

FIDIC and digital technologies in construction project management.

Building information modelling

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Abstract: The purpose of this research paper is to synthesize the specific positions and provisions that BIM (building information modelling) introduces in the context of the FIDIC contractual terms. Although the construction industry is positively shifting from the traditional design-build model to BIM, the legal corridors for transfer are very slow to keep up with the development of the economy and the change in technology. This study will also establish that when project management processes are integrated with BIM purposes, deliverables, and information management, the BIM model's value as a single source of truth is maximized. With regard to investors, contractors, and builders, the more practical application of FIDIC books and BIM principles will speed up the construction process and facilitate the establishment of proper, adequate, and mutually beneficial relations. The important thing is figuring out how the usage of BIM can coexist with the FIDIC form of contract.

Keywords: BIM, building information modelling, FIDIC, construction industry

1. Introduction

The International Federation of Consulting Engineers (FIDIC) contracts have been developed over 50 years as the international standard for the consulting industry. They are recognized and used globally in many jurisdictions on all types of projects. Researchers and practitioners in the construction and legal sectors alike have questioned the possibility of creating a “common law of construction contracts” across countries and regions owing to the vast and often insurmountable inconsistency in application and optimisation (Knutson, 2005). However, despite various differences and gaps, the applicability of FIDIC contracts—when transposed into the framework of national jurisdictions—has yielded effective and working results, which in turn implies that there is enough substantive common ground upon which to build and adapt FIDIC contracts (Charrett, 2019). In this regard, Bulgarian progress remains somewhat stunted and far behind the experience of other EU members such as France, Germany, and the UK, to name but a few, which merits further research into why FIDIC guidelines are yet to become a comprehensive and regularly used instrument in the drafting of construction contracts under Bulgarian law. Nevertheless, the standard forms of FIDIC are applied more often and directly in contract practices in Bulgaria, as numerous financing organizations explicitly stipulate that contracts in the investment process must be aligned with the “books” of FIDIC. (Valkova, 2020)

On the other hand, BIM (building information modelling) is a digital information management technique that the building and infrastructure industries are utilizing to increase productivity and quality in building and infrastructure projects, decrease financial losses

during construction, and serve as a foundation for developing future services. 3-D modelling with embedded data, which can be shared by and among all project participants at all stages of a project, from design to maintenance, is at the core of it. (BIM And ISO 19650 From a Project Management Perspective, 2020)

Therefore, the purpose of this research paper is to synthesize the specific positions and provisions that BIM introduces in the context of the FIDIC contractual terms. This study will also establish that when project management processes are integrated with BIM purposes, deliverables, and information management, the BIM model's value as a single source of truth is maximized. Thus, the foundation of this article is that all parties participating in the process will ultimately profit from investing resources and time to make the applicable construction legal framework more compatible with digitalization in use. The more practical implementation of FIDIC books and BIM concepts will speed up the construction process and make it easier to develop appropriate, sufficient, and mutually beneficial relationships with investors, contractors, and builders. The important thing is figuring out how the usage of BIM can coexist with the FIDIC form of contract. There are many difficulties that FIDIC and others may need to take into consideration.

When applying BIM to a project under the contractual conditions of FIDIC, the following issues should be considered more thoroughly:

- misunderstanding the scope of activities
- using data for an inappropriate purpose, and relying on inappropriate data
- ineffective management of information, documents, or data
- defining deadlines and deliverables.

2. Building Information Modelling (BIM)

Building information modeling (BIM) is steadily elevating its status as a vital component of the construction sector and of projects in general. As a result, standard form contracts that include clauses to facilitate and aid in the adoption of BIM are required. However, the Bulgarian contract suite currently in place gives no clear indication of what will be covered by stipulations that help facilitate BIM. The industry's cooperation in Bulgaria led to the successful deployment of BIM, but it also increased the level of contractual uncertainty. The adversarial nature of the Bulgarian construction sector, where each person is naturally motivated by their own self-interest, is particularly well-known. The issue that needs to be addressed by the Bulgarian construction industry is what changes in contractual issues are required as a result of the use of BIM. Contrarily, the International Federation of Consulting Engineers (FIDIC) general conditions do not govern contractual adaptation or its execution. The discussion below demonstrates the necessary modification to the standard contract form for the successful deployment of BIM⁷ in order to address this issue.

