The Support for the Integration of BIM Through Collaborative Action Research: ShareLab

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Abstract— **Building Information Modeling (BIM) deals with building technologies and techniques that cover the entire lifespan of a building or structure. It allows for building design and documentation (information modelling), as well as the coordination and management of information (information management) that describes the building, its limitations and its performance objectives. This article questions the integration of BIM in the integrated design processes of major architectural and engineering firms. It proposes collaborative action research: ShareLab as a new approach to the appropriation of BIM paradigms. Equipped with various methods of reflection and information collection, the goal of ShareLab use is to collaboratively construct a common understanding of various issues and a shared vision of the stakes at play. This is done in an effort to push businesses into the BIM integration process.**

Keywords-BIM; collaboration; action research; change management; the science of design; the performance of a design project: time and tools.

I. INTRODUCTION

This section describes the BIM context and issues as well as the notion of ShareLab..

A. BIM: a response to current industrial and societal stake

In today's world, collaboration plays an integral part in design especially in the public domain. There is an ever growing number of players who, as early as the initial stages, intervene in the layout of a project. This number continues to grow due to more stringent performance demands and shorter deadlines.

In this context, Building Information Modeling (BIM) methods and technology allow for integrated "teamwork" during the entire design, construction and life cycle of the building. BIM uses numerical models to design and represent the data relating to the building, its limitations and its performance objectives. This information is managed and coordinated by a collaborative process called the BIM, whose integration is yet to be concocted [1].

This innovative collaborative approach calls upon the participation of all the players involved in the construction project (architects, engineers, entrepreneurs, contracting authorities, managers and clients) and it covers the project's entire lifespan. While the management, sharing and synchronisation of information remains a major challenge in the process, the numerical templates of the building represent a fundamental evolution in the field and are effecting changes worldwide.

The results of BIM pilot projects demonstrate the many advantages of its implementation [2]: the meeting of delivery deadlines and the reduction of construction costs through decreasing human design errors. In contrast to other fields in the manufacturing sector, the construction industry has evolved very little in its methods and its work efficiency. The positive BIM performance results are revelatory of its potential. As a result of increased dialogue between various players who hope to improve project performance and overall productivity, construction projects have become more elaborate. The use of these integrated technologies and processes are seen as a promising way to respond to this increase in project complexity [3].

There are two main reasons why businesses have switched to BIM: 1) the every growing demands on the performance of buildings on a technical, environmental ad budgetary level, and 2) the legislative constraints that increasingly recommend the use of BIM technologies and methods to answer public requests for tender. For example, European Union member countries have progressively begun implementing the January 15, 2014 European Union directive, which encourages the use of BIMs for the financing of public projects. Since 2016, Norway, Denmark, Finland, Great Britain and the Netherlands have committed to managing these types of major projects through collaborative BIM processes.

B. Issues

Through the use of data sharing models, businesses can efficiently use new procedures and technologies to create projects that are more environmentally and economically friendly throughout their entire life cycle. However, this requires both internal and external action. Internally, it necessitates a review of current practices and workflows, and externally, a response to the new realities of competitivity and innovation [4]. Thus, the implementation of a BIM work process calls for significant change on an organizational, technical and even legal level.

The switch from a sequential organization, organization by "batches", to a BIM collective, where players work concurrently in order to achieve a common goal, entails the integration of complex organizational processes [5] . There is ever growing need to manage change in way that helps professionals and firms adapt to their changing environment

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and coordinate their market vision with that of present operational realities.

The goal of this study is to develop, experiment and validate a new participatory approach for understanding the implementation of BIM in the integrated design process. This study proposes collaborative action research as a means to achieve this end. This new method is structured in order to be applied in large construction firms and as a same time to take into consideration the specificity of each actors and its function in the organization of a building project.

C. Structure of the paper

The state of the art presents different studies and methods developed to guide the change to BIM work practices and technologies. The section following expound the structure of a new approach to deals with this issue: the Sharelab. Then, methodological tools used for the Sharelab are broached before demonstrating the interest of the method for BIM integration. The conclusion proposes a summary, with limitations and perspectives of the research.

