Veitvet primary and lower secondary school was a public-private partnership project (PPP), partnering the turnkey contractor and property developer Skanska and the municipality of Oslo. It was a Future-build and BREEAM Very Good project, with high environmental ambitions (passive-house level). It seemed that the project had a high potential for innovation and collaboration between the professional participants of the building process. The SamBIM partner LINK Architecture had a role as responsible architect. Initially, the BIM ambitions were high, and the ambitions from the research project SamBIM should be implemented in the Veitvet project. Due to different circumstances, the project was however withdrawn as a case quite early in the SamBIM project.

The findings reveal that the project in practice seemed to develop into a traditional turnkey project, and that the formalized BIM requirements neither were met nor implemented. The collaboration seems to have failed, partly due to challenges concerning the PPP model and contractual structures between the "partnering" participants (fixed prices), and partly because the model for collaboration was not sufficiently developed and/or rooted in the contractors' management. Both BIM model and paper drawings were requested by the project management, which may have resulted in an unclear perception of the model for project management and collaboration (as a mix of traditional management and BIM) (Flyen 2016a). Even if Veitvet was terminated as a SamBIM case project, the experiences had major ripple effects and seem to have made a vast contribution to the later development of a Skanska process model for collaboration used in subsequent projects.

4.3.3 Deichmanske

In 2013, Oslo Agency for Cultural Affairs commissioned a new library building. The new main branch of Deichman, Oslo's public library, is currently under construction in Bjørvika. The SamBIM partner Multiconsult won the main engineering contract for the new library, including the responsibility for coordinating the design team. Together with three other consultant companies, they are responsible for the detailed design phase. Multiconsult has for several years been developing a generic process model for BIM-enabled projects. As a part of the Deichman project, Multiconsult wanted to streamline and improve their model further, through experiences and insight from this significant project. Related to this aspiration, SamBIM's research partners have mainly focused on the following topic in this case:

- Effects of connecting BIM to the process model through milestones. This implies that decisions about the model status in different zones of the building will be frozen at a certain date.

Skinnarland (2015) found that using a Multiconsult process model has been a valuable experience for the various actors in the design team. Using the model puts pressure on the actors to make decisions in accordance with the model, often on an earlier point of time in the process than they normally do. The informants considered the model to have contributed to more and better interdisciplinary collaboration within the design team. However, Skinnarland (2015) found a mismatch between Multiconsult's position within the design team and their possibility to put pressure on the other companies to make all their decisions in accordance with the model. Consequently, one important conclusion from the case study is that too little attention was devoted by Multiconsult on core elements in the implementation and development process of the process model. The model was introduced to all participants in the design team without sufficient discussion. Hence, a necessary ownership was not created, nor a common vision for the use of the process model. These shortcomings were probably significant for the less successful results compared to what was expected when using the model in the detailed design phase.

4.3.4 Urbygningen

The case deals with the refurbishment of a University building named Urbygningen at the Norwegian University of Life Sciences located outside Oslo, with Statsbygg as the building commissioner. The preliminary design completed in 2009. In 2013, Statsbygg initialized the detailed design phase. The ongoing construction phase started in august 2014. The design team consists of several Norwegian, Oslo-based companies. The SamBIM partner Skanska was chosen as the general contractor. Statsbygg wanted to test the following in the design and construction phase, respectively:

- BIM combined with co-location of the design team, methods inspired by lean design methods;
- BIM for site workers in the construction phase ("BIM kiosks").

Statsbygg's expectation was that BIM and the lean-design-inspired work principles would lead to better collaboration among the involved actors, and thus lead to an improved design process.

The data suggest that this principally occurred. The findings indicate that BIM combined with some of the lean work principles yielded good results regarding the intentions, through linking the team stronger together, technologically as well as organizationally. In particular, it turned out that the combination of BIM and co-location of the design team created good results. The findings indicate that this approach helped to improve the inter-organizational and interdisciplinary collaboration. It fostered faster communication and made improvements in latency, as well as contributing to a better social climate in the design team. However, the data also suggest that not all parts of the contractual “BIM and Lean-package” were equally successful in practice. The analysis indicates that the various pieces of the lean and BIM concept were emphasized differently in the implementation process. Elements given little or no attention in the implementation process are less likely to lead to good results. In the construction phase, Statsbygg and Skanska introduced so-called «BIM computer-kiosks» in order to allow site workers on-site access to 3D models. Bråthen and Moum (2015b) investigated the use of the computer kiosks and the related consequences. The findings indicate that there are great advantages by adopting BIM and similar technology at the construction site. This relates, among others, to the fact that the workers obtain a more holistic understanding of the planned building through the excellent possibilities for visualization. The workers get the ability to investigate particularly complex issues and to access details that hardly can be seen on a traditional paper drawing. In addition, the findings indicate that in certain cases the data kiosks facilitate a greater level of face-to-face collaboration between site workers. This occurs because workers meet, both planned and randomly, to discuss in front of the computer kiosk while using the model for visualizing complex issues. This means that the data kiosks can pave the way for new on-site collaboration forms.