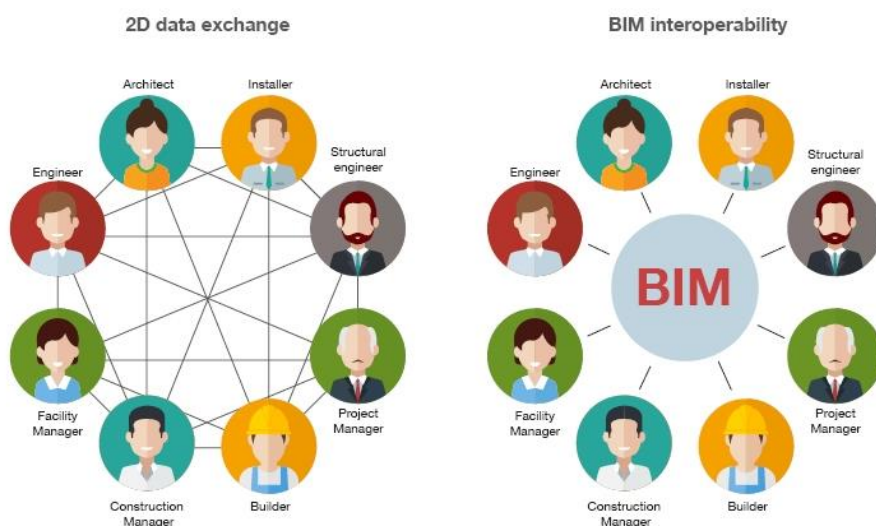
Although each partner is still in charge of their own data, project managers can use BIM as a single "accepted source of truth" for their decisions. This entails a more effective use of resources, enhanced long-term planning, increased flexibility, and improved communication within the partnership, all of which benefit the client, project manager, and contractor. Clients from the public and private sectors are being more and more insistent

that their projects be completed on a BIM platform. There is general agreement that the built environment around the world will significantly benefit from the potential inherent in BIM to improve its social and environmental performance, despite some nations adopting it more quickly than others. BIM is essential in the urgent search for more sustainable solutions and is rapidly becoming into a global industry-wide strategy.

The implementation of BIM in the form of a FIDIC contract can be considered because this practice is gaining speed and popularity in a number of countries characterized by well-developed and permanent construction sectors. BIM is the process of using digital tools and technologies for the digital visualization (in 3D format) of the physical and functional characteristics of a given building project during construction. BIMs are generated and stored most often in the form of computer files that can be retrieved, exchanged, and sent to support the decision-making process about an asset. BIM software and processes are used by individuals, private companies, and government institutions for various types of construction projects and ideas. Although the concept of BIM has been known since the 1970s, it came into wider use at the beginning of the first decade of the new century. The development and adoption of BIM standards happened in different ways and at different speeds in most countries (Sung Cha, H., Jiang, Sh., 2020).

Compared to traditional methods in construction, BIM offers an integrated and digitized (that is, easily accessible and easy to change) model that contains meta-data for different construction projects, as the following comparison image shows:

Fig.1 Comparison between traditional construction and construction organized according to BIM



Source: Pedicini, 2020

The main benefits of introducing this innovative method relate to the following issues (Hee Sung Cha & Shaohua Jiang, 2020):

- Saving costs and resources;
- increased efficiency and faster execution of a construction project;
- improved communication and coordination of the various project activities;

- More options for prefabricated and modular structures;
- The end result is of higher quality.

BIM and CAD are two different approaches. BIM is not simply the evolution of CAD but a completely new way of looking at the design and construction of a building. Some of the advantages of BIM over the traditional way of working are:

- time and cost savings: dedicated smart objects with embedded properties and information (material, cost, thermal capacity, maintenance, etc.)
- error reduction: modifications to the BIM model affects all the correlated views and representations
- simplicity: easy to achieve a complex model.

The specific functions of each discipline are managed by different software. Each professional involved in the BIM project will carry out that specific part of the project with what they consider the best BIM software (Palma, 2022) for their job. That would include architectural design, structure engineering, installation systems, infrastructure, etc.