II. STATE OF THE ART

There have been many recent studies on the interoperability of objects in 3D and on the advantages that BIM can bring to the optimization of construction deadlines [6]. In order to increase productivity through the use of BIM, businesses must implement specialised technologies from software providers and computer consultants. That being said, to fully benefit from the use of BIM, businesses need to go beyond this technocentric view and organize around their own company and management.

A. International Studies

On an international level, a Canadian study by Staub-French, [2] focuses on two primary objectives: the first, the analysis of the usage of BIM in a variety of professions and projects; the second, the study of best practices in real cases that cover different levels of the business. Among the recently developed methods and tools, Penn State University's [7] approach is at the forefront. The goal of this approach is twofold: 1) the identification of BIM objectives and the tasks and steps that need to be taken for their attainment, and 2) globally defining and coordinating BIM project requirements by involving all players. The study is based on the idea that BIM serves a large database of uses and that it is primarily suited for comparing user objectives and capabilities.

TABLE I. COMPARATIVE TABLE OF DIFFERENT BIM INTEGRATION GUIDES ' APPLICATION FRAMEWORK

	Author / Editor	Target audience	Objective announced	Field of application
PAS 1192-2 (UK, 2013)	BSI (British Standard Institution)	Every actor of building industry, BIM qualified and experimented.	To propose a set of tools to apply rapidly to support BIM integration	The whole life cycle of a construction project
Statsbygg BIM Manual 1.2.1 (Norway, 2013)	Statsbygg, buildingSMART member	Every actor involved in a BIM process	To guide the use of BIM software	The whole life cycle of a construction project
Singapore BIM Guide (2013)	Building and Construction Authority	A global document is addressed to the whole building trade and specific ones target every actor	To demystify the BIM and to give keys for the use of BIM at each stage of a project	The whole life cycle of a construction project with specific approach according to the different building trades.
Planning Guide for Facility Owners (US, 2013)	CIC, Computer Integrated Construction	Contractor	To help contractors implementing BIM in construction projects	Preliminary studies to prepare a project, from the definition of needs to execution deals
The Guide to BIM (Belgium, 2015)	ADEB-VBA	Every actwor of building industry	To propose a support for collaboration and digital information exchange	The whole life cycle of a construction project
Methodological Guide for BIM project convention (France, 2016)	Mediaconstruct, buildingSMART member	Every actor of building industry	To guide professionals in the formalization of a BIM convention in their projects	The whole life cycle of a construction project, vocabulary adapted for conception and construction stages

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B. European Studies

There has been much recent research in Europe concerning the development of tools for the evaluation of BIM practices in the construction industry. These research initiatives include the BIMetric method, which is the product of the collaboration of three research laboratories (LIST Luxembourg, LRA Toulouse and MAACC Paris) [8]. These laboratories developed this approach for "Plan Urbanisme Construction et Architecture" (PUCA), an interministerial French organization. It was inspired by two goals in the aforementioned Penn State University approach: 1) the evaluation of the maturity of the organization of the industry with regards to BIM and 2) the identification of investment return for the implementation of BIM processes on the project level. Today, many architectural agencies in France and Luxembourg have already implemented this type of evaluation.

C. Project Positioning

In parallel to international and European studies, many BIM guides and standards have recently emerged throughout the world, such as the *BIM Guide of Singapore* [9], the *Statsbygg BIM manual of Norway* [10], the *Guide to BIM* [11], *the British Standard Institution PAS* [12], and *the Methodological Guide for BIM project convention of France* [13]. These primarily technocentric methods allow for the standardization and guidance in the use of BIM technologies.

Table I proposes a synthetic comparison between a selection of guides frequently mentioned in conferences and used by professionals. These methodologies refer to the global project organization and aim to guide the interaction between the different building trade actors. The BIM integration at the scale of individual firm, internal change management, is not mentioned much. The Penn State University approach [7] distinguish itself to the extent that a specific maturity matrix is proposed in order to help contractors forming a project team in accordance to professional's competences. But the goal remains evaluating BIM expertise and not guiding professional to improve it.

