A possible tool for the territory regeneration

Organization and digitalization of the building process through BIM

Pier Luigi Carci, Cinzia Barbara Bellone, Stefano Savoia,
Università degli Studi Guglielmo Marconi, Rome, Italy

Received: March 22/2018
Revised: April 12/2018
Accepted: April 30/2018

ABSTRACT. The digitalization of processes in the rather backward construction sector is a fundamental and strategic step forwards that can no longer be postponed. Inasmuch, there is no doubt that it will bring about a full-scale revolution affecting every player in the building process: clients, builders, professionals, property managers and users, the credit system, the insurance system, etc. However, the broadness and impact of this cultural leap, this change of paradigm, cannot spread among building process stakeholders in a rapid, complete and uniform way. This difficulty seems already to emerge from the initial complicated attempts in the public works sphere where the process of change, which ought to be generated starting from full awareness by Contracting Stations, is only now taking its first steps. The recent ratification of the so-called "BIM Decree" (as envisaged in Article 23 paragraph 13 of the Tender Procurement Code/Legislative Decree No. 50/2016) however, at least confirms the mandatory launch of this approach in coming years for Public Works. The BIM may come forward as an "influential epi-phenomenon of digitization" (A. Ciribini). The way forward towards digitization should therefore embrace organization as an essential element for effective application in processes involving the construction sector, where digitization really should play an increasingly decisive role. Such awareness would also allow designers or small design organizations to approach specific individual aspects, that could be tackled by applying innovative logics, thereby helping to promote necessary widespread distribution of experiences dealt with in a more modern manner. In conclusion, the Italian route towards to digitalization may well start from the organized juxtaposition of individual experiences, thereby stimulating the transition into the future from the particular to the general. The task, therefore, is to identify feasible operational practices rather than improbable and abstract complex theoretical models (as already mentioned, not readily applicable in the Italian context) that are probably

premature at the present time. Such operational practices will naturally have to be clearly defined and refer to a broad scenario where university research and the world of standardization are reliable landmarks. This research describes and analyzes some of these practices, which seem to confirm the practicability of this pragmatic approach that, as already mentioned, is perhaps unique in the particular Italian scenario and based on incremental organization and digitalisation of the process or, as suggested, specific parts of it.

KEYWORDS: *BIM, building process, digitalization, innovation, organization*

The state of the art and the analysis of the development of digitalisation in the construction industry

BIM and the digitalisation of the building process

The building process shows significant features that distinguish it from the manufacturing one. In fact, in manufacturing, the control of the process remains in the hands of the manufacturer, who is the key actor in the supply chain. He tailors both design and production according to the clients, sometimes succeeding in influencing their actual needs. The building process instead "sees as normal a deep segregation of tasks and project stages together with a similar substantial lack of interaction between the actors involved. In construction, indeed, it happens that a client, a designer, a contractor and finally the user, all different, participate in various forms in the same process, and the necessary coordination is often undervalued" (Gottfried, Di Giuda, 2011).

It seems that this intrinsic complexity of the process is outdated and could be simplified, or even overcome (in some optimistic views), by digitalization and BIM, Building Information Modeling.

The "BIM framework" can host every piece of information related to the building/infrastructure throughout all its life-cycle, not only the information necessary for its construction: "BIM is the creation and management process of an information model through the whole life of a building, from the design phase to its operation & maintenance one, passing through the construction phase" (Zacchei, 2010).

The American Institute of Architects (AIA) defines BIM as "a modeling technology linked to a database of project information", reinforcing the deep relationship between the model and the specifications database on which it is based on.

In other words, BIM is not simply a 3D model, but a wide methodological approach which potentially enables the management and the improvement of the whole building process.

"Therefore, BIM is made by the full set of the processes needed to realize, manage, extract and communicate information between the different stakeholders. These processes use the models created by all the actors involved in the process, in different moments and for different purposes, to ensure quality and efficiency throughout the whole building life-cycle" (Osello, 2012).

Actually, the *unique information box* could definitely contribute in fixing the confused and fragmented set of operators of the construction industry, leading them to an efficient way of communication based on a single, shared informative environment.

Through the BIM approach it is possible to jointly manage the information needed by the client, the professionals, the main and sub-contractors and the facility manager.

In Italy, the main topic regarding digitalisation in constructions, relates on the assumption that it must be necessary faced through multidisciplinary methods and processes. Traditionally this subject is barely considered in our country, which is characterized by the persistent individualism of private practice; the data from the 5th National Report made by CNAPPC and Cresme (2016) show that in Italy the Architectural firms are almost 7 thousand and hire, on average, four members: 1.5 partners, one employee who is not an architect, 0.2 employee who are architects and 1.4 freelancers.

Every consideration about construction, seen as the result of a complex and articulated process, should receive a strong and convinced push from designers and design firms, considering the key role of the design phase in the building process.