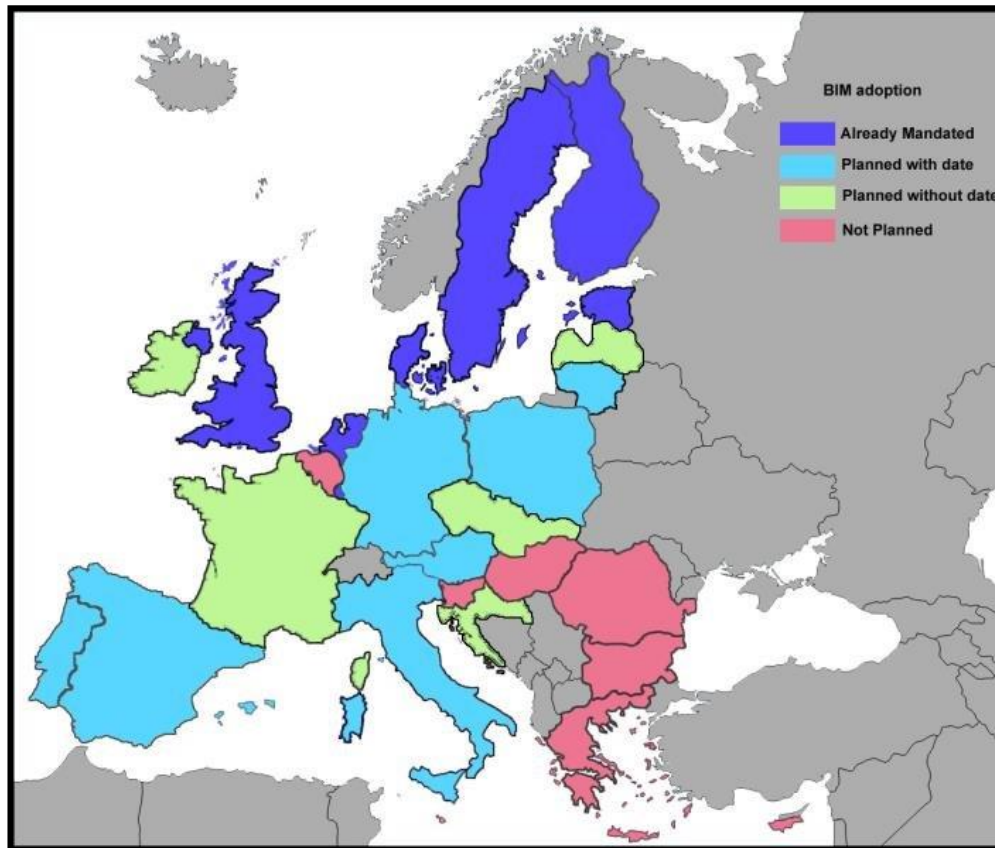
In addition, the application of technological solutions such as BIM has been proven to contribute to more innovative and productive procedures in the construction sector, with some analysts also claiming that BIM is a sufficiently sustainable practice that can even help reduce poverty in developing countries, such as by linking to the United Nations (UN) Millennium Development Goals (Merschbrock, B., 2016).

The introduction of BIM around the world shows that, at this stage, the practice is most popular in developed countries such as the USA, Great Britain, and Australia, as well as in technologically advanced countries such as Singapore and parts of the Scandinavian peninsula. For example, in the case of Great Britain, the introduction of BIM in 2010 showed only 13% usage of the technology in the country, which grew to 39% in 2013, and subsequently, BIM level 2 became a mandatory tool for use in all public construction projects. For comparison, in 2015, as Assoc. Dr. Boyan Georgiev from UACEG mentioned in an interview on the topic of BIM, in continental Europe this practice remains relatively unknown and its use is rarely resorted to, although there is an increasing interest in understanding the methodology and its real benefits. Some of the main obstacles preventing the wider application of BIM in Europe and Bulgaria in particular include the need to appoint a BIM manager or manager (who will be responsible for the initial coordination of the use of the new technology) and the need for specialized training of participants and the acquisition of new technological knowledge and skills. Also, with the inclusion of a new person and a new role in the overall process, as the need for a BIM coordinator implies, some of the traditional participants in the construction process may feel threatened, in particular the architects, who are used to stepping into this coordination role at various stages of planning and building. (Cobuilder, 2015).

The map below shows BIM adoption and usage rates around the world compared to a 2013 report, highlighting countries where BIM is more commonly used. For example, in the US, the implementation of BIM as software and process has grown by 45% in the last three years of the study period (i.e., before 2013) and by 400% in the last five years, with construction firms leading the way. innovation revolution. Statistics show that 74% of these

companies already implement BIM, and the percentage of architects and engineers who have adopted the new practice is 70% and 64%, respectively.