For the purpose of our study, we hope to satisfy the need for a global collaborative approach that is user oriented. We adapt the tools developed in the Penn State University study to consider social issues of BIM implementation, that is to say the change management to new technologies and work practices. It is this that will propel businesses to go beyond the evaluation stage of BIM integration to demanding industry change and support in their technological implementation of collaborative processes between various players in the construction sector.

III. PROPOSED METHODOLOGY: SHARELAB

The novelty of our research resides in the fact that it is based on a collaborative research approach. In this approach, borrowed from social sciences, actions are at the heart of the research and they aim to understand and transform practices. The individuals involved in the observed processes are thus both players and collaborators in the research [14]. In order to measure the weight of the effects of each action, the researcher is required to observe the tasks, attitudes and the language used, as well as quantitative data that resulted from the action. This method is well-developed in the field of social and human sciences and should prove to be of great interest in this new context. In the short term, collaborative action research yields a better understanding of the evolving organizational and technological implementations, thus aiding businesses in their improvement and mastery. The long-term goal is "learning how to learn" by to enabling companies to progressively develop their own processes and workshops.

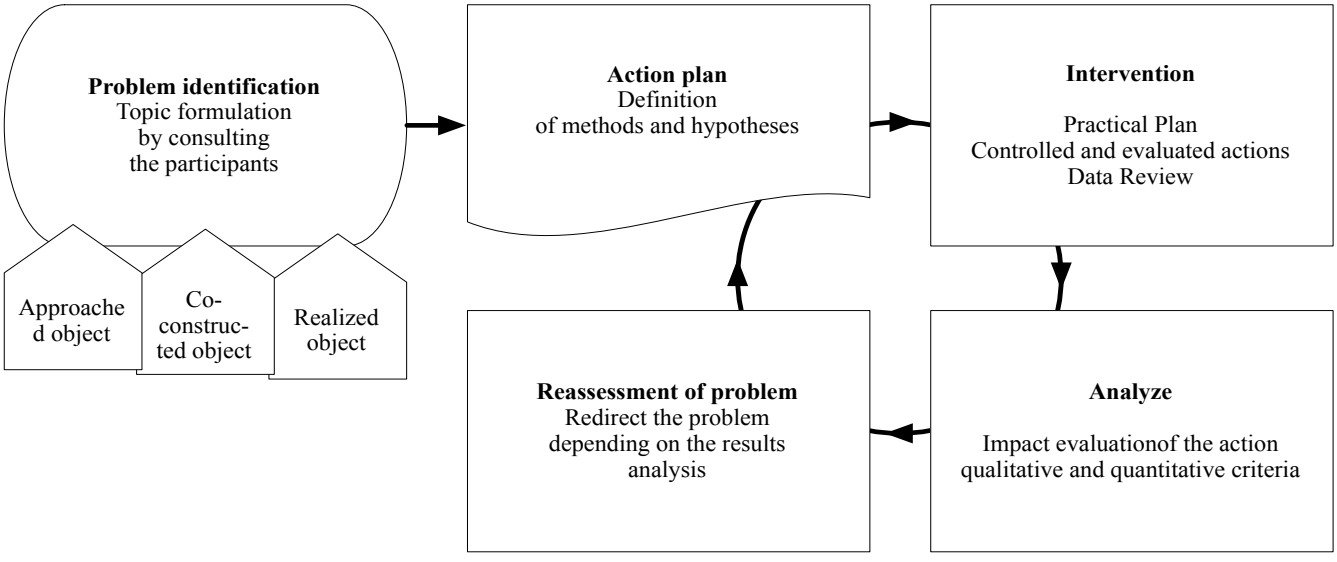

Figure 1. The cyclical approach to Action Research, inspired by [16].

