# Collaborative platform in clashes resolution process: Study of the added value for BIM coordination.

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Abstract
BIM coordination is a process where three temporalities take place (Mehrbod & al. 2019): before, during and after the coordination meeting and where different practices are carried out, like ''Clashes detection '','' Model visualization and review '' and '' Collaboration management'' (Forgues & al. 2018). This work questions the added value of using a collaborative platform in BIM coordination. An experimental framework was set up within the Collaborative Digital Studio BIM project at the University of Liège (Rahhal & al. 2020a). Observations over two consecutive years permit a comparison between a situation with and without a collaborative platform. Many results led to the conclusion that the use of a collaborative platform facilitates the tasks of the coordinators, the understanding and locations of clashes, as well as collaboration between the project actors. However, this comes at the cost of extra work to reach a well-defined organization of the project team.

Keywords: BIM coordination, Digital model, Clash detection, Collaborative platform

## 1 Introduction

It is widely recognized that beyond the technological challenge, Building Information Management (BIM) represents new ways of coordinating architectural, engineering and construction skateholders (Kubicki & al. 2019). The main challenges of BIM coordination concern communication, monitoring of clash resolution as well as the difficulty of characterizing and documenting them (Mehrbod & al. 2019). This work is focused on the clashes resolution process, that is articulated in three time frames: before, during and after BIM coordination meetings. Nowadays, many collaborative platforms have emerged in the construction market, in order to support this BIM coordination activity. Thus, in an experimental context, we question the use of a collaborative platform to assess whether it improves the clashes resolution process within the framework of BIM coordination.

## 2 BIM coordination

### 2.1 Definition

BIM coordination is a way to link design and construction activities through digital 3D models (Korman & al. 2003). It enables 3D clash detection coordination that is only achieved when the design reaches a certain maturity. At this stage, a simple visual check is no longer enough to find

the errors between the business models (Kubicki & al. 2019). 3D coordination, more specifically is “a process in which interference detection software is used to determine clashes, by comparing the 3D models of each discipline with each other. The main goal is to eliminate major clashes before and during the execution of the works (Messner & al. 2010). BIM coordination makes it possible to automate the clash detection step (quantification and filtering of the results), to better identify clashes in digital models and therefore to focus more on the correction steps (Forgues & al. 2018 ).

## 2.2 Temporality of the clash resolution process

Coordination requires the establishment of jointly established rules, setting out the roles and responsibilities of each actor in the project, the information and necessary modeling levels, called LODs for "Level of Development" (Sacks 2018). The coordinator also sets the places and times for coordination as well as the working methodologies to resolve clashes and collaborate (Tahranii & al. 2015). All of these rules are recorded in the BIM Protocol, as the contractual document defining all the procedures within the framework of a BIM project, including that of coordination. According to Mehrbod & al. 2019, the coordination process is a cycle of three interconnected stages, as shown in Figure 1. These stages are explained in Listing1.

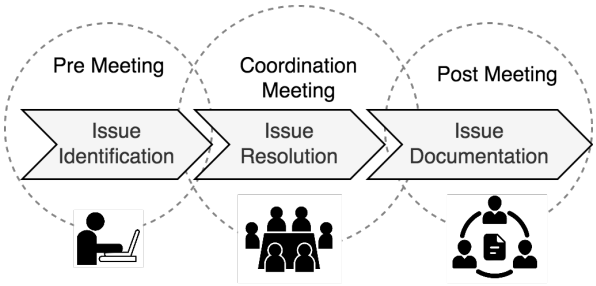


**Figure 1.** Coordination process, adapted from **Mehrbod & al, 2019.**

**Listing 1.** Explanation of the stages of the coordination process, adapted form

1 **Identification of clashes**, before the meeting: The BIM coordinator receives the project requirements and the design specifications then integrates the models produced by each discipline into a clash detection software. Then, he examines the clashes detected automatically, identifies the real problems and prepares the meeting.

2 **Clash resolution**, during the meeting: Project stakeholders come together to discuss problems and develop solutions. To this end, the BIM coordinator presents the clashes and exchanges with the project team in order to find solutions. Various media can be used (Rahhal & al. 2020b).