Nevertheless, even the design phase does not seem to be acted in an innovative way. The design micro-organizations previously mentioned show, within their boundaries, the same issues of the whole process. These issues derive from the fragmentation of professionals, who precisely participate in the process depending on their role, usually without integration with the other actors.

The fundamental disciplines of management systems (e.g. *UNI EN ISO 9001 – Quality management systems)*, project management (e.g. UNI ISO 21500 – Guidance on project management), risk management (e.g. UNI ISO 31000 – Risk Management – principles and guidelines) are totally unknown or not known enough by the average of professionals.

These subjects, instead, are widely considered within the international design contexts.

Therefore, the digital transformation of the construction industry has to go through organization, an essential requirement for the useful implementation of those digital procedures that should become increasingly crucial. So, it is necessary to identify operational practices, avoiding unlikely (and, as said, difficult to implement in the Italian scenario) theories which are probably premature, today.

Information management in the building process: standards and regulations

The Italian normative efforts for the standardization of technical information in the building process began at the end of the Seventies. The necessity of standards and regulations arises from the industrialization of the construction industry which aims to solve the need of residential buildings of those years. At the time, the focus was on classification systems for technical information and on standardisation of terminology.

One of the main international reference was, for example, the CIB (Conseil International du Batiment) and its proposal of a *Master List of Properties*, an exhaustive list of the whole set of performances that a building product can ensure in response to a set of requirements. It was the premise to the definition of "performance standards", but it could also be used as a tool to catalog building products and materials. The Sfb, Swedish Committee of Coordination for Building Issues System, was structured on the same schema (Vetrini, Marolda, 1983). Arch. Lars Magnus Giertz designed the Swedish system to solve the issues that arise in the classification of the technical aspects of both design and construction. Obviously, this method did not solve every problem related to information management, but nowadays it is still considered a solid base for the coordination of technical and commercial information within the building process.

In Italy, in 1981, UNI published the standard UNI 8290 – *Residential buildings. Technological system. Classification and terminology*. The standard classifies the building elements in Classes of Technological Entities, Technological Entities, Classes of Technical Elements and Technical Elements: these hierarchical subsets progressively identify the different parts of a residential building.

The scope of this classification system is to enable the formulation of performance specifications.
In 1984, the standard UNI 8690 – *Building process. Technical information* was added to UNI 8290; it was made by three different parts: *Terminology*, *Classification of the levels of completeness of the informative contents*, *Articulation end exhibition order of the informative contents*. The standard originated after a long period of maturation and promotion by scientific and technical operators of the construction industry and it was completely aligned with the CIB's *Master List* and the ISO terminology.
Nevertheless, "even if, at the time of its publication, this standard could seem complete, if not exhaustive, nowadays it appears at least outdated: the modern informative tools for representation and communication of information have deeply changed the request for technical information" (Scapicchio, 2009).
Anyway, UNI 8290 represents the first meaningful attempt, in Italy, to force the construction industry towards a regulatory system based on requirements and performance specifications, a system able to overtake the *good practice rule* and set an industrial approach towards construction.
In 2009, UNI 11337 – *Building and civil engineering works. Codification criteria for construction products and works, activities and resources. Identification, description and interoperability* integrated the existing body of standards.
The standard unified the principles through which it is possible to unambiguously identify any actor, product or action within the construction industry, considering both its nature and its features. To ensure this result, information needs to have a standardized structure, a shared content and an interoperable format.
In January 2017, UNI 13377 has been renewed, acquiring the final name of *Digital management of the informative processes*: even if it is still not completed, the standard constitutes the backbone of the Italian standard about BIM. The 2009 edition has been withdrawn (apart from part 3), while parts 1, 4, 5 and 6 have been officially published in 2017.
The current plan expects the publication of the following parts before the end of 2018:

- part 1: Models, documents and informative objects for products and processes
- part 2: Naming and classification criteria of models, products and processes
- part 3: Models of collecting, organizing and recording the technical information for construction products
- part 4: Evolution and development of information within models, documents and objects
- part 5: Informative flows in the digital processes
- part 6: Guidance to redaction the informative specific information
- part 7: Knowledge, ability and competence requirements for professionals involved in the digital management of the digital processes

Within the backward Italian construction sector, this recent step represents an important attempt to approach the subject in an organic way.
The new standards, once each part will be completed, could constitute a fundamental push to spread innovation and increase efficiency in the construction industry, which is now conscious of its low productivity and its technological inadequacy. This positive transformation should concern the procedural aspects of the whole process, as pointed out at the beginning of UNI 11337:
"The quality of a building, an infrastructure or of the environment in which these are built, strictly depends on the way through which the same pieces of information that determines a construction work are produced, managed and transferred throughout the whole building life-cycle, from the concept stage to the disposal or re-use ones. The building process sees a huge production of data and information, which are directly linked to each other, but derive from various procedures, disciplines and competences. Nowadays this amount of different facts, notions, concepts, etc., needs to be managed in a more effective and efficient way: the key is the digitalization of the informative processes, as it has been happening in manufacturing or service sectors for a while now.
This scenario highlights that, in the construction industry too, it is necessary the definition of a regulatory framework able to help the spread of collaborative and digitalized work environments. In these work environments, product and process information is generated, managed and shared on the basis of reference procedures and standards, with the aim of improving the transfer of knowledge, the quality of the product, the sustainability of production processes and the customer satisfaction. The digitalized process of the construction industry has the scope of producing information that can be easily and promptly found end that can be used by anyone who needs it. The digital management of the informative processes enables the reduction of errors or faults related to subjective interpretations of data, through:

- data legibility, unambiguity, transmissibility and availability
- information transparency, efficiency and effectivity"(1)

Moreover, the definition of Italian standards and regulations allow the representatives of our Country to participate in the discussion at international level (CEN and ISO) bringing our typical identity and needs, avoiding to passively accept the foreign standards, which are typically far from our features.
Finally, some expectations arise from the hypothesis that UNI 1337 could be implemented with parts specifically dedicated to restoration and renovation, considering the huge amount of historical and artistic building heritage that Italy boasts.
In the same direction it seems to look also the Italian Public Administration. The new regulation about Public Procurements (D.Lgs. 50/2016), at Article 23, Paragraph 13, expects that: "The procuring entities can request for new construction works, restoration and renovation projects or in case of variations, primarily for complex works, the use of specific methods and electronic tools described at paragraph 1, letter h). These tools use interoperable framework by means of open, non-proprietary data formats, in order to protect the free competition between software providers and to not preclude the involvement of any professionals. Only those procuring entities that are equipped with a staff appropriately trained can request the use of the mentioned methods and electronic tools. The way and the deadlines through which the mentioned methods will be made progressively mandatory for the procuring entities, the granting administrations and the economic operators, will be set by a decree of the Ministry of Infrastructure and Transport. The decree must be adopted within the 31 July 2016 and could be edited by a specific Committee appointed by the Ministry without additional costs for the public finance. The progressive introduction of the mentioned methods will be defined considering the different construction works typologies and the digitalisation strategy of the public administration and the construction industry. The use of such methodologies is a valuation parameter of the rewarding requirements described at article 38".
Despite the request included in D.Lgs. 50/2016, it has been necessary to wait till the 12th January 2017 for the publication of the expected act on the Ministry website.

The decree n.560, to so called "BIM decree", had been signed by the Minister Graziano Delrio on 1st December 2017 and entered into force on 27th January 2018. It defines the manner and timing through which the innovative methods and electronic modeling tools for buildings and infrastructures will be made mandatory for the procuring entities, with the aim of streamlining the design activities and the relative checks.
However, the decree introduces some progressive obligations which will be active only starting from 2019. In facts, the mandatory requirements for the use of methods and electronic modeling tools are going to become effective from the 1st January 2019 only for those construction works whose amount exceeds 100 million euros. Year by year, the obligations will regard construction works whose amount is increasingly lower, till the 1st January 2025 which is the term for works under 1 million euros.
In addition, the regulation sets the preliminary fulfilments for the procuring entities: the adoption of a training plan for the employees; the definition of a plan for the acquisition and maintenance of hardware and software tools used to manage the decision-making and informative processes; an administration deed which clarifies the control and management process, the clash management and the data managers.
The procuring entities are required to use interoperable environment by means of non-proprietary, open data formats. It is defined the use of data and information created and shared between all the participants in the design, construction and management of the project.
The decree allows, since its entry into force, the use of methods and electronic tools for new construction works, for restoration and renovation projects and in case of variations, as long as the procuring entity is compliant with the required preliminary fulfilments.
However, D.M. 560 does not mention the standard UNI 11337, even if it would have constituted an useful reference or at least a semantic guide.
Probably, the uncertainty on what should mean *digitalisation* will have bad impacts on the technicians and the procuring entities of the Public Administration: the P.A. should, indeed, include BIM in their calls for tender, be able to evaluate these tenders and manage the informative processes.

Innovative elements gained from the case studies (2)

1) Development of the MEP design for the Etlik Integrated Health Campus in Ankara, Turkey (BIM and project internationalization)

The Etlik Integrated Health Campus which is under construction in Ankara is going to be one of the biggest hospital complex in the world, with its 3600 hospital beds and about 1 million square meters of covered surface. The client is the Turkish Ministry of Health and, at this moment, this project is the biggest implementation of a private-public partnership in Turkey.
This case study regarded support services provided for the modeling activities of the mechanical and electrical systems and for clashes solution; clashes are geometrical interferences or overlaps among the objects of the models. The modeling activities regarded two of the six towers which make up the whole complex. For each tower we dealt with the CAD to BIM conversion of seven systems: ventilation, heat and cooling, waste water system, plumbing, medical gas, pneumatic system, firefighting system, electric (in terms of both cable trays and electrical devices). Considering the close deadlines of this commission (it had been employed a team composed by seven persons for two months), some Dynamo scripts were developed in order to automate the modeling procedures.
In parallel to the modeling activities, the same team dealt with the solution of the clashes identified by the client, with the aim of developing interdisciplinary, clash-free models.
The software products used in this commission were Autodesk Revit, Autodesk Navisworks and, as said, Dynamo.

