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Overview: the opportunity of BIM in railway

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Abstract

Purpose – The authors will give an overview of the railway market, with a focus on Morocco, before seeing the challenges to face, before listing some benefits of rail links in terms of development, ecology, security, space management, etc. The authors will then give an overview of the development of BIM, its benefits, risks and issues. The purpose of this paper is to verify that the BIM can provide the railway with the tools to face some of its challenges and improve its productivity.

Design/methodology/approach – This paper is part of our research project on the integration of BIM in railway, which is the result of a partnership between Colas Rail Maroc and the ENSAK of the Ibn Tofail University of Kenitra. The objective of this paper is mainly to confirm that the integration of BIM with the railway, through a theoretical and practical study, can have positive impacts. To do this, our methodology consists in studying briefly the development of the railway, the need to improve the budgets and schedules of the projects, to increase the productivity, before showing the advantages of the BIM in the sector of the Architecture, Engineering and Construction (AEC). The study of feedback from railway projects (chosen for their date of completion – beyond 2014, their size, their geographical situation in several countries and for the availability of literature in a new field) will confirm the initial hypotheses. Among the projects studied will be a project that has been the subject of an article written by the authors of this paper. In the discussion of the results, the authors will focus on the benefits, risks and limitations of integrating BIM into the railway. In conclusion, the authors are laying the groundwork for future research in the field.

Findings – The cases study discussed in this paper and previous research confirms the hypotheses of the literature. The integration of BIM into railway projects can have several advantages: collaboration, time saving, cost optimization, prevention of conflicts between networks, construction before construction, optimization of facility management, improvement of the quality of works, prefabrication. They also allowed us to illustrate the risks (status and appropriation of the BIM model, lack of standardization of versions or software and lack of understanding of the basics of schedules and specifications) and limitations (lack of feedback, lack of adaptability and convergence of tools). These experiences have also shown that the use of BIM is not just a technological transition, but a revolution in the project management process, which requires several key success factors (participation of all, commitment, change management and adoption of the collaborative approach). Visualization, collaboration and conflict elimination are the three main chapters where the benefits of BIM can be organized. In fact, there is a lot of intersection between these chapters, but they have been chosen as the main ideas around which all the benefits can be better understood. Visualization primarily addresses the benefits to an individual and improving one's personal understanding as a result of using BIM. The collaboration refers to the cooperative action of several team members, which is encouraged and facilitated by BIM. Conflict elimination mainly concerns project-related benefits, such as conflict reduction, waste, risks, costs and time. For railway infrastructure projects, the main purpose of using BIM is to improve the design integration process, internal project team communication and collision detection to eliminate risk of rehabilitation.

Research limitations/implications – The application of the BIM process in railway infrastructure requires constant improvement. This concerns the development of libraries and the models available to all users in order to encourage the development of this methodology and, consequently, its use of information throughout the life cycle of an infrastructure work.

Practical implications – The case study of real projects incorporating BIM confirms the results of the literature review. The benefits of integrating BIM into rail projects are multiple and proven: cost control,

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decision support, avoids extra work due to design errors, improves detection of interface problems, improves planning of vision, help with prefabrication and facility management, etc. Finally, the BIM process is able to overcome delays in procedures slowing the development of the construction industry in many countries, especially in Morocco, because of the slowness of design (or downright bad design).
Social implications – The integration of BIM into rail is becoming a global trend. This integration requires government decisions and a maturation of technology and tools. The authorities of some developed countries studied (Sweden, UK, France, Germany) in the railways, at different stages of implementation, are adopting BIM in the process of setting up new railway projects. This political impulse is still behind in southern countries, such as Morocco. The trend and the data collected indicate an adoption between 2020 and 2030 of BIM in all/some AEC projects in developed countries. This will have an impact on other countries that will soon be doing the same, especially in the railway sector to adopt the BIM.
Originality/value – As part of the realization of this paper, we proceeded to the implementation of an electrical substation as part of the project to build 40 electric traction substations built by Colas Rail on behalf of ONCF.
Keywords Management, Design, BIM, Building information modeling, Railway infrastructures, Architecture, Engineering and construction
Paper type Research paper

Introduction

Rail is a critical infrastructure industry for economic and regional development at the country level. It contributes greatly to economic growth and human exchanges. This market represents today an annual growth of 2.3 percent until 2010 (Bensalah *et al.*, 2018a). The railway projects are spread over several years and include several phases from the idea, realization to operation and maintenance. Throughout these phases, the men of the art (architects, engineers, builders, maintainers and operators) exchange thousands of 2D documents. This reality implies that many tasks remain sequential, the collaboration remains difficult between the different disciplines and the errors are more probable (Suchocki, 2017).