3 **Documentation of clashes**, after the meeting: When the discussions with the project stakeholders are completed, the BIM coordinator informs them of the management necessary for the resolution of clashes, as discussed during the coordination meeting, such as the choice of the chosen solution. He is in charge of monitoring, validating and closing clashes.

## 2.3 Obstacles to clash resolution

The first obstacle to conflict resolution is a poor characterization of coordination issues, such as clashes that are not sufficiently documented before, during and after coordination meetings. This makes it difficult for those concerned to understand the relationship between the clash and its extended context and then return to these questions afterwards (Mehrbod & al. 2019). The strong mobilization of resources and time to analyze and sort out clashes in order to exclude 'false clashes' before the meetings (Tahranii & al. 2015), the intense nature of the meetings and the lack of time are the main reasons (Tommelein & Gholami 2012). The second obstacle concerns the poor monitoring of clash resolution leading to significant loss of time and misunderstandings. The third obstacle concerns the lack of information on the clash which leads to a poor understanding of the problem. When coordination meetings are poorly documented, there is a direct impact on problem identification (Mehrbod & al. 2019 and Wang & Leite 2012). The last obstacle is the lack or ineffectiveness of communication between stakeholders, in particular when taking into account each other's constraints (Mehrbod & al. 2019).

# 3 Methods

## 3.1 Research question & hypothesis

Supposed to provide a response to the main challenges identified above (Tahrani & al. 2015), it would be interesting to assess the impact of a collaborative platform and its added value in the clash resolution process. The first studied aspect deals with the working methods of BIM coordinators. As a reminder, they are in charge of the tasks of clash detection and analysis, preparation and facilitation of the coordination meeting, as well as monitoring of clash resolution by all stakeholders. ***Q1: Does the use of a collaborative platform facilitate the tasks of the coordinators before, during and after the coordination meeting?***

The second aspect, for its part, involves employees' understanding of clashes and their location; on the one hand during the meeting coordinator's presentation and on the other hand after this coordination meeting when the modeler implements the previously decided modifications. ***Q2: Does the use of a collaborative platform facilitate the understanding of a clash and its location during and after the coordination meeting?***

The third aspect, finally, concerns the collaboration between the actors of the project in order to resolve clashes. This collaboration takes place initially in a meeting, during discussions following the coordinator's presentation, in order to decide on the changes to be made. ***Q3: Does the use of a collaborative platform facilitate collaboration between project actors during and after the coordination meeting?***

## 3.2 Experimental context

Observations in an experimental context were carried out to answer the questions above. The modalities of the experiment, as well as the data collection and processing methods will be detailed in the following sections. This experimental framework is part of the "Collaborative Digital BIM Studio" (SDC BIM) provided to students of Master 1 Civil Engineer Architect of the University of Liège. This exercise was observed over two consecutive years in order to be able to provide a collaborative platform. It's about making a comparison and being able to rule on the impact of a collaborative platform on the resolution process. This exercise lasts over 4 months and it explores several facets of BIM and involves several steps (Rahhal & al. 2020a).

### 3.2.1 Project choice

Two projects similar in terms of size and overall architectural and technical complexity, are chosen for the experiment. Each of them are designed by civil engineers in Masters 1 from previous years as part of the "Architecture Workshop IV - Integrated Project", of University of Liege, in Belgium, is used for the SDC BIM. This project is then technically detailed and pre-dimensioned by Master 1 construction engineers from IMT Mines Alès, in France, as part of the "Building Project" course. Thus, when SDC BIM participants pick up the project, it is already at an advanced design stage. When starting their work, participants receive all the information useful for architectural and technical understanding of the project. In 2019, 17 students worked in 2 groups of 9 and 8 people. The selected project was entitled “Maison de la Musique”. It was an ensemble dedicated to contemporary music. In 2020, 18 students divided into 2 groups of 9 people, worked on the project entitled "La Villa Massilia". It is a museum on Roman antiquity, located in Marseille.