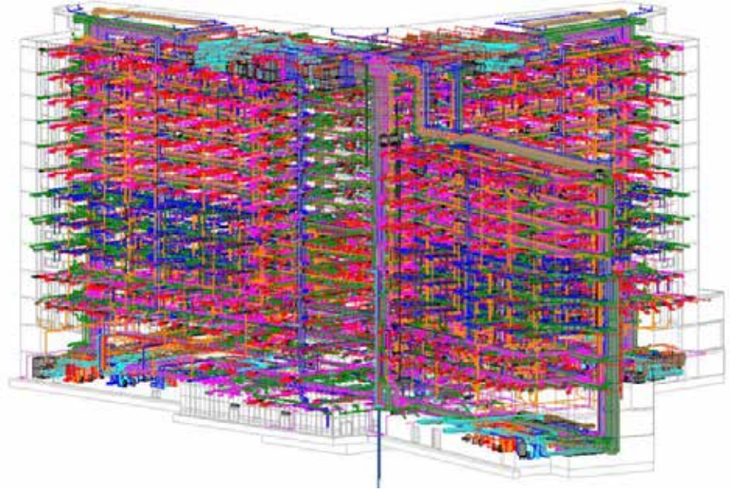

Figure 1. Global view of the MEP model

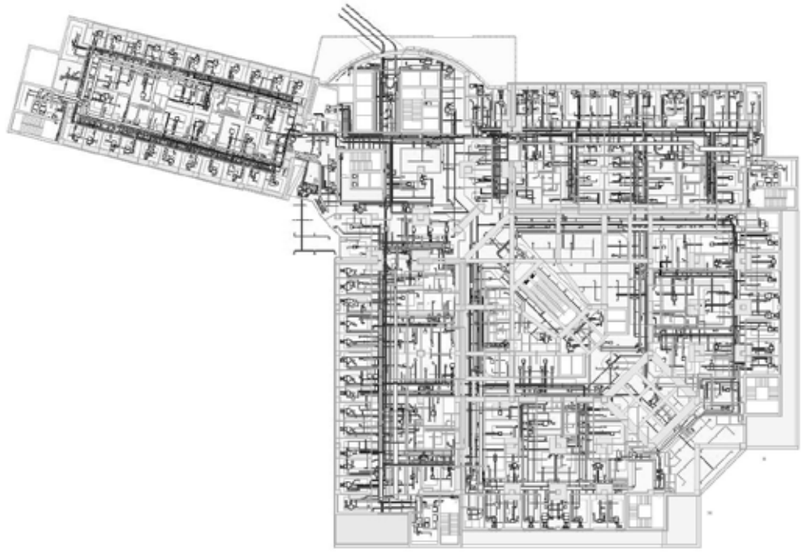

Figure 2. Plan view of the MEP model

2) Technical design of bathroom pods in the Television Centre project, London, UK (BIM and off-site)

The Television Centre (TVC) project, in London, started in 2013 and involves a surface of about 57000 square meters: it represents one of the main ongoing construction sites in the British capital. The TVC is the renovation project of the old BBC headquarters, which will be used for residences and offices.
The activity consisted in the technical design of bathroom pods with high quality finishes. The pods had been assembled in Italy by Stone Italiana S.p.a before they were installed in London in both existing and new buildings.
Even if the contract did not require explicitly the use of the BIM methodology, it was chosen to implement innovative procedures and tools with two main purposes.
On the one hand, a software of parametric modeling was used to produce the drawings of the bathroom pods' steel structure. The 3D model allowed the production of the necessary fabrication views and of the cut lists, in particular, extracting directly from the model the information related to identification, geometry and quantity of each element.