4.3.5 Eikefjord

The Eikefjord primary and lower secondary school case is a comprehensive demolition- and new building project situated on the coast of Western Norway. The project- and building owner is Flora municipality. The execution model is interaction based turnkey contracting. The SamBIM partner Skanska is the Turnkey contractor (engineering, procurement and construction). The researchers from the SamBIM project have been following the project from the initiation of the design-build and tendering competition, through the design process and start-up of construction works. Eikefjord is the fifth and final case-project in SamBIM. The process encompassed demolition, relocation and temporary housing of school functions, building of the new school and sports arena, and build-up of outdoor areas. The school operations were to be running parallel to the demolition of the old school and building of the new, with operations partly in the localities of the old school, temporary barracks, and gradually employing the new buildings. Skanska generated an internally developed collaboration process model prior to the initiation of the early stages in the design-build tendering competition. The case project was a pilot for the new process model. The project team was complete already from the initial stages of the competition, adapting full collaboration, team building, and collective experience learning from early design and composition of tender. Skanska managed the project and the project design team, had the BIM coordinator and a process supervisor/change agent to follow collaboration process. Consultants, architects, and manufacturers were both locally- and

Oslo based. Both collaboration- and BIM ambitions were initially high, and the research focused on the following areas in the collaboration process model employed in the case project:

- Implementation of a collaborative focus from initialization of design-build and tendering competition;
- Lean-construction inspired backwards planning/scheduling and implementation of tendering, design and construction stages;
- High BIM-ambitions, both in tendering, design, and construction, and as a support tool for close collaboration;
- Workshop-based collaboration approach, with frequent gatherings;
- Virtual and physical BIG-ROOMS in the design phase.

The primary focus of the newly developed process model ensured collaboration and co-localization from initial start-up, and upheld the baseline goals agreed upon throughout the whole of the process. Due to the partners' different localities, a continuous focus on collaboration has been imperative. The use of virtual and physical BIG-ROOMS, frequent workshops, and clarification of expectations for deliverables for each other to the next gathering has been important drivers to achieve this goal. The Lean construction-inspired scheduling approach yielded complete overview of all participants and interfaces. Both holistic and interface coverage between professions has successfully been ensured by the all-team and two-party clarification meetings during the workshops. The consensus-based rules for collaboration and workshop-based process ensured a rapid and effective design process, but required that all participants were present and had decision-making authority in the workshops (also the owner). The results of the earlier case projects in SamBIM seems to have inspired, and partly driven, the development of the Skanska collaboration model. The experiences with the model so far are very promising in terms of efficiency and quality of both collaboration and project results (Flyen 2016b). The model has thus proven to be an important driver for collaboration and the use of BIM in construction projects. Further, the participants have expressed that this way of collaboration is inspiring and positive, and that they want to continue to pursue this approach in further projects.

5. Discussion - Learning from SamBIM

What are the first lessons learned across the single case studies and adjacent activities? In the following, we discuss how the SamBIM team has identified main drivers for successful BIM-driven collaboration. We elaborate on three key topics: 1) learning loops and maturity levels 2) implementation strategies and, 3) commitment and continuity.

5.1 Learning loops and maturity levels

Three factors were particularly challenging throughout the project: 1) to achieve a shared understanding of ambitions, activities and roles, 2) to find appropriate case studies and, 3) to close the gap between the ambitions and the various maturity levels in the organizations and the projects. The initial ambitions of SamBIM were high. The starting point was a broad and holistic view on developing new ways of collaboration, enhancing the full potential of BIM. The partners wanted to develop new generic models and methods, which, in the next step, should be

applicable for other actors in the Norwegian AEC-industry. To orientate in this rather complex landscape of interdependencies, and to operationalize the overall objectives into definite actions, required much effort in the first stage of SamBIM. The related discussions between the researchers and the practitioners (and the study of state-of-the-art elsewhere/in the industry) gave valuable guidance. Based on the knowledge gained from the case studies and the discussions about the goals and ambitions, the SamBIM-team decided to establish three thematic working groups as an arena for elaborating the selected cross-case topics as previously described. An important function of this work is to transform the pool of empirical data into definite and applicable outcomes for the industry partners. Important topics in the SamBIM-team discussions were e.g.; to which degree can the SamBIM project realistically hope to influence on cultures of collaboration within real-life projects and organizations? What is process-innovation for each of the partners involved?