During the last decade, academic research and industrial development have evolved significantly in the field of building information modeling and have resulted in models to support the improvement of various aspects of design, architecture, engineering, construction and operation. Building Information Modeling – BIM – is a new approach to managing infrastructure projects that is based on an intelligent digital model of 3D representation (Pezeshki and Ivari, 2018). BIM promises to foster work collaboration around a database (or digital model), optimize the overall project planning and deepen the mastery of economic data throughout the entire life cycle. In recent years, scientific research and industrial progress have focused their efforts on the development of building information modeling and have tested and used models to support various aspects of architecture, engineering, construction and construction and facilities (Nepal *et al.*, 2008). "BIM allows participants to collaborate in a shared software-based environment to share information, enabling better decision-making throughout the project life cycle" (Kurwi *et al.*, 2017, p. 47).

We will list the economic, social and environmental impacts of railways by showing the global trend in the sector in Morocco and the need to increase productivity and improve schedules and budgets. Next, we will show how BIM has helped to improve the management of projects and facilities in various sectors before talking about BIM in rail. Concerning this last point, we will discuss examples of regulatory frameworks (norms, legislations, etc.) or their absence, feedback from four projects in different countries (realized after 2014) and a project in Morocco (Bensalah *et al.*, 2018b). In the end, we will discuss the results and conclude on future research.

Methodology

This paper is part of our research project on the integration of BIM in railway, which is the result of a partnership between Colas Rail Maroc and the ENSAK of the Ibn Tofail University of Kenitra.

The objective of this paper is mainly to confirm that the integration of BIM with the railway, through a theoretical and practical study, can have positive impacts.

To do this, our methodology consists in studying briefly the development of the railway, the need to improve the budgets and schedules of the projects, to increase the productivity, before showing the advantages of the BIM in the sector of the Architecture, Engineering and Construction (AEC). The study of feedback from railway projects (chosen for their date of completion – beyond 2014, their size, their geographical situation in several countries and for the availability of literature in a new field) will confirm the initial hypotheses. In conclusion, we are laying the groundwork for future research in the field.

Railway – formulation of the problem

Railway is hardly able to contribute actively to the economic development of the States and to the balanced development of their territory. In the global race to improve logistics, allowing for more and more goods to be exchanged, and thanks to its greater reliability in the face of uncertainties and climatic hazards, the railway could reduce delivery times and mitigate disruptions of stocks, thus ensuring relative safety during harvest peaks and limiting waste. Thus, regarding the railway projects sector, the choices and investments are heavy, their implementation is laborious and their profitability is slow to assert itself. Political will is crucial in this respect (Bavoux, 2000).

To take the example of Morocco, the current rail network at the end of 2017 has approximately 3,600 kilometers of track managed by the ONCF, public manager of the interurban railway infrastructure (ONCF, 2017), two tram lines in Rabat-Salé de length 18 km, managed by STRS (local development company in charge of the tramway of Rabat – Salé) and a tramway line in Casablanca 30 km long run by Casa Transport (local development company in charge of the Casablanca Tramway). In 2018, the ONCF will open 360 km of high speed line and 300 km of conventional line (more than 18 percent of the current network) and by 2035, more than 1,100 km of high speed line are planned (ONCF, 2009), in addition to the planned conventional lines. In Casablanca, a 15 km tram line will open in 2018, and two lines totaling 30 km will be operational by 2022 (Casa Transport, 2015). In Rabat, 29 km of trams are planned, of which 7 km will be operational in 2019 (Kacimi, 2017). The global trend is not lagging, as the rail market is growing at around 2.3 percent per year (Bensalah *et al.*, 2018d), which exceeds global GDP growth.