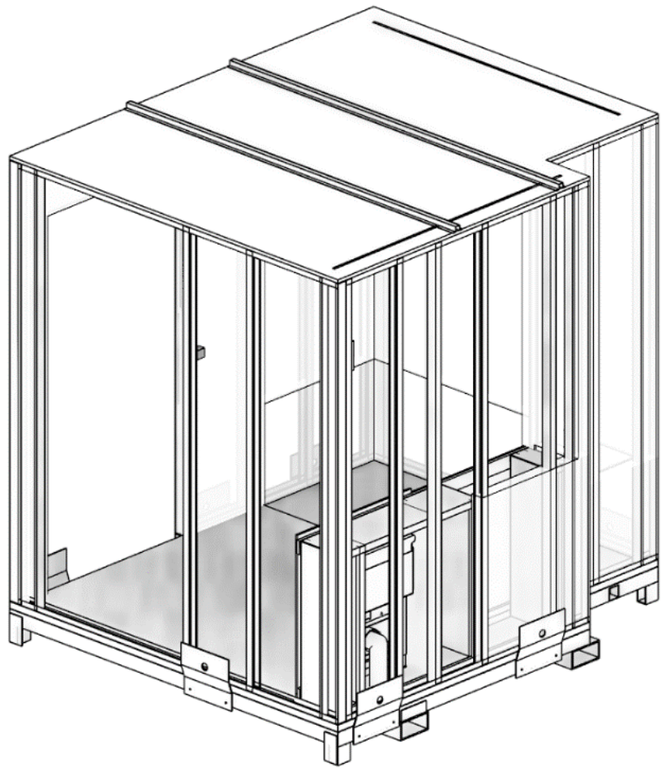

Figure 3. Structural model of a bathroom pod

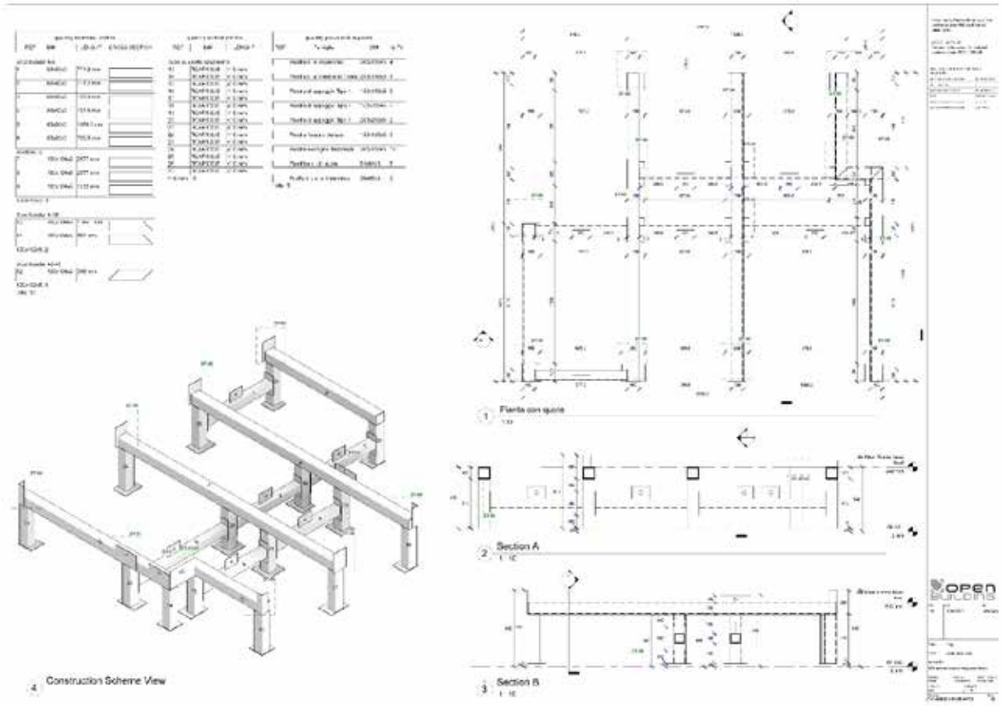

Figure 4. Drawing with cut list extracted from the model

On the other hand, the second experimentation, which was maybe more interesting by a scientific point of view, dealt with quantity take-off and cost estimation. The used BIM authoring tool was analysed in order to identify its potential and limits in quantify objects and materials and gain a realistic estimation of the whole cost of a bathroom pod.
Both these two experiences showed to the team involved that the adoption of new procedures and new tools enables a more efficient and profitable information management. For what concerns the drawings, knowing precisely what should have been the output, it was possible to measure the gained benefit: while through traditional methods three persons were necessary to develop a single drawing, with the new procedures a single person was able to produce the same result in the same time, managing the model on his own.

3) The management of technical information within the building maintenance process (Facility Management). A study in the retail sector for the compliance with law requirements

The operation and maintenance stage is a phase of the building process which is traditionally less considered from the owners or from those who deal with Facility Management. As statistics show, however, considering the whole building life-cycle the Facility Management costs are four or five times higher than the design and construction ones.