In order to better monitor the evolution of BIM in various firms, we advocate ShareLab, an approach based on collaborative action research and adapted to the realm of design and construction. ShareLab [15] unites partners from various levels in the industry. With the assistance of a researcher, the collaborators are able to create a common understanding of the issues. This shared perspective helps them advance in their reflection on and their creation of a common vision and of a shared short- and long-term strategy for the implementation of a BIM process at the heart of the business. In this immersive process, researchers and industry players have an equal role to play in the design of the various stages of the research. This grants us access to information that is useful to understanding complex situations. Applications are conducted in the various types of multidisciplinary businesses and multi-sites of professionals in building construction and design.

More precisely, this action research approach, adapted to the building domain, is conducted by means of a series of cycles that are composed of the following five steps (Fig. 1).

To complete the description of the cycle that is described in Fig. 1, here are a few precisions on the initial step for the identification of the problem. The basis for these precisions is a threefold concept:

- the definition of the object related to the preliminary work carried out by the researcher, as well as the researcher's understanding of the subject, its logic, impact and scope. It is from this starting point that the researcher can propose the general direction of the research to the collaborators;
- the formulation of the subject and its validation (goal co-constructed), architects and engineers involved in the company management are requested at this stage in order to integrate the research project to the firm objectives;
- the elaboration of hypotheses, that are based on a depth study of the issues, allows for the development of an initial action plan (goal accomplished) [17].

The second step of the cycle is to define the action plan: the researcher formulates hypotheses and develops, with the collaboration of the change project's supervisors on site, different scientific methods and protocols.

The following step is the intervention phase, during which the action plan is put in place. Actions are measured, controlled and examined gradually through data collection. Afterwards, the effects of the actions are quantitatively and qualitatively analysed, with tools and indicators presented in the next section. This step, like the entire cycle is achieved collaboratively: each player contributes to the evolution of the process.

Lastly, the initial question is re-evaluated with the whole change project's actors and the results of the analysis are kept in mind in order to draft the subject of the research. The subsequent cycle will, therefore, begin on the basis of this new definition of the problem.

IV. SHARELAB'S METHODOLOGICAL TOOLS

In order to have a complete understanding of BIM implementation on the business level, one must begin by describing the actual situation. This description must reflect a vision shared by each of the participants. This new approach that we are proposing by means of ShareLab plays a role in change management and helps brings about transformation at the centre of the organization. This is achieved through a common understanding of the problem's main issues and goals. As a process for change, our hypothesis is more effective and less disruptive if each player is aware of the stakes and the issues at hand, and when they each contribute to the definition of the project's objectives. Furthermore, this method involves groundworkers in the research process. Their involvement allows for the consolidation of a shared business consciousness, which facilitates the creation of a common vision. This, in turn, moves the change process toward the desired craftsmanship.

The first stage of analysis of BIM integration is observation by means of an analysis chart, based on the Penn State University study, defined and readjusted according to the circumstances as presented in the next paragraph. This phase serves to define BIM's operational capacity in the selected fields of study.

Researchers use observations, partially guided interviews, self-confrontation and other participatory practices, within agencies and design offices, to map out the various situations and attitudes that can help businesses better define their processes and expertise. These maps represent a common point of reference for all the players involved in the design process. These results are then used to define and implement an action plan (corporate governance). This plan is key in guiding the integration process toward the realization of the efficiency goals defined in the previous stage.

An interactive heuristic chart will then provide users with a tool that is adaptable and suitable to reflection. Inspired by *design thinking*, this method provides support to the conception phase of the process. Its objective is to stimulate cognitive processes of design in order to re-examine work methods, practices and strategies [18].

A. Maturity Chart

The maturity chart developed by our team was inspired by the American Penn State University study [7]. As mentioned in the state of the art, this study participates in the production of reference documents in the United States. The purpose of these documents is to help contracting authorities implement BIM in the management of their projects. Here, we have adapted this tool to the process of design. The chart that we use in our study has the following six main categories: (1) strategy, (2) the uses of BIM, (3) processes, (4) information, (5) infrastructure, (6) operational. These categories are divided into subcategories, ranging from 0 to 5, that detail their level of maturity. Fig. 2 is an example of our "Infrastructure" chart.