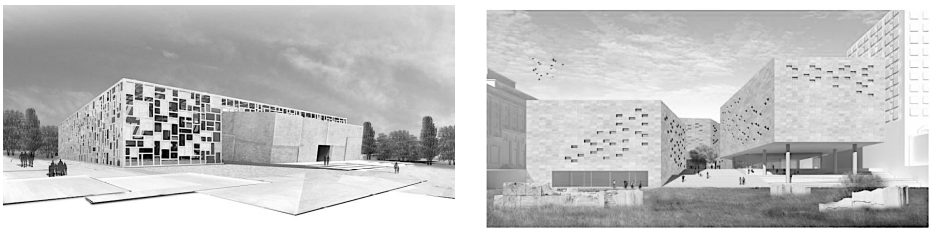

**Figure 2.** On the left, 3D perspective of the “Maison de la Musique” project, on the right, 3D perspective of the “Villa Massilia” project.

### 3.2.2 BIM coordination tools

No clash detection tool was imposed on participants. On the contrary, the participants were trained on several tools (Navisworks, Solibri Model Checker or Tekla BIMSight, Trimble Connect, etc.) and they were able to choose the tool that best suited them in terms of use. However, it was requested that these tools make it possible to carry out the following 3 activities: the detection, visualization and verification of clashes as well as the management of collaboration as defined by Forgues & al. 2018. On the other hand, we have adapted definitions of geometric and non-geometric clashes (Akinci & al. 2000) for the research experimental context: 1- **Hard Clash**: geometric spatial collisions of two unique components. Two building elements occupy the same space (Eastman & al. 2011), 2 - **Design error**: 3 types of errors, errors involving illogical design, between batches without consultation, design conflicts of multiple systems and incorrect design details, 3 - **Modeling error**: 2 types of error, missing information from the modeled object, following an oversight or an encoding error or an omission in the modeling of a component., 4 - **Request**s: Requests include all queries and questions relating to design or coordination, exchanged between stakeholders.

Several collaborative platforms were compared by the participants in order to choose the most suitable for the SDC BIM modalities. Several criteria justify the choice of BIM Track, such as the possibility of importing the BCF format, the existence of plug-ins that allow information to be synchronized (clashes, notes, comments, etc.) between the platform, the modeling software and clash detection software, as well as the possibility of managing and viewing clashes positioned in the model, through an IFC viewer of the project integrated into the platform. The provision of this platform to participants in an experimental framework was facilitated by the availability of a free version. Finally, this platform presented several useful features for coordinators, such as the creation of questions, their documentation: location, comments, view, due date, assignment to a collaborator, and their sorting by attribute; zone, floor, author, disciplines concerned, status, etc.

## 3.3 Data collection protocols

Figure 3 illustrates all of the data collection protocols set up for each of the 3 phases of the coordination process and they are detailed in the following sections.

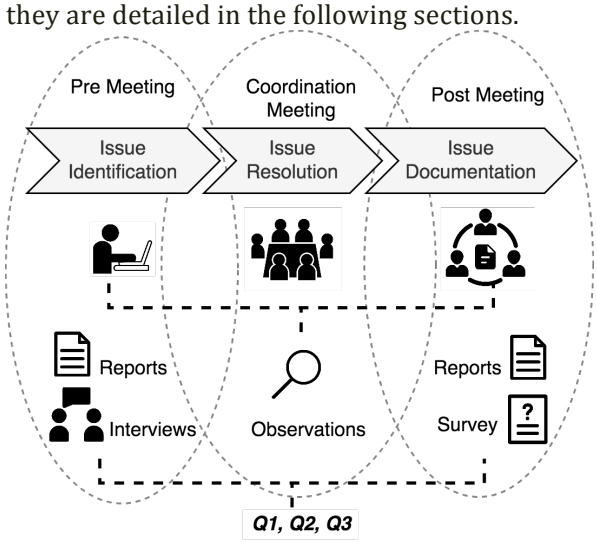


**Figure 3.** Methodology of the collected data

### 3.3.1 Before the coordination meeting - Pre Meeting

In order to answer sub-question Q1 (as previously defined in section 3.1), dealing with the methods implemented by the BIM coordinators, two data acquisition modes were chosen. All this information was recorded in written coordination reports. For 2020, the coordination report was supplemented by a semi-structured interview with 2 coordinators in order to complete missing informations of group 1. Table 1 explains the four components of the report.