For this reason, during the selection phase of products and suppliers, the focus on maintenance aspects represents a strategic choice by the client, who starts - by defining his needs - and closes – by using the asset - the building process.
After having selected the suppliers, the building systems and the products, the relevant technical information can then be hosted within the BIM model which originates from the design stages. The updated model, comprehensive of the variations that could potentially occur on site, will become the as-built database that collects those pieces of information useful for Facility Management.
The information assets thereby generated constitute the basis on which set, update and optimize the maintenance activities.
The discipline of Facility Management is often considered only from a daily, operational point of view: administration of building assets, building maintenance, spaces and services management. Actually, there are some legal obligations (with possible criminal consequences) which forces the clients, or their delegates, to take care of the workplaces they are responsible for.
In particular, D. Lgs. 81/2008 defines a set of mandatory fulfilments needed to ensure the compliance of the workplaces towards both the employees and external suppliers. The same regulation identifies some tools through which satisfy these obligations; for instance, the DUVRI (the Single Document for the Evaluation of Interference Risks, art. 26).
It still needs to be clarified which one should be for the employer the most efficient way to ensure compliance with the legal obligations and to preserve himself from the possibility of legal consequences. The primary need is the knowledge of the Facility that required to be maintained, of its status and the relative risks. In most cases this need does not receive any satisfactory answer. The conducted research aimed to investigate, for this specific topic, which solutions the digitalization could provide.
The scope was to identify an effective, user-friendly solution able to put the wide information assets that the employer is required to manage in order. In other words, the idea was to gain a benefit through a tool easy to implement.
As a case study, it was identified a building used for retail purpose; the building was then modelled creating a 3D informative model.
With reference to the products installed in the store, the model hosted the performance parameters required for CE marking (which is mandatory itself) and its relevant standard. External documents, such as the data sheets and the certificates of conformity, were also linked to the relevant objects.
Moreover, it was attached to the model the administrative mandatory documentation related to both the whole building (the certificate of compliance with safety standards, the fire prevention certificate, etc.) and the contractors that could be required to work in the store in accordance with Title I and Title IV of D.Lgs. 81/08. The model and its informative content can be freely visualized and analysed thanks to the open data format for BIM models (IFC) and open-source software.
We all know that, today, the implementation of a complex informative environment for Facility Management represents the most advanced application of digitalization in this field. However, the proposed solution allows the employer to enlarge his protection towards legal issues by creating a visual database that organizes the technical information.

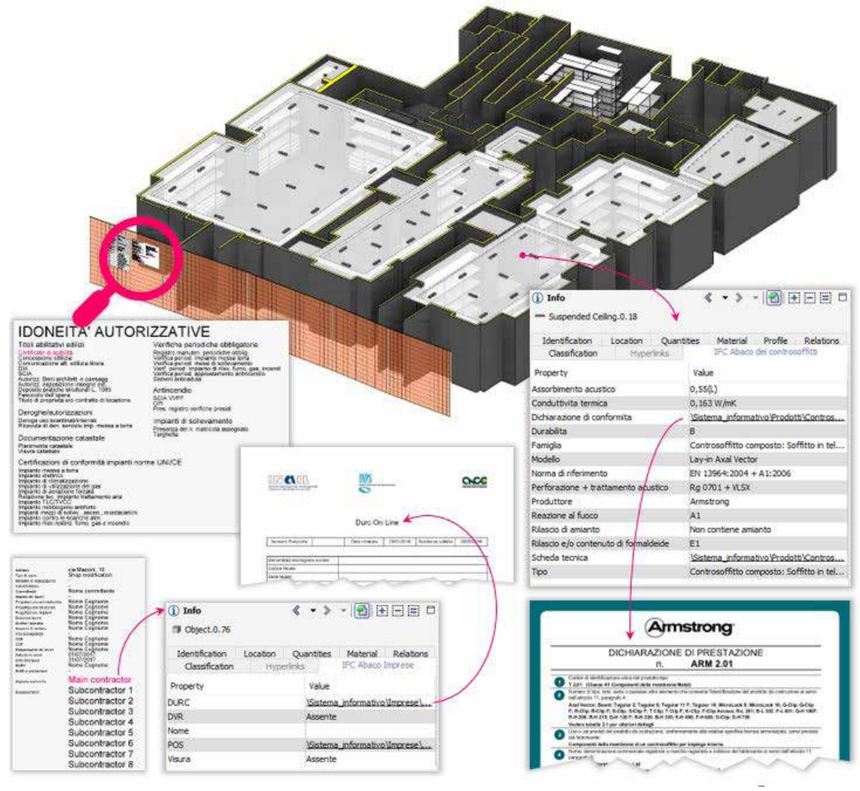

Figure 5. Functional diagram of the model's informative structure

Therefore, the BIM model and its associated documentation constitute the complete catalogue of the technical and administrative information of a built asset. This catalogue needs to be progressively updated, to form the fundamental substructure on which the Facility Management procedures should base. Even if it does not exempt the employer from his responsibilities, there is no doubts that the implementation of such an informative system, if well administrated, represents for the employer a useful tool to prevent legal issues.

Conclusions

The brief list of the case studies previously described let us to make some reflections about the opportunities that the digitalisation of the building process offers to Italian professionals.
The scientific literature and the conference proceedings on this subject appear to unambiguously indicate the benefits of this ongoing transition. Nevertheless, these references do not focus that much on the ways through which this transition should happen.