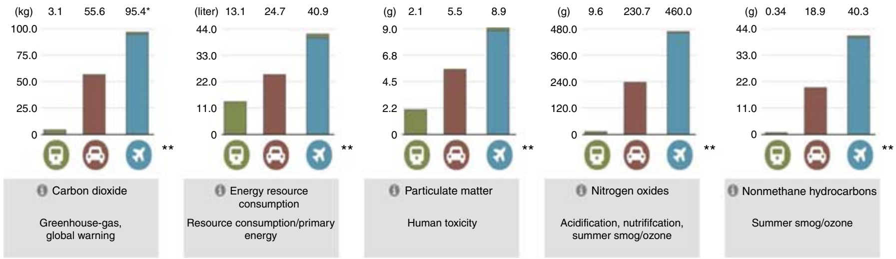
It is undeniable today that the strengths of rail (Bensalah *et al.*, 2018a) are extremely important. To name only these:

- Safety: the train represents a solution to reduce the deplorable human invoice due to road accident (the bitter reality is that Morocco, for example, counts the 3,600 deaths per year in road accidents in the country).
- Space saving: for cities congestion, rail is an asset. Also, it should be noted that a double rail track requires 14 m against 40 m for highway.
- The environment: the reduction of greenhouse gas emissions, the reduction of energy pressure and dangerous goods transport solutions are important for decision-makers today.

On this last point, rail is the most environmentally friendly means of transport. The UIC data for a Paris–Lyon trip gives the following comparison in Figure 1.

It is certain that railway will continue to grow significantly, but budget, planning and ecology constraints represent a major challenge for this sector and the AEC industry in general. Indeed, at a conference held in 2011 in the sector, the UK government (UK Government, 2011) argues that:

- 38 percent of carbon emissions in the US come from buildings, not cars;
- 30 percent of projects do not implement a schedule or budget follow-up;



Notes: *This does not cover the whole global warming impact of the flight. To consider it totally, select "CO_2-emission with climate factor" in the setting. The RFI Factor takes into account the additional climate effects of other GHG emissions especially for emissions in high attitudes (nitrogens oxides, ozone, water, soot, sulphur); **incl. feeder by railway services respectively car
Source: Bensalah (2018a)

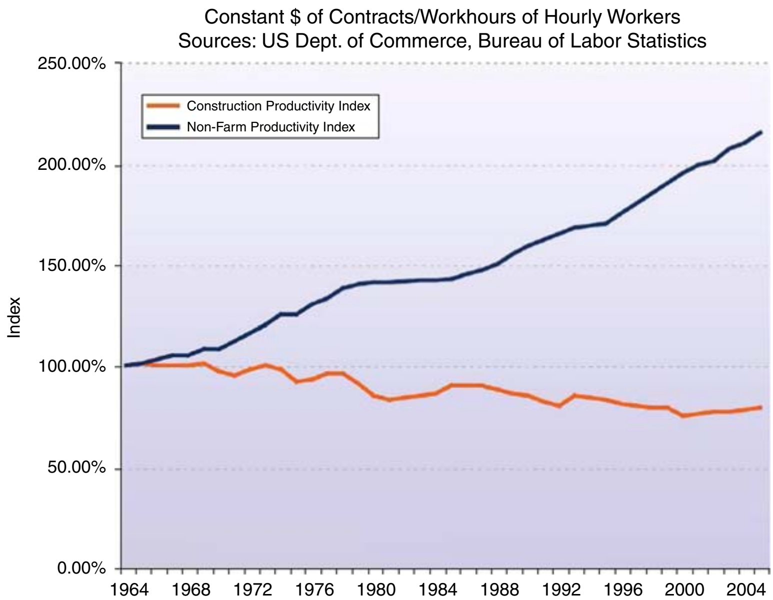
Figure 1. Emission comparison of different means of transport

- 37 percent of the materials used in the construction industry become waste (i.e. not reused); and
- 10 percent of project costs are due to changes in progress.

This same document showed the productivity decline in the AEC industry in the USA, qas shown in Figure 2.

In summary, rail is a sector that will experience major development in the near future, but it faces, like the AEC industry, significant constraints in terms of cost reduction, optimization of schedules. Our approach proposes to integrate the BIM throughout the life cycle of railway projects in order to respond positively to these constraints.

In the next paragraph, we will discuss BIM and its development.



Note: UK Government (2011)

Figure 2. Construction productivity index

BIM

BIM is not only a software, it is a culture: collaboration, organization and team working. BIM is more sociology than technology, and BIM culture should be maintained in the project before adopting the cutting edge technology (Gamil, 2017).