Researchers can take a variety of situations into consideration in order to fill in the analysis chart. The Penn

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State University Study [7] suggests that researchers must examine two conditions to complete this maturity matrix:

- the maturity of the BIM in the business at the moment of the study.
- the maturity desired by the business.

In order to apply this tool on site, we propose that researchers make a distinction between the "perceived" and the "real" situation so to define the current level of maturity (Fig. 3).

TABLE II. AN EXAMPLE OF THE ELABORATED SUBCATEGORIES OF THE "INFRASTRUCTURE" CATEGORY.

Infrastructure	Level of maturity					
	0 Non-existent	**1 Initial**	**2 Defined**	**3 Managed / Shared**	**4 Formalized**	**5 Optimized**
Software The programs and IT architecture used in BIM implementation	No BIM compatible software	Object-oriented software (BIM software)	BIM software database	Advanced software systems compatible with BIM	The use of software systems compatible with other participants	A program created to evolve with the BIM software market
Hardware The technical equipment and information used in BIM implementation	Inadequate hardware	Some hardware that ensures the use of BIM software	All hardware is BIM software compatible	Some hardware can support advanced BIM software systems	All hardware can support the use of advanced BIM software systems	The program is developed to ensure that the hardware adapts to changes in market requirements.
Software and Hardware Management The management of the transition between old and new infrastructure	No BIM infrastructure	The business has initiated a BIM infrastructure through various pilot projects without changing its former infrastructure	The business has defined a hybrid infrastructure between the old and the new	The business applies the new infrastructure in certain departments / satellite offices	The business applies the new infrastructure to each of its departments / satellite offices	The business develops its own API* in order to work with its external partners

Example of modification from Penn State University matrix

* An API (Application Programming Interface) is a programming interface that grants access to a selected piece of program data.

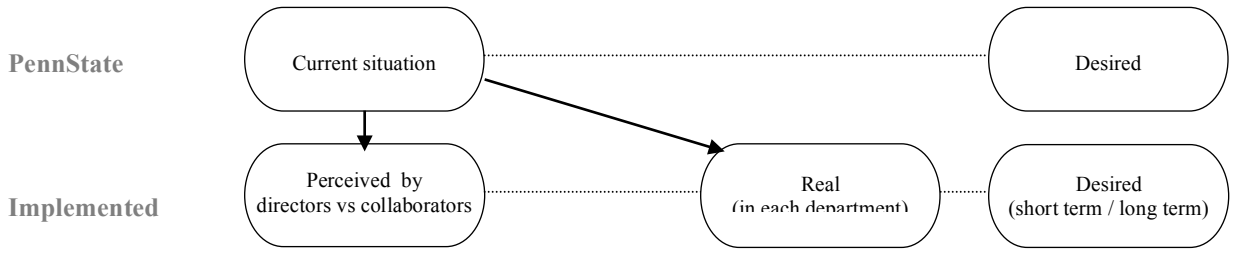


Figure 2. Taking different situations, specified by actors, into consideration for charting BIM maturity levels.

B. Self-confrontation

Our research team applied this analysis chart to pluridisciplinary and multi-site design agencies and construction firms. We adapted this method to define the level of BIM implementation in various agencies based on the perceptions of employees and upper management. In order to collect this data, we combined self-confrontation techniques with partially directed interviews and observations on site. Self-confrontation is vital to our approach, as it uses collaborative action, to characterize and chart the flow of data and work in the project. Self-confrontation is composed of the following six steps:

- use introductory questions to appeal to short-term memory. The researcher asks the participant general questions about the project on which the participant has worked by way of BIM. The researcher encourages the participant to speak about concrete project components (the schedule, teams affected, libraries consulted, the tools used, his or her role, his or her use of BIM in the project, the level of detail that he or she managed etc.). The answers to these questions can either serve as new examples for the maturity chart, or they can help the researcher to better conduct the remainder of the interview and formalize the process;
- begin to work on the groundwork for the layout of the project (supported by a legend created by the researcher). The researcher asks participants to sequentially draw the main phases of the process and to list, in the order of importance, the various players involved. Only the participant draws in this step. The researcher is permitted to accompany the participant in parallel;
- detail each phase by describing the main actions that were taken in the process. It is important to explicitly highlight the start and finish of each phase, as well as the main decisions that were taken;
- review and supplement the actions in each stage (by way of a tracing paper placed on the outline of the actions that have been successfully carried out). In an effort to verify the interoperability between various documents/ models used/ produced, specify the input documents/ models, the software used and the output of each player and describe the transition from one document or model to another;
- detect the problem areas and provide a description for them (by placing another piece of tracing paper placed on top of the former). This is done in an effort to understand their source, to glean expertise and feedback regarding participants' experience and to potentially optimize the process;
- define and standardize the different workflows that were discussed during the sum of the interviews. After a couple of days, ask the participants to evaluate them.

This approach removes the researcher from his or her traditional role in data collection, treatment and analysis. In the traditional model the creator relies completely on the researcher's interpretation of the information collected, observed, treated and analyzed. In compliance to the principles of collaborative action research, through our approach, the creator is also one of the actors and she or he contributes to the creation of his or her own workflow. This type of research method not only fosters a shared understanding of the role of each player in the design process, but it also helps chart the different steps. The charting of these stages helps standardize, manage and optimize them.

C. The heuristic card

Our team used an interactive heuristic card to focus the discussion on the skills that were developed at the heart of an agency in relation to BIM. This was done in an effort to highlight internal expertise, as well as the difficulties and disappointments encountered during the implementation of BIM. This card has a two input approach: (1) the expertise applied to support the implementation of BIM in the business, (2) the skills devoted to the creation of a design project. For each of the aforementioned inputs, researchers suggest and define various fields of action on the heuristic card. This is done in an effort to encourage contemplation on the part of the participants with regard to their own practices. Fig. 4 illustrates an example of the proposed field, with the definitions of the terms used.

The application of a heuristic card is characterized by a two-step process:

- understanding the proposed sites and questioning the way in which actions are implemented in the agency - do they use a BIM, classic or hybrid method;
- concretely describe the practices used, by answering the questions: "why?", "with what?", "with whom?".

V. SHARELAB AT THE SERVICE OF IMPLEMENTATION

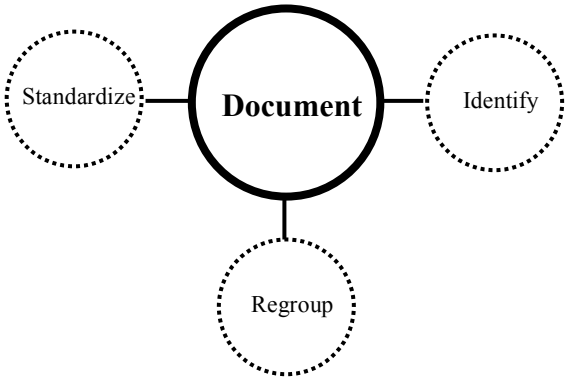
A. On site use: building a context for exchange

The Sharelab, based on collaboration and interaction, requires confrontation between the results of actions and the participants (Fig. 1), so the practical use of this approach on site requires a minimum of two cycles. The first allows for exchange, the creation of a collective consciousness and a shared understanding of the context and the issues at hand. This first cycle permits participants to work together to create a shared vision of the realities on site.

A second interventionary cycle is then necessary to construct a common goal. The synchronisation of the various players with regards to the present context serves as support for the definition of the project's aim and of the steps required to be taken in order to solve the problem at hand.

1) The involvement of different partners

The choice of ShareLab partners and players is a question in its own right. The same issue can be broached in each level of the organization through the participation of players with differing views and roles. With regards to the types of questions asked and the subjects discussed, the presence of members from the upper echelons of the company can greatly influence the direction of the conversation.