**Table 1.** Content of the coordination report.

| 4 parts | Description of each part |
|---|---|
| **Detection** | Its purpose is to know the methods of clash detection (information sought, software used, procedures implemented). |
| **Processing** | It concerns the processing of the results provided by the clash detection software (manipulation, visualization, understanding and sorting). |
| **Communication** | It concerns the communicated results in order to prepare the coordination meeting. It includes the documentation and description of information relating to clashes, the reports generated and the synchronization via BIM Track. |
| **Management** | It concerns clashes management by monitoring of their resolution by the rest of the team, for example on the BIM track platform. |

### 3.3.2 During the coordination meeting

In order to answer the sub-questions Q2 and Q3 (as previously defined in section 3.1), we decided to compare the meetings in the 2 situations, with and without a collaborative platform. In total, 13 coordination meetings were filmed, recorded, viewed and encoded in an observation grid, by using Microsoft Excel. The meetings last on average 1 hour. The observation grid has three section explained in Table 2.

**Table 2.** Content of the observation grid.

| 3 sections | Description of categories encoded by section |
|---|---|
| **General** | It contains the video identification data and clash temporal data. It represents the time spent on each clash on the viewed videos. |
| **Presentation** | A description of the clash, the tools serving as visual aids and presentation support (Reports, Navisworks, Solibri Model Checker, etc.) and the used artefacts (drawings, 2D plans, navigation in the BIM model, etc.). |
| **Discussion** | The discussion includes: the time allotted for each clash to be determined and the assessment of the understanding of the clash using a gradual scale, for example, 'Immediate' understanding means that there were no requests for clarification. It includes also the assessment of the participants' ability to find a common solution to the clash and to assign it to a collaborator. A gradual scale is also used, for example, 'Immediate' means no debates and direct approval of the solution. |

### 3.3.3 After the coordination meeting - Post Meeting

In 2019, the collection of post-meeting uses and methods of coordinators to ensure the follow-up of clashes was carried out thanks to the coordination reports drawn up by the participants. For the rest of the data, a questionnaire (GoogleForm) was distributed to participants in 2020 in order to know their post-meeting uses, including that of the BIM Track platform. To be able to answer the sub-questions Q1, Q2 and Q3 (as previously defined in section 3.1), the survey was built in 5 sections, described in Table 3.

**Table 3.** Content of the survey

| 5 sections | Description of each section |
|---|---|
| **Location of clashs** | This section asks about the means that modelers use to find a clash (BIM Track, meeting or clash report). In the case of using the platform, the frequency of use of functions like a "saved view" in a '' Question '', the '' Viewer '' and the synchronization of the '' Questions '' with the modeling tool. This section also includes a judgment on finding easily the location of a clash with the platform. |
| **Understanding of clashs** | Identical to the first part but it concerns the understanding of a clash after the meeting. |
| **Management of clashs by statuts** | This section questions the management of clashes by seeking to know the frequency of updating of the "statuts" of resolved clashes. |

| | |
|---|---|
| **Use of the platform** | This section questions the frequency of use of the platform and the features for adding comments or an image and email notification to collaborate and communicate after the meeting. It also asks participants to indicate the other means of communication (phone call, email, instant messaging) used. |
| **Platform capacity assessment** | This component allows participants to judge several statements dealing with the platform's capacities (context of clashes, collaborating outside a meeting or managing the resolution process). This last section also questions the influence and the constraints entailed by the use of a collaborative platform. |

# 4 Findings

## 4.1 Pre meeting collected data

The information collected was classified according to 3 sections dealing respectively with: 1-clash detection, 2-communication of these results and 3-clash management. The *Industry Foundation Classes* (IFC) format is used by all groups, for models that are used in clashes detection. A summary of the results is presented in these tables.