The case studies show that this digital transformation is reformist, rather than revolutionary. In this scenario, the new methods and tools are still applied specifically or occasionally, and in a partial way. The mentioned cases were actual implementation of operative practices on processes or sub-processes; these practices base on the same theoretical framework described in premise.
These case studies play a meaningful role within the digital transition of the construction industry. Even if they are not completely aligned to the integral and comprehensive BIM approach - as it is described by the most recent literature - their weight is significant in a perspective of digitalization of processes.
These examples, in their dimensional and ontological variety, seem to have some common features that confirm what have just been stated:

1 – The systemic and multidisciplinary approach to the digitalization requires organization. Design management as a key discipline

The MEP design and modeling of the Etlik Integrated Health Campus in Ankara (Turkey) were addressed through the concurrent intervention of various specialist competences.
The technical activity was necessarily performed through well-structured staff, whose collaboration possibilities are structurally linked to specific organizational standards which derive from the reference quality management system.
As it has been already highlighted in the described case study, the digital approach needs to be carried out via multidisciplinary, planned processes. Comparing our context with the international one, this behaviour is inescapable and, especially, it is taken for granted.
In other words, the subject of Design Management is strictly related to Information Modeling, even if they are traditionally independent.
As Ciribini writes "therefore, it is clear that the integration between various design competences - which cannot be ascribed fully to a unitary system even within a digital environment completely sharable in real time - requires to be set on a cultural framework of a management nature. This kind of a culture is almost unknown in our context" (Ciribini, 2016). Indeed, the most significant experience that arises from the case studies previously described can be identified in the execution of technical activities within structured and organized processes. In these processes, the information management procedures (document management) have a key function.
In this cases, it was crucial, and even not that simple, the comprehension and adoption of collaboration concepts and tools such as, for example: the workflows for data sharing; the verification and approval procedures; the CDE, Common Data Environment, namely the digital environment for data sharing - in Italy, its name will be *ACDat*, a "structured environment used to collect and share data coming from digital models, drawings and documents related to a single construction work or to a single complex of construction works" (Ciribini, 2016).

2 - The sequence: digitalization - standardization - industrialization

A standard for the semantic definition of information allows the whole building process to evolve towards its industrialization, as well as ensuring an effective data interoperability. Such an evidence can be seen in the case of the bathroom pods of the Television Centre, in London. These informative aspects are accompanied by a likely, increasing use of off-site production processes.
Off-site processes and products give the opportunity to optimize time and costs on the construction site (which is becoming ever more a place in which prefabricated elements are assembled) and, above all, to maximise quality and performances of the final construction work. As Prof. Ciribini states, the consequence of the digitalization in the building process will be the transition from an artisanal site to an industrial one. The first is characterized by a high technical ability of the workforce, but a low managerial and organisational culture; the second shows, instead, a precise and synergistic site planning. These concepts have been seen in the Television Centre project, where the most interesting aspect regarded the technical interface between the technical design process and the construction site. In that specific case, the provision of a high quality, off-site product forced the design team to act as a conjunction element between the project management structure and the production process, namely the contractor responsible for the provision of bathroom pods.
The necessity to make the design team responsible of design activities typically controlled by the contractor's technical office and rarely carried out by Italian professionals, the so called *construction design* or operative design, was, and probably it will be, the new challenge introduced by the digitalisation of the building process (Gottfried, Di Giuda, 2011). Even if the described assignment formally remained within the boundaries of *detailed design*, there is no doubt that the precision of the industrial production requires efforts which are uncommon in traditional design activities.

3 – Extending the building process to the O&M (operation and maintenance) phase and Facility Management concepts

The described experience about the retail sector and related to aspects such as O&M (Operation and Maintenance) and FM (Facility Management), is probably the most significant. Among the stakeholders, the most widely held belief is that the building life-cycle management is really the building process' phase which most can take advantage from the digitalisation. The case previously mentioned shows an operative practice which aims to be immediately useful. The scope is to ensure compliance with the legal requirements, which, if not fulfilled, led to the risk of economic and legal consequences (which could also be penal) on individuals, namely on the clients or their representatives.
Our experiences show that even big multi-site companies have not set yet an informative system able to protect them from such a risk. It is then clearly necessary the implementation of a controlling/monitoring system for the mandatory documentation which is required to ensure the technical suitability of a building, no matter if it is a factory, a store, a warehouse, an office building, etc. A digital, informative structure constitutes a necessary tool, the fundamental base through which approach the subject of compliance with legal requirements.
During the operational phase, the protection from responsibilities related to occupational safety (D.Lgs. 81/08) usually translates into the management of external service suppliers. The client often assigns this task to the Facility Manager. In this respect, a digital environment for real estate management could represent an effective tool to protect the employer from its responsibilities: the qualification of the suppliers and the obligation to inform people about spaces and products features and, therefore, about the relevant risks.
Moreover, the BIM, as an informative model that integrates spaces and products, could constitute the database that hosts the attributes of spaces and products which are useful to fulfil the legal requirements (e.g. CE marking for construction products) and to ensure safety conditions (e.g. performance of elements needed for maintenance).

