The information exchange in the construction sector in the age of BIM: a multiple case study from Italy

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Abstract. In recent years, due to the request of public clients, Building Information Modelling (BIM) projects are more vastly deployed in construction sector. Furthermore, BIM seems to be the digital methodology with the potential of enhancing the productivity in the construction sector. However, due to the large number of actors involved in a project, the internal information flow of the same actors and the information flow among the stakeholders need to be refined. This article, therefore, by focusing on the Italian contractors’ perspective aims to examine the contractors’ internal information flow and the information exchange with the stakeholders. 13 interviews were conducted with several individuals in 3 Italian construction contractors. The informants were selected from different levels of the enterprises, spanning from the owners to the foremen. Combined with site visits, these interviews provide an insight of the contractors’ internal information flow and an overview of the information exchange among the contractors and their stakeholders.

The article highlights the current criticalities in the information exchange between the contractors and other actors of the projects. Furthermore, the study points out the opportunities of the digitalisation of the internal and external information flow that could improve the information exchange and the productivity in the Italian construction sector.

1. Introduction
Global competition, technological changes and advances in information technology are pushing organizations of different sectors to improve their processes to deliver high quality products in a short time. Correspondingly, the construction industry has been facing several changes related to technology and innovation in order to improve the productivity, that is on a significantly lower level than other industries [1]. However, this digitalization process is not easy since it requires investments in digital technology, in new equipment, in staff training and especially needs a radical change in the information exchange among the project stakeholders. One of the methodologies which could be well-matched for the optimization of information exchange is Building Information Modelling (BIM). The peculiarities of BIM concern the information management across the all construction process (design, construction, operations and maintenance, decommissioning). With the implementation of the European Directive 2014/24/EU, EU Member States may require in the coming years the use of specific electronic tools for public tenders. Consequently, the expected large-scale application of BIM will imply a strong change within the construction enterprises due to the EU Directive recommendations and to the rapid evolution of the market in this era of digital transformation.
By focusing on the perspective of the Italian contractors, this short paper wants to answer the following research questions.

RQ1: how the Italian contractors exchange the information internally?
RQ2: how the Italian contractors exchange the information with the stakeholders?
RQ3: how the digital innovation could modify the internal and external information flow of the Italian contractors?

The study is structured as follows: Section 2 presents the method used; Section 3 provides the results and the discussion; Section 4 presents the conclusions.

2. Method

Given the RQs defined in the previous section, the research approach of this study can be defined as an interpretative approach. The intention of the researchers was indeed to enter and observe the field without any action on it, opening further examination of the phenomenon observed. Therefore, exploratory case study was chosen as the most suitable research method. By means of exploratory case studies it is possible to observe actual practices, and to understand the nature of phenomena that are not completely known [2]. This methodology is indeed the most pertinent to explain and understand in-depth phenomena within a real-life context on which the researcher has little control [3]. The decision taken for the study was to perform a multiple case study that represents a critical case in testing the research question, since this research is related to 3 small and medium-sized enterprises (SMEs) with at most 12 employees. The SMEs represent almost the totality (over 99%) of the Italian construction enterprises [4].

In this research investigations were performed by using semi-structured interviews. A semi-structured format allows researchers to structure interviews and ensure they follow a logical order. The unit of analysis was the Italian construction contractor. The projects were followed for 7 months and 13 respondents from 3 enterprises were interviewed. The language was Italian. The data collection involved the following three activities:

- 13 individual interviews;
- 2 group interviews;
- 1 meeting observations.

Before to start the interviews, the enterprises owners introduced the interviewer about the position of the respondents inside their organisation. The individual interviews were from 20 to 60 minutes long. Multiple informants, with various functions, spanning from the owner to the foreman were interrogated. The 2 group interviews lasted about 30 minutes and involved:

1. two technical officers in the first group interview:
2. one technical officer and a foreman in the second group interview;

The group interviews aimed to reflect collective understandings of the respondents. The one meeting observation in a technical office permitted to observe directly the carrying out of the work without any intervention on it.