A building information model can be used for the following purposes: visualization 3D renderings, fabrication/shop drawings, code reviews, cost estimating, construction sequencing: a building, conflict, interference and collision detection, forensic analysis, Facilities management (Bensalah *et al.*, 2017; Lu *et al.*, 2017). Studies reported major benefits of BIM: Up to 40 percent elimination of unbudgeted change, Cost estimation accuracy within 3 percent as compared to traditional estimates, Up to 80 percent reduction in time taken to generate a cost estimate, A savings of up to 10 percent of the contract value through clash detections, and Up to 7 percent reduction in project time (Bensalah *et al.*, 2017; Lu *et al.*, 2017).

As part of this literature review (Bensalah *et al.*, 2018c), we have estimated that BIM has several levels of maturity. They are the steps to move toward collaborative BIM:

- BIM level 1: the isolated BIM includes the realization of the digital model, the use by one or more actors, but does not include the exchanges between the models, each one updates its data individually.
- BIM level 2: establishment of collaborative work between actors where several models linked and put in common and allows to combine all the models into a single or federated model. It includes: a graphic model or 3D digital mockup, non-graphical data (information for the use and maintenance of the work), structured data, documentation, a native file format (IFC).
- BIM Level 3: the ultimate goal of BIM (for many, only level of the BIM process), a unique model shared by all actors. It allows the possible intervention by all and at the same time. It includes "Level 2" + storage on a centralized server.

A recent article (Bensalah *et al.*, 2017) has already tested the benefits of BIM during all phases of an installation's life, that we list in Table I.

In this sense, here are the main contributions of BIM:

- Idea phase: improve feasibility, increase quality, promote integration by facilitating collaboration.
- Design phase: correction at low level of impact of errors, detection in phase study of "collisions," visualization of what "we build," Improve performances safety, security, energy, etc.
- Construction phase: to favor the early start, to make the tasks more parallel rather than sequential, prefabrication, to discover the errors of studies before the construction, optimization of the use of the materials.
- Operation phase: improve maintenance processes, integrate changes into the life cycle.

As the construction industry in recent years has noticed a sudden development in the way and the construction technique such as the use of prefabricated elements and more innovative materials such as carbon fiber or machinery. But meanwhile, the construction industry is still poor in the implementation of BIM and uses more of its features for the planning of construction and site planning. "It is important to note that BIM is not just software; it is a process and software; BIM means not only using three-dimensional intelligent models but also making significant changes in the workflow and project delivery processes" noted Gamil (2017).

Phase	BIM benefits	Cost impact of using BIM	Results and comments
Idea	Concept, feasibility and design benefits		
	Increased building performance and quality		
	Improved collaboration using integrated project delivery		
Design	Earlier and more accurate visualizations of a design		
	Automatic low-level corrections when changes are made to design		
	Generation of accurate and consistent 2d deawings at any stage of the design		
	Earlier collaboration of multiple design disciplines	Reducing 15% change orders	Change orders estimated to 10% of project costs. This corresponds to 1.5% reduction of the cost of construction
	Easy verification of consistency to the design intent		
	Extraction of cost estimation during the design stage		
	Improvement of energy efficiency and sustainability		
Construction and fabrication	Use of design model as basis for fabricated components		
	Quick reaction to design changes		
	Discovery of Design Changes		
	Synchronization of design and construction planning	Reducing 5–15% Schedule	10% reduction of time correspond to 5% reduction of the cost of construction of the project (50% of the cost of the projects are relative to manpower, management and machinery)
	Better implementation of lean construction techniques		
	Synchronization of procurement with design and construction – Reduction of waste and reworks	Saving 9% of materials	This correspond to 4.5% reduction in the cost of construction
Post construction benefits	Improved maintenance process	Saving 10% of cost	
	Improved commissioning and handover of facility information		
	Integration with facility operation and management systems		

Source: Bensalah *et al.* (2017)

Table I.
Benefits of BIM during life cycle

At the same time, it must be considered that the integration of the BIM reveals some risks that must be considered to master. BIM risks can be divided into two broad categories: legal (or contractual) and technical (Bensalah *et al.*, 2017). As legal risks we can mention: Ownership of BIM data, license limit issue, mastery and mastering of the database with regard to the impacts of the modifications, etc., and as technical risks we can mention: the use of different software or different versions, the use of different planning or cost estimate,

In addition, "There is a need to standardize the BIM process and to define guidelines for its implementation." Software today does not make it possible to carry out all the steps of the BIM. The steps of the implementation are not standardized either. "Additionally, the industry will have to develop acceptable processes and policies that promote BIM use and govern today's issues of ownership and risk management" (Lu *et al.*, 2017).