Fig.2 State of BIM adoption across European Union (May 2017) Nearly one-fourth of Europe has no plans for enforcing BIM implementation in the near future



Source: Stoimenov, 2014

3. Project management and BIM

To facilitate the use of BIM and the exchange or sharing of digital information across the project, all aspects should be considered to clarify the corresponding terms.

By far, the best results are obtained when the information deliverables are of higher quality and when cooperation is expanded in an organized manner and integrated into the project management process. The project management procedure must continue to be followed just as before, with all necessary background information and experience. Design, planning, tendering, execution, communication, and coordination are the same underlying traditional processes to which BIM adds new tools, metadata, and concepts too. Improvements in lowering financial losses, saving time, enhancing quality, and minimizing hazards follow naturally from this. It enhances communication and cooperation between various project stakeholders and phases, resulting in an integrated strategy for adjustments and improvements.

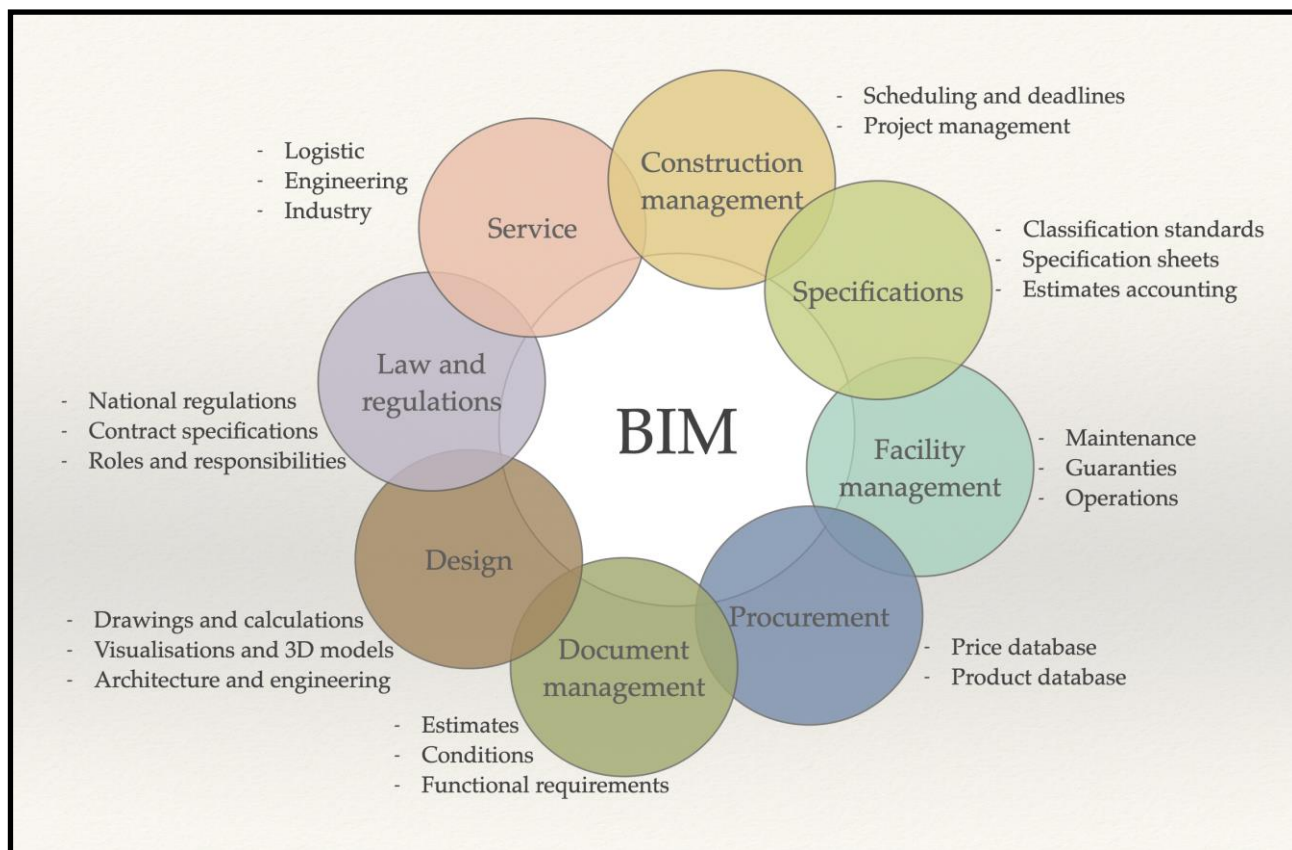
The following terminology should be clarified in order to simplify the usage of BIM and the exchange or sharing of digital information between customers and suppliers throughout the project and asset lifecycles:

- hierarchy of the information
- intellectual property ownership
- obligations and liabilities of suppliers
- purpose of information exchanges
- roles and responsibilities for information management

BIM information can be shared via "containers," according to the ISO 19650 fundamental principles of container-based collaborative working. That is collaborative working across an asset or project team using containers for sharing asset or project information.

Cost, time, quality, and risk are the four key project metrics that are used to evaluate the success of BIM adoption. From the standpoint of an engineering consultant and project manager, an effective BIM implementation is using BIM as a tool to complete the project within the allotted budget and time period, free of design conflicts and challenges, unscheduled work, reworks, claims, unreasonable deadlines, etc. BIM is helping with project management and quality control with its procedures and tools. Through the use of BIM technology, a number of automated and semi-automatic quality control methods may be accessed for use across a wide range of BIM applications and stages of a project. Project managers working on BIM projects must be familiar with the BIM process and the model's capabilities for tracking progress in order to do their jobs effectively. For example, in a BIM project, it is not possible to monitor development by counting the number of finalized drawings. Having project managers who are on the same page as BIM entails adopting its ideas and technologies across a wide range of project activities and then making use of the resulting increase in data for improved decision-making, quality assurance, and risk management. Lean, end-goal-oriented planning is essential for successful BIM implementation, which takes into account the project's specifications, the mode of delivery and contract, the number of involved parties, and the structure and age of the buildings already in place. While data entry with no subsequent use is a waste of time, providing too little information might limit the usefulness of various BIM applications and studies. Since the BIM model itself, the "digital twin," serves as the foundation for most BIM applications generated from it, the information needs for it should be properly established, taking into account all subsequent uses of the data, additional input, process and software requirements, etc.

Fig.3 BIM lifecycle elements



Source: <https://www.mdpi.com/2076-3417/10/4/1371>

Information entered once should propagate through the process and be used to the fullest extent possible. The defined information requirements for each BIM deliverable should take into account software output interoperability between deliverables and ensure that outputs from one procedure can be used as inputs and references for another.

Information requirements and handshakes should follow systems engineering principles. This implies information isn't lost to another project participant, and collaboration is strengthened not only among immediate co-workers and co-participants but amongst stakeholders who won't have direct touch on the project (e.g., designers and facility managers on some projects that follow a waterfall design-bid-build-operate method). This increases the quality of output, reducing the likelihood of obsolete papers and confusion.

When the BIM model is used as a single source of truth, the value is increased when project management processes are integrated with BIM goals, deliverables, and information management. The transition's initial cost is frequently offset by reduced risks and unplanned savings. These expenses are hard to quantify and prove, making ROI tough to calculate. BIM can help project managers, investors, and contractors control risk. Much of the risk linked to design quality and synchronization, obsolete or imprecise numbers, undefined or out-of-scope tasks, unrealistic schedules, unplanned rework due to collisions, and faulty cost estimates can be avoided or mitigated by using BIM as a tool for estimates or quality control. This can lead to more realistic timetables and cost projections, less unpredictability, and lower bid and tender risk margins.

4. FIDIC and BIM

When FIDIC presents its second edition of the "rainbow," there is no specific mention of BIM in the General Terms and Conditions. Instead, there is a special advisory note in the special regulations that deals with the use of BIM. This is also the approach in the Emerald Book of Tunneling Contracts, issued in May 2019.

Rather than setting out a specific approach, FIDIC chooses to highlight issues that BIM practitioners should consider when applying the FIDIC books. For example, although it notes that many projects use a BIM protocol, FIDIC has not produced its own protocol or recommended the use of any particular one. Instead, FIDIC states that two documents are currently being prepared: "Technology Guidelines" and "BIM-Specific Scoping Guidelines Definition." They are intended to provide additional detailed support for the use of BIM for projects that use FIDIC.