3. Results and discussions

Once finished the data collection, it was possible to analyse data and to interpret the results obtained.

3.1. Current contractor’s internal flow

According to enterprises interviewed, folders are the preferred way to store information. In all the enterprises the data of each work order are organized in numbered folders according to an internal procedure. The folders can be accessed by a corporate network. In the enterprises interviewed a poor communication among the employees is found. In two enterprises, during the procurement phase, the technical office makes scant reference to the suppliers estimates already obtained from the sales office in the tender stage and requires new offers from the suppliers. Furthermore, at the end of a group interview the structural engineer, speaking to the electrical engineer of the same enterprise, affirms “we
never talked about the communication with the suppliers and we thought that the information problems about the structural and electrical sector were so different. Now we are discovering best practice that we can exchange with each other”. In two firms interviewed an Enterprise Resource Planning (ERP) system is used: both the technical officers of the two enterprises affirm that using ERP based on their knowledge is not very good. A technical officer affirms “for the metric calculation is needed to create ad hoc items and it is impossible to link the calculation to the Work Breakdown Structure (WBS). Furthermore, our ERP does not automatically integrate information from other ways such as e-mail, and from various formats such as docx, pdf or jpg, which must be searched and analysed manually”. In one enterprise the employees can access data both from the corporate network and from the ERP: sometimes the data are not consistent, but the files duplication is necessary because in the past they encountered a problem with the ERP system and they lost all the data saved on it. In one of the enterprises interviewed the technical office is beginning to implement a BIM system, but the use is still marginal.

3.2. Information exchange with the contractors’ stakeholders
This subsection consists of two subsubsections: the first is about the information exchange with the suppliers, the second is about the information exchange with the clients.

3.2.1 Information exchange with the suppliers. According to the enterprises investigated, there is no standard procedure for requesting offers to the suppliers and the relationship with the suppliers is very much founded on personal factors. The technical officer or the project manager base the choice of the suppliers on their own memory and often the contact information of the suppliers is not uploaded into the enterprise database. The enterprises know some suppliers with which exist a long-standing relationship of trust and base principally the own business on them. Nevertheless, a manager affirms that is very important to select carefully the suppliers in the first moments of a project considering also the possibility to contact new ones. To this end, the manager developed a contact list of qualified suppliers that is occasionally updated. There is no standardized procedure about the estimates from the suppliers (for example a form that suppliers must return filled out). The information exchanged is mainly based on e-mail and telephone calls: a technical officer in charge of building orders asserts “on the telephone you can interfere with the human side of the suppliers” and adds “the use of a digital system, as ERP, to store information from the suppliers could be for us a constraint and a waste of time, indeed we must enter manually the information from e-mail, doc and pdf in the ERP”. Another technical officer, instead, uses the telephone calls exclusively to check in real time if the e-mail sent to the supplier is correct. Because the difficult to compare the offers from the different suppliers in different formats, the contractors prefer frequently to consider only the trusted suppliers. However, in cases where a comparison is needed or preferred, it is done differently by the enterprises interviewed and it is done differently within the same enterprises according to the work to be done: in some cases there is an expert who, based on his own knowledge, evaluates the offers and then selects the best; in others cases, for continuous supplies, this process is instead semiautomatic by using a spreadsheet in order to compare mainly the price of the offers. Each approach is obviously consolidated inside the enterprises but it will not be preserved for ever: according to the interviews, the future intention of the managers is to adopt a semiautomatic digital approach to consult the data history of the offers, and to not depend purely on the knowledge of an individual expert. In the case of complex supplies, all the enterprises prefer to meet in person the suppliers.

3.2.2 Information exchange with the client. In the information exchange with the client it is necessary to distinguish the private case from the public one.

Private case. The enterprise receives the request from the customer and makes the offer. Depending on the scale of the intervention, the time required for this phase may be long. According to the respondents there is no problem of communication for small projects. Instead, in case of bigger projects some
problems could exist because the enterprises need to interface with the design team of the client and often there is a hard hesitancy to transmit data. 