Document: use a physical or numerical way of expression that is both transferable and shareable, in order to express a decision or a piece information.

Standardize	create a single model to represent information related to different entities (the same object database for different projects, a framework for process mapping …).
Identify	indicate the nature, the category and the characteristics of a decision or a piece of information.
Regroup	assemble the information that has been produced separately in order to optimize and facilitate their access.

Figure 3. An example of the field of reflection of a heuristic card.

Figure 4. Photos showing the situations for the application of ShareLab.

In the goal of promoting collective awareness of the realities on site and of elaborating a goal for the future, the presence of these actors is fundamental. Therefore, the various players can participate in the research process at any one of the many steps of the cycle with the knowledge that it is the researcher who secures the transmission of information and assures participants' anonymity.

In the context of pluridisciplinary professionals, the involvement of participants from various backgrounds in the research process creates an environment that is ripe for exchange. The interaction of different types of industry professionals from various sectors fosters in depth discussions regarding the realities on site. Moreover, it promotes cooperation of services that often work toward the same goal through different approaches and/ or project timelines (Fig. 5).

2) Restitution as a foundation for research

The systematic planning of a minimum of two phases of intervention allows for feedback, in the second meeting with the participants, regarding the analysis made during the first meeting. The restitution step is one of the "methodological commitments" that frames players in the interactive research process [19]. Restitution allows ShareLab participants to confirm the analysis that the researcher proposed at the beginning of the intervention. This validation is key in preparing results and in ensuring conformity in the data that ShareLab participants provided. While the second cycle presents an interesting opportunity for return, each ShareLab should have a restitution phase so to corroborate the researcher's analysis and to respect his or her commitments.

Furthermore, restitution is in and of itself an object of analysis for the researcher. Not only do participant responses contribute to adjusting the intentions of the study, but they also bolster them. In fact, participants see restitution as a possibility to give feedback on the entire situation, and this new perspective can bring about many different types of reactions among the participants. As Beaujolin-Bellet note [19], the observation and the collection of this return is highly useful in the development of a plan for the comprehension of the subject, and it can also challenge to the initial version of the researcher's analysis.

If restitution is fundamental in the course of action-research in preparing and reinforcing data analysis, it is all the more necessary at the end of the process to bring a close to the intervention. Restitution at the end of the research protects the researcher from the "temptation of a hasty conclusion" [20] and it ensures the continuity of the work

performed during the research phase by encouraging professionals' ownership and autonomy.

3) Equip and organize the context for exchange

In order to respect professional time constraints and in the spirit of efficiency in the discussion of key issues, moments of sharing and discussion are moderated by the researcher. The research team prepares the proposed ShareLab methods beforehand, and the individual researcher allots the time that he or she deems necessary for the completion of each step. The researcher is, therefore, the master of his or her own time during the intervention phase.

During the discussions, the researcher's goal is to guide the topics of conversation with a dual objective in mind: 1) to collect sufficiently elaborated data for analysis and validation and 2) to compile varying points of view in order to highlight controversial, as well as agreed upon topics. To properly execute this mission, the researcher must relaunch certain topics during the discussion. There are two ways to relaunch a discussion in order to comply to both of the aforementioned goals: 1) ask for precisions with regard to a specific subject that is discussed by one of the participants. Questions such as "why?", "with whom?", "with what?" allow the researcher to better define the comments' intention. 2) Go back to the remark of one of participants and ask the other participants to comment on them.

4) Participant Feedback at the end of each ShareLab

Participant feedback with regard to ShareLab is an important step in the process. The assessment of the participants allows the researcher to discern their opinion and understanding of the methodological tools that the researcher used (such as the maturity chart or the heuristic card that was presented in paragraph IV). It also helps the researcher understand the participants' opinion on the relevance of the intervention of an external researcher in internal business issues. In fact, in the interest of the business, ShareLab's goal is to help professionals in change management and in periods of transition, where traditional work practices and methods are put into question. In this context it is essential to evaluate the impact of the use of ShareLab during the course of the research in order to glean answers to the issues facing BIM implementation.