The particular difficulty for FIDIC is the fact that contracts are so widely used worldwide, but BIM is still a versatile and differently applied methodology in construction projects around the world. A September 2017 [e]port on the use of BIM in Europe by the FIDIC Young Professionals Forum Steering Committee highlighted that 49% of those surveyed had used BIM in their work, compared to 44% who had never included this practice. Although this figure has changed, it shows the wide knowledge gap that FIDIC needs to consider when issuing recommendations and advice to participants in construction contracts and processes regarding the practical use of BIM (Glover, 2008).

In fact, the Advisory Note recognizes that there is a wide range of understanding and use of what FIDIC calls "varying degrees of complexity" associated with BIM. This is something for FIDIC to consider, which probably explains, in large part, the time it is taking to finalize its position and guidance. As noted by FIDIC, "Based on a team approach and successful projects, BIM promotes cooperation" (Glover, 2008).

FIDIC also recognizes the value of early and proactive involvement by all parties in a project. Here, one potential problem with BIM is managing expectations. FIDIC notes that any request for a proposal must outline what the procuring entity expects in terms of objectives and benefits.

Therefore, the problems outlined below in the application of BIM to a project under the contractual conditions of FIDIC should be considered in more detail:

- misunderstanding the scope of activities
- using data for an inappropriate purpose, and relying on inappropriate data
- ineffective management of information, documents, or data
- cyber security and responsibility for "holding" the models or data
- defining deadlines and deliverables

The reference to the importance of clear definitions is particularly relevant in international projects where there are often companies from a number of countries working together, and in fact, FIDIC is well placed in this regard. One of the golden principles of the treaty framework calls for "clear and unambiguous drafting." It is therefore likely that any

"BIM definitions" adopted by FIDIC will be based on international standards, preferably ISO 19650. As Jns Sjgren, Chair of the ISO Technical Subcommittee, says: "Bringing this to an international level not only means more effective collaboration on global projects but also allows engineers and contractors working on any construction work to have clearer and more efficient information management" (Glover, 2008).

As regards the issues of copyright and use of the contracting authority's and contractor's documents, a number of issues are likely to arise that require consideration in addition to the main FIDIC position. For example, does the contractor have the right to license to the client all the data in the project documents? Currently, there is no such right, but this only applies to the contractor's documents. A model can be a collection of elements and/or objects from a number of countries. An extended confidentiality clause may be needed, which, of course, will also require participants to identify confidential data when it is included in the model. In addition to this, it may be essential to have restrictions on access, copying, and transmission of data. Another issue that increasingly needs to be addressed in any project is how project data should be collected and used and to whom that data belongs.

Like insurance, clause 19 does not currently deal with parties other than the contractor and the principal. Consideration may need to be given to the role of funding parties as well as subcontractors, suppliers, and those with design responsibility. Often the works under one FIDIC contract are part of a larger overall design (Antonov, 2005).

A key feature of projects based on BIM technology and processes is the need for a BIM execution plan. It is good practice to prepare this plan as early as possible in the life cycle of a project, and the requirements of the plan should be linked to subclause 8.3. This plan is best viewed as a supplement to, but consistent with, the construction and design programs. However, subject to subclause 4.20, progress reports are a condition of payment.

Additionally, FIDIC encourages a mode of labor that is more collaborative and coordinated, both of which are essential components of BIM projects. There is a significant emphasis on early warning of problems and real-time dispute avoidance and resolution in the 2017 second edition of the FIDIC books, and this attitude also matches the expectations imposed by the BIM concept, as described in the previous section on the definition of BIM and the benefits of using BIM.

In addition, FIDIC defines BIM as "a process that has varying degrees of complexity" and "a mechanism for providing an environment in which all parties have access to information related to their role in the design and construction of a project" in its Advisory Notes to BIM Users. This information can be found in the document. This indicates that it is critical to have a transparent understanding of the roles and duties that each of the parties plays. The strategy that FIDIC takes, which is outlined in the second edition, is to adopt a variety of step-by-step procedures in addition to regulations that are established very specifically. Their goal is to provide clarity and comprehension regarding the activities that are to be carried out, as well as who is responsible for each activity and/or stage and when those activities are to begin and end. When it comes to outlining the requirements for a project that will adopt BIM, these are some of the most important things to take into account,

and it has been stated that the present approach taken by FIDIC is particularly suited for the drafting of BIM-specific provisions.