Public case. The enterprise receives the project documentation and analyses the data received assessing the completeness. The analysis of completeness is done directly by the technical officers based on their experience and, sometimes, by using checklists. Often data are missing or incorrect. Two technical officers assert that there is a strong reluctance to transmit data and is needed to make a lot of requests. Many calls are made and e-mails are exchanged with the public institution in charge of the project. In the case of deficiencies (i.e. drawings, metric calculations, etc.) a technical officer states “our enterprise takes the risk of finding the solution rather than expecting it, in order to carry on the work”.

3.3. Implementing a digital information flow

Some respondents affirm that the adoption of a digital flow is not so hard. All the three enterprises interviewed admit that could be strategical to invest on the digital innovation of the enterprise. The owners questioned affirm that implementing a management system could be very useful to improve the internal and the external information flow. Two of the three enterprises have already the tools as ERP and one of them uses BIM, but the employees affirm they do not have the knowledge and the ITC skills to use these instruments in a proper way. Indeed, in this respect a senior technical officer asserts “we have an ERP system but at the moment we are not able to use all its potential”. In a group interview the technical officer and the foreman sustain that it is the time to improve and innovate the own enterprise in a digital way. They agree that a 3D model provided by BIM tools could be very useful to avoid misunderstanding among the construction site and the technical office. The foreman interrogated affirms “talking on the telephone in the while you see the 3D model enables us to focus better on the problem and to avoid wasting time’. Furthermore, the employees have a desire to create automatic registration of transport documents by using Barcode or QR Code: a foreman says “it would lose much less time and probably there would be fewer errors”. Furthermore, he claims that this system is already being used successfully in some supply warehouses. Additionally, he states that uploading a digital site activity log inclusive of photos in a cloud system might allow real-time control by the technical office.

3.4. Recap: the criticalities of the current flow and the opportunities of a digital flow

According to the contractors’ viewpoint, the main criticalities of the current information flow and the main opportunities of a digital information flow are presented in Table 1 and in Table 2.

Table 1. Criticalities of the current information flow.

| Criticalities |
|---------------|
| • Poor internal collaboration and poor dialogue between the employees |
| • Inability to standardize the selection of the suppliers |
| • Suppliers submit offers on their own form that the enterprises must decipher |
| • Many data to be processed and entered manually |
| • Running-in phase of the management tools in possession, such as ERP and BIM (there is potential that is not yet exploited) |
| • Data from the client are not completed |
Table 2. Opportunities of a digital information flow.

| Opportunities                                                                 |
|-------------------------------------------------------------------------------|
| • Use of a cloud system to instantly upload files even from the construction site |
| • 3D visualization of the project to avoid misunderstandings between the technical office and the construction site office |
| • Use of QR code or barcode for automatic registration of the transport documents |
| • Digital Site Activities Log for efficient communication between the construction site office and technical office |
| • More efficient use of the ERP and BIM systems                                |

4. Conclusions

This study investigated the internal flow of the Italian contractors and the information exchange among the contractors and their stakeholders. 13 interviews were conducted with several individuals in 3 Italian construction enterprises. The informants are selected from different levels of the enterprises, spanning from the owner to the foremen.

The following topics were investigated:
1. internal information flow of the Italian contractors;
2. information exchange of the Italian contractors with the stakeholders;
3. evolution of the internal information flow and evolution of the information exchange among the stakeholders with the spreading of the digital innovation.

According to the respondents there are several criticalities in the current information flow and several opportunities in the adoption of a digital information flow. The current problems in the information exchange could be solved by the adoption of an efficient and effective digital information flow that consequently might improve the construction sector productivity. It should be emphasized that, in this digital transformation age, chances of successful innovation could consist of finding a transitional phase between the traditional modus operandi and the new one. Future works may start by investigating the adoption of a digital information flow by general contractors in order to verify the changes of the internal and external information exchange.

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