This evaluation helps justify (or not) the need for and the intervention of a research team on site. The reciprocal interest of the research team and the group of professionals is a motivating factor for participants, and it can positively influence their involvement and dialogue.

B. The possibilities and difficulties of ShareLab: the position and the involvement of the researcher

The participation of different players in the ShareLab project allows for the creation of an environment of exchange. The participants are accompanied by the researcher through the evaluation of the level of maturity of BIM in the company or through the use of interactive heuristic cards. These moments of communication create the ideal environment for the collection of data that is related to participants' experiences and daily practices. The spontaneous sharing of this information and its subsequent analysis promotes the creation of a common consciousness to support the process of change.

A multi-participant dialogue about an issue that puts into question customary work practices will inevitably generate heated debates [19], where a social or sensitive issue may come into play. It is imperative that the researcher clearly defines his or her role so to avoid any confusion on the part of the participants regarding his or her opinion on the subject matter. The researcher's adoption of a non-judgemental approach and his or her assurance of participant anonymity is vital to encouraging participants to speak freely without feeling evaluated and without the fear of negative repercussions outside the ShareLab. Furthermore, by attentively listening to each participant, researchers are able to maintain their neutrality and to guide participants in their thought process in order to help them find the words to describe their frustrations.

In the spirit of encouraging participants to define their objectives and to elaborate on different solutions, the expression of individual frustrations and points of contention can prove helpful in the development and the conception of vectors of change.

C. Participant feedback: what are the next steps in ShareLab?

Participant feedback regarding ShareLab use gives researchers the opportunity to collect data regarding participants' perception of ShareLab's contribution to the implementation of BIM in the business.

The initial ShareLabs examine the issue at large. This is done by way of a maturity matrix at the agency level or through heuristic cards at the project level. This allows the researchers to define the primary factors for crisis and the areas for development. With the goal of proposing more and more concrete solutions for the problem, once the initial phase is complete, ShareLabs can target more specific problems and focus on specific questions, such as the integration of BIM on the building site, the creation of an agency specific BIM chart or even the elaboration of a BIM offer suggested to a contracting authority.

VI. CONCLUSION: SUMMARY, CONTRIBUTIONS AND LIMITATIONS

The implementation of ShareLabs through collaborative action research is a new way of finding solutions to the issues that construction companies face in their application of BIM technology. Contrary to a technocratic view regarding the implementation of BIM tools and practices, the ShareLab approach takes into consideration societal and individual stakes with regard to change. Actual studies led on site gave significant results. Following our intervention in a large company of engineering and architecture, the firm developed different actions to structure the change to BIM with its collaborators: working groups to solve specific questions, a BIM day to share the progress with the whole team.

The immersion of the researcher in the professional environment can give rise to concern regarding his or her

position on the topic and his or her relationship with the various players. By remaining neutral and objective throughout the entire process, the researcher promotes an environment of exchange among all players on site.

Businesses may consider the time that participants dedicate to ShareLabs as unproductive. Moreover, the professional environment makes it difficult for all staff to participate in such research. These factors oblige researchers to use test groups that may not be entirely representative of all levels of the organization. Moreover, involvement and motivation of actors on site are essential and these parameters still have to be included in the structure of the ShareLab method. That being said, if BIM methods and technologies are to succeed in improving the efficiency of the organization of a construction project, businesses must optimise the time it takes to synchronize and coordinate the implementation of BIM. This way, businesses are able to reduce the time it takes between making a decision and its execution. This optimization of the time needed to synchronise between stakeholders requires a discussion and exchange phase in order to build a common understanding of the stakes within companies and agencies.

The actual perspectives relate to the relation between the building designer, the contracting authority and the builder. That why our research will go on larger intervention, involving more actors with different function at the scale of the construction project.

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