**Table 4.** Summary about the clashes detection procedure.

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| **Models format** | IFC | IFC | IFC | IFC & Revit |
| **Location of the models** | BIMPlus<br>Google Drive | Google Drive | Google Drive<br>BIM Track | Google Drive<br>BIM Track |
| **Used Software** | Solibri<br>Checker | Tekla BIMSIght<br>Solibri Checker | Navisworks<br>Trimble Connect | Navisworks |
| **Clashes Updates** | IFC Models | IFC Models | / | IFC Models + BIM Track |

**Table 5.** Communication of the clashes results

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| **Used tools** | Views/BCF note<br>Presentation | Views/BCF note<br>Presentation | Views/BCF note<br>Presentation | Views/BCF note<br>Presentation |
| **Shared information** | Title/Discipline<br>Description | Title/Discipline<br>Zone/ Floor level<br>Description | Title/Discipline<br>Zone/ Floor level | Title/Discipline<br>Attribution<br>Description |
| **Information support** | PDF Report<br>+ Excel Report | BCF file<br>+ Excel Report | BIM Track<br>syncrhonisation | PDF Report<br>+ BIM Track<br>syncrhonisation |

**Table 6.** Clashes management by coordinators

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| **Monitoring the clashes resolution of the team** | Dissemination of a meeting report<br>+ Coordinators trust in their team<br>+ Additional clashes resolution meetings | Dissemination of a meeting report<br>+ Coordinators trust in their team | Coordinators trust in their team<br>+ Late use of the update conflict status option on BIM Track platform | Updating the clashes status on BIM Track platform from "Open" to "Resolved"<br>+ Archiving resolved clashes |

## 4.2 Coordination Meeting collected data

The collected data were classified according to the observations grid sections, in the tables below. The results of the four teams are compared and analysed in section 4.4.

**Table 7.** Number of clashes and cumulative duration of their resolution in coordination meeting

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| **Number of clashs** | 46 | 154 | 50 | 39 |

| | | | | |
|---|---|---|---|---|
| **Cumulative duration for clashs resolution** | 01 :01 :01 | 02 :38 :05 | 01 :02 :53 | 00 :38 :37 |
| **Average time by clash** | 00:01:20 | 00:01:02 | 00:01:15 | 00:00:59 |
| **% of time spent for presentating a clash** | 50,71% | 60,08% | 59,76% | 69,3% |
| **% of time spent discussing a clash** | 49,29% | 39,92% | 40,24% | 30,7% |

**Table 8.** Presentation of clashes in coordination meeting

| | **Group 1** | **Group 2** | **Group 3** | **Group 4** |
|---|---|---|---|---|
| **Support for the presentation** | TeklaBIMSight<br>Solibri Model Checker | TeklaBIMSight<br>Solibri Model Checker | Navisworks<br>Trimble Connect<br>BIM Track | BIM Track |
| **Information shared about conflict, with a sharing frequency > 50%** | Discipline/Type<br>Description | Title/Discipline<br>Floor/Zone<br>Type/Description<br>Proposed Solution | Title/Discipline<br>Floor/ Zone<br>Type/Description<br>Proposed Solution | Title/Type<br>Discipline<br>Proposed Solution |
| **Artefacts used as support, with a frequency of use > 50%** | Navigation in BIM Model<br>Saved views<br>Notes/Color<br>Transparency | Navigation in BIM Model<br>3D Section<br>Saved views<br>Notes/Color<br>Transparency | Navigation in BIM Model<br>Saved views<br>Notes/Color<br>Transparency | Saved views<br>Notes/Color<br>Transparency |

**Table 9.** Pourcentage of immediate understanting of clashes

| | **Group 1** | **Group 2** | **Group 3** | **Group 4** |
|---|---|---|---|---|
| **On the location** | 72% | 73% | 70% | **87%** |
| **On the concerned disciplines** | 91% | 95% | 96% | **100%** |
| **On the problem** | 57% | 76% | 76% | **87%** |

**Table 10.** Pourcentage of clash resolution with an immediate agreement on a solution and its assignment

| | **Group 1** | **Group 2** | **Group 3** | **Group 4** |
|---|---|---|---|---|
| **Agreement on a solution** | 41% | 47% | 40% | **54%** |
| **Assignement of the resolution** | 76% | 85% | 84% | 82% |

Finally, 87% of the participants surveyed were “agree” or “fully agree” that using BIM Track saves time during the coordination meeting. On the other hand, a majority (93%) of project stakeholders recognize that the use of a collaborative platform created additional constraints.