In Figure 3, we show a building project whose design was realized with the BIM process as part of our research project.

BIM integration to railway projects

The benefits of adopting BIM technologies go beyond time management, but also include better solutions, more committed players, substantially reduced errors during the project construction phase of projects, and significant improvements during the use of facilities. (Suchocki, 2017). (Figure 4)

The integration of BIM into railway projects, in view of the above, has many advantages, among others (Bensalah *et al.*, 2018c):

- Decision support: allows you to make the right choices from the start through simulations, tests and representations (integration of the budget dimension for cost optimization, consistency of information, avoid repetition, detect contradictions and reduce delays).

Figure 3.
Modeled building under 3D BIM process

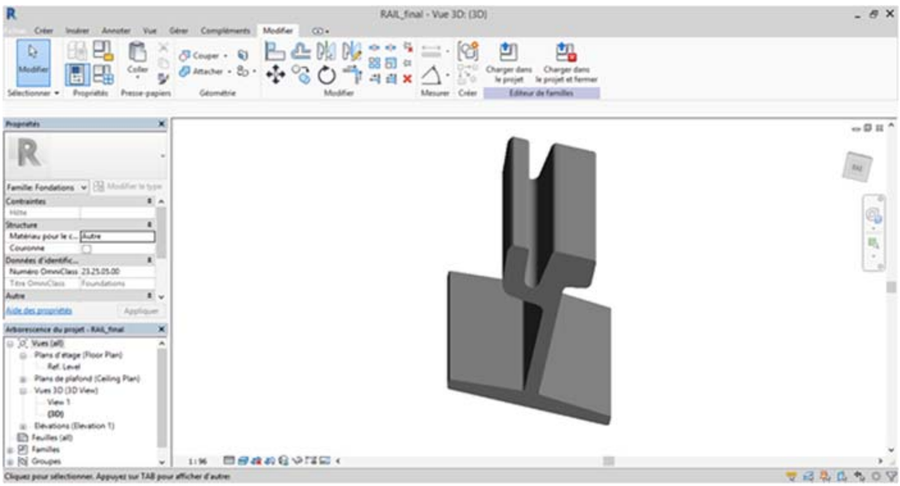


Figure 4.
Creation of the railroad type family under BIM software

- Mastery of the implementation phases: better planning of needs and supplies combined with anticipation of difficulties is one of the main advantages of BIM.
- Assistance for management, operation and maintenance: makes it possible to facilitate the future evolution of new works and to facilitate their adaptation to new needs or to the evolution of the environment.

The adoption of BIM in the railway is usually the result of a high-level political decision and requires years of model building. For example, in the UK, the Crossrail project started adopting BIM at the beginning of 2007, under the impetus of the government, and will not be effective until 2019! Prior to 2011 (Government Conference on BIM Adoption), the implementation of BIM on major civil projects in the UK is still in its infancy but is rapidly gaining momentum (Smith, 2014; UK Government, 2011). In France, from 2016, the use of BIM has become mandatory in all public sector projects. France has established a regulation and from 2017, the BIM will be used for all public buildings. By contrast, there is no BIM regulation in Sweden, but the big public players have been inspired by British development by adopting BIM strategies, which is in line with the 2014 Mc GrawHill report which indicates that many public goods and public customers need BIM for their projects (Davies *et al.*, 2015). The German BIM initiative ("Stufenplan" of the German Ministry of Transport and Digitization) defines the BIM project implementation level 1 which should be carried out in all infrastructure construction projects from 2020 (Borrmann *et al.*, 2016, p. 3).

Analysis of BIM application in railway

In what follows, we will proceed to studies of 5 selected cases for their sizes, their completion dates (beyond 2014), for their geographical situations in several countries, for the variety of typologies (urban, interurban, subway) and for the availability of literature. Each case will be synthesized in a table summarizing its identification, proven benefits, identified risks and limitations.

Project Mälarbanan, Sweden

Table II summarize information about Mälarbanan project.