Of course, this informative structure must be put in relation with a wider informative system, which shall be able to include information of different nature and to allow the data control.
The common subjects highlighted by the described case studies confirm which are the current topics regarding the digitalization of the building process.
The ongoing transformation involves each actor of the process, from the clients to the final users.
It is in progress, globally, the use of a wide and unique digitalization system, which will assist in determining an actual paradigm shift. In the short term, the stakeholders will hardly assimilate this change in a homogeneous and synchronous way, mostly because of the fragmentation of the construction industry.
Within the construction sector, the application of concepts such as management system (3), project management (4) and risk management (5) are traditionally pretty uncommon. The same references are, vice versa, broadly applied within the international context.
The Italian route towards the digitalization could then go through the organized and regulated juxtaposition of single experiences and competences, driving the transition to the future from the particular to the general, not the opposite.
In conclusion, the BIM methodology seems able to extend the range of technical services, offering a *simulation* in place of the traditional *representation*. This approach makes nearer the points of view of the client, the designer, the contractor and the end user, creating new business models for the design firms, as long as these will be ready to catch the opportunities of this historic transformation.

Notes

(1) Standard UNI11337-1 - Building and civil engineering works - Digital management of the informative processes - part 1: Models, documents and informative objects for products and processes
(2) The described cases are taken from actual commissions of the Contec Group's engineering companies in Verona
www.gruppocontec.it
(3) Standard UNI EN ISO 9001 – Quality Management System
(4) Standard UNI ISO 21500 – Guidance on Project Management
(5) Standard UNI ISO 31000 Risk Management – Principles and guidelines

General References

Arlati Ezio (2011), *Modellazione e gestione del patrimonio edilizio esistente. Alla partenza un Programma di ricerca di Interesse Nazionale*, INGENIO Sistema Integrato di Informazione per l'Ingegnere

Caputi Mario, Odorizzi Paolo, Stefani Massimo (2015), *Il Building Information Modeling – BIM. Valore, gestione e soluzioni operative*, Sant'Arcangelo di Romagna, Maggioli editore

Caruso di Spaccaforno Angelo (1999), *La valutazione economica dei progetti nell'arte del costruire*, Torino, UTET

Cennamo Gerardo, Savoia Stefano (2017), *Ruoli identitari ed utilità sociali nell'opera professionale: il supporto della ricerca scientifica nell'evoluzione di nuovi approcci, procedure e strumenti,* in *Territori e frontiere della rappresentazione*, Atti del convegno UID 2017 – Focus 4 *Territori e frontiere della rappresentazione*, Roma, Gangemi Editore

Ciribini Angelo (ed. 2016), *BIM e digitalizzazione dell'ambiente costruito*, Palermo, Grafill

Cossato Maurizio (2012), *Contec Ingegneria: costruiamo il futuro dal 1962,* Verona, Grafiche Aurora

Garau Giorgio, Dal Zio Palutan Emma (1990), *Informazione tecnica per il progetto in edilizia. Il programma schede,* Padova, CLEUP

Gottfried Arie, Di Giuda Giuseppe Martino (2011), *Ergotecnica Edile*, Bologna, Esculapio

Guida Pierluigi, Ortenzi Antonio (2017), *Project management in edilizia e nelle costruzioni civili. Manuale per il project manager e RUP,* Roma, DEI

Landini Franco, Roda Riccardo (eds. 1989), *Costruire a regola d'arte. Repertorio di soluzioni tecniche conformi e di specifiche di prestazione per la formazione di capitolati d'appalto*, Milano, BE-MA Editrice

Nissim Lorenzo (2016), *BIM. Modellazione elettronica delle informazioni edili per un'edilizia sostenibile,* Roma, EPC

Osello Anna (2012), *Il futuro del disegno con il BIM per ingegneri e architetti*, Palermo, Dario Flaccovio Editore

Scapicchio Sara (2009), *Sistemi di classificazione di organismi e prodotti edilizi. Ipotesi metodologica e sperimentazione applicativa su organismi edilizi pre-moderni*, Università degli Studi di Napoli Federico II. [tesi di dottorato]

Scheer David Ross (2014), *The death of drawing: architecture in the age of simulation,* Oxford, Taylor & Francis

Tronconi Oliviero (ed., 1990), *L'edificio intelligente*. Milano, ETAS Libri

Vetrini Giuseppe, Marolda Maria Cristina (1983), *Piano di classificazione PC/SfB*, Milano, ITEC Editrice

Zacchei Valeria (2010), *Building Information Modeling. Nuove tecnologie per l'evoluzione della progettazione – costruzione*, Roma, Aracne Editrice