### 4.3 Post Meeting collected data

The following tables summarize a part of the data collected by the survery and the coordination reports. The results show that participants made limited use of the platform to communicate with each other: 67% of them "never" use it or "rarely" use it, those who used it added comments (33%) or images (20%) after the meeting to communicate. Morever, 94% of those surveyed were “agree” or “fully agree” that using BIM Track saves time after the coordination meeting for finding and understanding a clash.

**Table 11.** Frequency of use of the platform to find, understand the clashes after meeting

| | **Platform BIM Track** | **Report of the meeting** | **Clashes Reports** | **Other meeting notes** |
|---|---|---|---|---|
| **Finding the clash location** | 93% | 33% | 0% | 7% |
| **Understanding of a clash** | 80% | 85% | 84% | 82% |

## 4.4 Analysis and discussion

### 4.4.1 Added value of a collaborative platform for coordinators' tasks

The use of a collaborative platform changes the pre-meeting coordination tasks, with the neccesity of double filing of digital models. It was observed during the exercise that the actors of the project deposited their models on BIM Track, so that the Questions could appear in the'' Viewer", as well as on a Google Drive in order to group their shared documents. These extra publication steps resulted for the participants in a heavier workload as well as a risk of human mistake. Another change the collaborative platform seem to have induce, is in pre-meeting coordination practices and concerns clashes communication. The export of clashes reports from clashes detection software has become obsolete, instead clashes are automatically synchronized to the platform. However, encoding the right information and communicating it on the platform requires rigor and represents an additional workload for BIM coordinators.

During coordination meetings, the group that presented on BIM Track was the one that spent the least time by clash (see table 7). Yet it was one of the groups that shared the least information orally and only used 3D model navigation for complex cases (see table 8). In addition, in a coordination meeting when the clashes are grouped together and available on the platform, the coordinator only presents a few clashes in detail. Knowing that team can find clashes as well as additional information later and thus they question the coordinator less.

Finally, the use of a collaborative platform facilitates the post-meeting tasks of BIM coordinators who are responsible for clash management. With clash synchronization, project stakeholders can work and interact directly from the platform. Thanks to the update of the clash status, the team implicitly inform about the correct implementation of the solutions. This allows the coordinators to manage the resolution process and have a vision of the problems that remain to be resolved. This tool therefore provides an answer to the usually poor monitoring of clash resolution which had been stated as one of the brakes of BIM coordination (Mehrbod & al. 2019). The automated synchronization of the clash status between both the platform and the detection files ensure their consistency and facilitate their monitoring. By doing so it simplifies future detection tasks by conversely keeping "closed" solved clashes.

This first discussion has shown that the use of collaborative platform to share models and issues has added value for the clash resolution process. The synchronization of clashes from the through acollaborative platform allows coordinators to document clashes and share information with all stakeholders, with a real time monitoring of clash resolution.

### 4.4.2 Added value of a collaborative platform on understanding clashes and their locations

During coordination meetings, BIM coordinators use the interface of the detection software or that of the collaborative platform to expose clashes (table 8). During SDC BIM 2020, only one group presented their clashes directly on BIM Track. This is one of the groups that shares the least location information and does not use 3D navigation to show context except in complex cases. Yet this is the group with the best results when it comes to understanding clashes, their locations and the disciplines involved (table 9). If the tool seems to play on the visualization of clashes, another point was raised by the questionnaire. He showed that knowing that they can find their clashes later, the actors of the project question the coordinator less and approach meetings more calmly.

Regarding the feedback on clashes after the coordination meeting, the platform has become an essential tool replacing the PDF or Excel reports exported from detection software. With the platform, the actors of the project sort the results and can access the characteristics of the clashes (concerned disciplines, location, description, discipline having to make the modifications etc.). In order to view the clashes, they use the images saved with the clash or the "Viewer" to see the clashes in the model. The Revit plug-in for locating and accessing clash information directly in its own model is also used. The coordination meeting report remains a document used, in addition, by a majority of modelers in order to understand the clashes and the solutions to be implemented. It has the advantage of being a support to document decisions. This additional use is a response to the "insufficient documentation" penalizing BIM coordination (Mehrbod & al. 2019). Despite a perfectible Viewer on BIM Track, a majority of

users consider the platform as a time-saving and efficient tool for understanding clashes and their locations.