Finding real-life projects to match the high ambitions of investigating new ways of collaboration and advanced BIM-use from early design to production was challenging in the first stage of the SamBIM-project. The partners had thus to apply a rather pragmatic approach to narrowing down the scope and limiting the ambitions. It was necessary to adjust to the restraints of the available case studies, and to the maturity of the involved organizations. Still, as the project developed and the insight and the maturity of the industry partners increased, new cases replaced or succeeded the initial ones. The new projects could thus benefit from the preceding experiences. An example is Skanska's steep learning curve on their way from the Veitvet to the Eikefjord case.

Would SamBIM have benefited from a more limited scope and more mature case studies from the beginning? Not necessarily. To move from the overall picture down to the details, and to research the not-perfect real-life situations might have been challenging, time-consuming and partly painful. This process has however also revealed findings and experiences, which might otherwise have remained undiscovered. More important, this process has been useful in order to harmonize the progress with the actors' need for time to move upwards on the learning ladder, step by step.

5.2 Formal and informal implementation

The case studies show, in different ways, the importance of a good understanding of implementation drivers and related strategies. An obvious implementation driver for "SamBIM-working" (BIM-driven collaboration) is formal contractual requirements of the client (for instance early contractor involvement and co-location/big-room solutions). The SamBIM findings do however indicate that this is not enough to achieve successful implementation and related change of traditional practice. Not only formal, but also informal drivers of implementation can be powerful. For instance a dedicated design manager (or a change agent), who, with a personal engagement and belief in what he/she is doing, motivates and inspires colleagues or a team to try out new technologies or ways of working. A good implementation strategy should include formal measures, as it should take into account, be aware of, and utilize the power of informal drivers such as involvement and participation of involved parties.

5.3 Commitment and continuity

Initially, one of the case-study criteria was that at least one SamBIM industry partner had to be involved in the building case projects. The role (and the authority) of the partner in the project affects the ambitions and possibilities of a broad implementation. Statsbygg and Skanska in their client or turnkey contractor role could put pressure on the implementation of the SamBIM-approach (top-down). The architect or the consultant company (bottom-up) did not have the same impact in the projects with an external and not "SamBIM-committed" client. To create interest and commitment among all building project participants, would enable a broader impact and probably also enhance greater benefits. This is however not always possible, and calls for activities with realistic scope, adjusted to the constraints of what is possible to test or change. Tight collaboration between research partners and industry partners is an important premise for success in innovation projects such as SamBIM. In AEC-companies, there is often a high labor turnover and change of people in management positions. The SamBIM-companies have been no exception to this. Throughout the project period, the team members in the SamBIM group have changed several times, including the project management. This creates challenges for the team building and the continuity of the work. The same situation has also partly characterized the building projects studied. Changes in work force can affect both positively and negatively on the progress and success of a project. They are however unpredictable and not possible to influence on. This makes it even more important to create robustness in organizing such tight research-practice collaborations.

6. Concluding remarks

A motivation and crucial expectation of the industry partners (and the Norwegian Research Council) is that the SamBIM-activities will contribute to actual improvement of their practice. This is relevant both for the building projects they are involved in, and for their own organizations. In order to wrap up this tentative report, we summarize how in-depth case-studies of the building process in real-life projects has revealed main drivers for successful BIM-driven collaboration:

- Learning across the case-studies has been highly valuable. To develop knowledge step-by-step from case to case has given an added value to the SamBIM project beyond what would have been possible with parallel and isolated cases;
- To develop and implement research-based knowledge on holistic, "soft" and hard-to-measure issues in real life settings is challenging. In SamBIM, it has been important to allow for maturation, unexpected findings, necessary corrections and limitations as the insight and understanding among the partners have gradually grown;
- The dynamic interchange between the four knowledge development arenas (Figure 1) has been highly valuable. The activities have boosted each other and the progress of the SamBIM project. They have also stimulated learning loops and continuously pushed the partners into investing in new fields;
- The multidisciplinary profile of the research team has been fruitful in order to grasp the complexity of the observed phenomena. The broad approach has made it possible to view the SamBIM topics from different traditions, both practically and theoretically. The research has contributed to increase the industry partner's knowledge, as well as to the scholarly literature (the latter particularly through the Ph.d-works);

- The close interaction between the researchers and the industry partners has been a driver in SamBIM, with the dedicated change agents in front;
- The complexity of both the consortium and the research requires clarified roles and responsibilities, and a common understanding of aims and ambitions;
- In SamBIM, it has become important to both strive for the high and ambitious goals (long runs), and grasp for the low-hanging fruits (short runs). The Urbygningen BIM-kiosk or the big-room of Risløkka enhanced an immediate effect which was useful and motivating, and which created pride and ownership among the actors involved.

The SamBIM project will be completed in the autumn of 2016. Important work to be done in the last stage of the project are the cross-case and cross-activity analyses and summaries, the deliveries of the thematic working groups, and the dissemination of the findings from the project in its totality.

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