For instance, consultants are strongly encouraged to clearly define the following items: the proposed management systems and processes, the access rights of the client himself, other consultants, and contractors, taking into consideration the possibility that data may also be contributed to the digital environment by other countries;

- potential access restrictions and liability for technical malfunctions;
- accessing all versions of the project model and keeping track of modifications
- taking professional responsibility for the activities of others
- defining accountability in the event of a cyber attack

FIDIC's 2019 Strategic Plan (FIDIC, Strategic Plan, 2019) recognizes that one of the main emerging challenges facing the consulting and engineering industry is precisely what is summed up in the plan's title, "impact of new technologies, including building information modeling (BIM) and collaborative work."

BIM is more than just digital work and simple software—it is a management process that must establish who is responsible for what and bring together and coordinate all participants in the process. With this in mind, contract risk management never changes whether BIM is used or not (Fenwick, E., 2008).

- No matter what contracts, protocols, guidelines, or other requirements are put in place for a project, it is important that all parties involved understand their obligations, responsibilities, and limitations in each document.
- If procurement documents are not agreed upon and reviewed in sufficient detail, this can lead to ambiguity and uncertainty.
- All parties must understand the activities involved in the construction contract.

BIM does not substantially change the content of the employer's and/or contractor's missions, but the way to respond to them. It must be more explicit on roles, responsibilities, and information traceability to increase its quality and therefore its value. Few authorities (Dubai, UK, Finland, Hong Kong) have already included BIM in their legislation. An annex to the contract or a protocol will allow the practitioners to identify the basic parameters.

The following example points of such annex in a FIDIC environment, will have to be defined:

- BIM protocol: who does what, when, and how it terms of main activities and access
- Legal definitions and conflict resolution provisions (in case of conflicts between the contractual parties)
- duties, obligations, and liabilities of the parties (Employer, Contractor and Engineer) (Efcenet, 2020)

However, BIM, along with huge data stores (Big Data) being accessible through the World Wide Web, changes the world. In the end, it could be possible that the ideas of architects and engineers find their way easily into new projects - including all connected data like calculations, descriptions of materials, and so forth. It is important to think about

worldwide copyrights and big data-based services that can protect intellectual property rights. The evolution of BIM has been strongly supported by software, and working in a BIM process is simply not possible without it in some way, whether it is limited to the creation of 3D models or involves the full cooperation of all stakeholders in a Common Data Environment (CDE). Since BIM is all about evolving towards a digital twin, the "single source of truth," software vendors become an important and powerful supplier in a project. Digitization is becoming more and more part of our global culture and is evolving and changing very fast. Also, contractual agreements should preferably contain mechanisms on how to deal with partners joining and leaving the project team with regard to software implications. In projects using multiple software with cloud solutions, there is a risk that the concept of "single source of information" may be compromised. The architecture, engineering, and construction industries should apply open BIM standards and use open cloud software products. This is also in the interest of the IT industry because their business case is growing because of a growing international standard for the same tools.

But BIM and the availability of vast data repositories (Big Data) online alter everything. Ultimately, it is likely that architects' and engineers' concepts, along with any associated data such as calculations, descriptions of materials, and so on, might be easily included into new projects. Global copyrights and services based on big data are crucial to the defense of intellectual property. Software has played a crucial role in the development of BIM, and without it, the generation of 3D models or the full collaboration of all stakeholders in a Common Data Environment would be impossible (CDE). The use of digital technology is rapidly expanding and altering across all cultural realms. The software effects of team members joining and leaving the project team should also be addressed in the contracts between the parties. The IT sector benefits from this as well, as internationalization of use of similar tools strengthens their business case.

5. Conclusion

In practice, BIM is used in the planning, design, construction, and exploitation phases of a building or facility, helping architects, engineers, and builders visualize the future project in a simulation environment, which in turn allows them to identify problems and improvement issues at an early stage rather than facing these dilemmas during project implementation itself. In this way, BIM facilitates the optimization of the overall process and project and supports the integration of all stakeholders and direct participants in the project into a common coordination team (Azhar, 2011).

It is crucial to comprehend the obligations, liabilities, and limitations in each document, regardless of the contracts, protocols, guidance notes, or other requirements that may be included for a certain project. Ambiguity and confusion may result if the contract documents are not consistent with one another and/or are not carefully taken into account. Depending on the terms of the contract, these may be legally binding contracts with obligations contained within that everyone needs to comprehend and be aware of.

Although the construction industry is positively shifting from the traditional design-build model to BIM, the legal corridors for transfer are very slow to keep up with the development of the economy and the change in technology.

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