This second discussion, made it possible to affirm that a collaborative platform facilitates the understanding of clashes and their locations. This tool can be used as a presentation support in a coordination meeting but above all allows access to all the information a posteriori by all the actors of the project. They can therefore access clashes in digital models and access information from a web interface. This was raised by the participants to the experiment as the highlight of the platform, by enabling in the possibility to access the clash related information at any time.

#### 4.4.3 Added value of a collaborative platform on collaboration between project stakeholders

Without a platform available, the clashes detected are communicated via the reports exported from the detection software. These reports in PDF or Excel format included the list of clashes, the information describing them as well as a possible image to illustrate. However, these reports do not allow any interaction with digital models, which does not go in the direction of optimized BIM coordination or facilitated collaboration.

The coordination meeting report also serves as a working document recording the decisions to be implemented. Exchanges between actors to coordinate changes to resolve clashes are done by email, call or messages. To be able to fully use the collaboration features, the elements must be shareable and easily assimilated. This is why the BCF format was used. It allows easy communication of discovered clashes, their information and their locations. A group from SDC BIM 2019 shared their clashes in BCF format but they could only be opened on the detection software that created them. The collaborative platform solves this by centralizing the clashes synchronized in BCF format from the detection software. Thus, everyone can have access to clashes, to all their information and to view them in digital models from the platform's web interface. Synchronizing clashes therefore improves the transmission of information from the BIM coordinator to project stakeholders during and after coordination meetings. It is therefore possible to go back and forth between modeling tools, clash detection tools and clash management and communication tools.

During coordination meetings, the platform can be used to expose clashes but also as a visual aid during discussions aimed at resolving them. Thus, three moments of collaboration equipped by BIM Track were observed during a Group 4 meeting. In order to collectively decide on modifications to be made to the models, the navigation in the 3D model and the 3D sections were used. The platform also allowed participants to communicate and interact with clashes. They can do this by commenting on clashes, adding attachments or notifying people. While the questionnaire showed that these were interesting collaboration features, it was not the preferred mode of exchange by the project stakeholders. Faced with the lack of responsiveness in responses, instant messaging or direct contacts were preferred.

The third discussion shows that the use of a collaborative platform brings added value to the collaboration between actors. Synchronizing clashes via the BCF format allows you to view and interact with clashes. This tool completes the cycle of exchanges of OpenBIM formats: IFC and BCF, the sharing of information from the BIM coordinator to project stakeholders during and after coordination meetings is guaranteed. In addition, a collaborative platform can serve as a support during collective decision-making or to communicate. However, users have encountered difficulties finding clashes in the platform's visualization tool. In addition, regarding exchanges around clashes, a collaborative platform is not able to replace the conventional modes of communication such as telephone, email or instant messaging.

## 5 Conclusion

### 5.1 Limitations and concluding remarks

As a result of our study, the use of a collaborative platform improves the clash resolution process within the framework of BIM coordination. This added value, however, comes at the cost of great rigor on the part of all the project stakeholders and an important work of documentation of clashes by the BIM coordinators. The platform entails additional constraints.

These include the information encoding, sorting and documentaion time or the redundancy of certain manipulations between the detection software and the platform. This study remains limited to observations made in an experiment and context, capable of answering the research question. In addition, to carry out these observations, the BIM Track platform was chosen, still imperfect, thisplatform could also be improved.

### 5.2 Future Works

Through this work, it is mainly the technical and technological aspects of BIM coordination that have been observed, however, this process obviously requires a social approach, because the coordination meeting is notably the seat of many human interactions. Even if this experimental environment tends to come as close as possible to professional realities, it would be interesting to observe the use of a collaborative platform in companies with real constraints and challenges. It would also be beneficial to compare the results of this study with those resulting from alternatives situations, such as in contexts using : - other collaborative platforms (for example Revizto or BIMcollab), - other coordination environments (in professional context for example), or - other common data environment (supported by BIM servers like BIM360 for example).

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