Project name	Mälarbanan
Project owner	Swedish Transport Administration
Company	Vectura
Country	Sweden
Probable delivery year	2016
Benefits	Concept, feasibility and design benefits; increased building performance and quality; improved collaboration using integrated project delivery (IPD); cost estimates throughout the design phase; discovery of design errors before construction; Synchronization of design and construction planning; better implementation of lean construction techniques; integration with facility operation and management systems; a better understanding for the railway facility since all CAD designers can see the common 3D model at an early stage in the project; better review of object placement, everything is in a 3D environment; design material in a digital environment can facilitate visualization, simulation, quantity take-off, time planning, cost calculations, etc; 4D-modeling; re-use of data through different stages in the process; Better quality and time saving through a more effective work method; fulfillment of new industry standards for upcoming procurements
Risks	The designer does not benefit most as the key adopter; collaboration challenges; legal status of the model; changes in practice and use of information
Limitations	A condition is that all technical areas work in the same model
References	(Norberg, 2012)

Table II. Project file Mälarbanan

TUC/INFRABEL experience, Belgium
Table III summarize information about TUC project.

BIM at SNCF maintenance department, France
Table IV summarize information about SNCF maintenance project.

Crossrail, UK
Table V summarize information about Crossrail project.

ONCF electrical substation, Morocco
Figure 5 shows layouts of 3D model of the project.

Table VI summarize information about ONCF project.

Discussion

For railway infrastructure projects, BIM's main objective is to improve the design integration process, the project team's internal communication and collision detection to eliminate the risk of rehabilitation. The case study discussed in this paper and previous research confirms the hypotheses of the literature.

The integration of BIM into railway projects can have several advantages: collaboration, saving time, optimizing costs, prevention of conflicts between networks, construction before construction, optimization of facility management, improvement of

Project name	Schuman–Josaphat Tunnel
Project owner	Infrabel
Company	TUC
Country	Belgium
Probable delivery year	2016
Benefits	Improve the integration of design; internal project team communication; collision detection to avoid re-work during project; minimize delays of project execution on the site; higher quality projects delivered on time and on budget
Risks	Bad communication between designers; communications, manuals, training courses and workflows inadequate with the target audience
Limitations	Different levels of BIM maturity of each project unit of the project team; clear communication of the BIM vision to all colleagues; guiding the management of change and taking into account the specificity of the company; minimum requirements for BIM data must be defined such as the status of the object
References	Nuttens *et al.* (2018)

Table III.
Project file TUC

Project name	Railway SNCF maintenance (regions of Metz and Strasbourg and the catenaries in the framework of the Charles de Gaulle Express project)
Project Owner	SNCF
Company	SNCF; Dassault Systèmes.
Country	France
Probable delivery year	2018
Benefits	Improve our knowledge of the network; economic performance, during studies, during renovation or construction work […] and during the maintenance of tracks or stations; maintaining internal requirement in terms of the safety of the users
Risks	Poor 3D data acquisition
Limitations	Different levels of BIM maturity of each project unit of the project team
References	(Landes, 2016)

Table IV.
Project file SNCF maintenance

Project name	Crossrail (Elisabeth Line)
Project owner	Crossrail Limited
Company	Bechtel Civil Limited
Country	UK
Probable delivery year	2019
Benefits	25% reduction in waste and rework; virtual elimination of design coordination error; direct fabrication from BIM: 0 errors; 12–16 week savings; increased investor/lender confidence; return on Investment (ROI) range = 3:1 to 12:1, 70% Claim reduction
Risks	Implement the BIM commercial framework at the start of the project; CIC (Construction Industry Council) BIM Protocol (or similar) should form part of the contract basis to provide governance around the use, liability and ownership of the BIM model; the whole project team needs to understand their role in BIM as it affects their work responsibilities and all phases of the project life cycle; Common Data Environment (CDE) foundation for collaborative design is essential, this should be enabled for the whole supply chain to foster innovation and maximize data reuse; design change needs to be carefully managed at model element level and preferably as a work process built into the CDE rather than an external additional process; intelligent (object-oriented) 3D models are an essential foundation for leveraging 4D, 5D, and design analysis; consistent application of standards is fundamental to the success of BIM; for example, schedule WBS needed for 4D modeling
Limitations	
References	Smith (2014)

Table V.
Project file crossrail

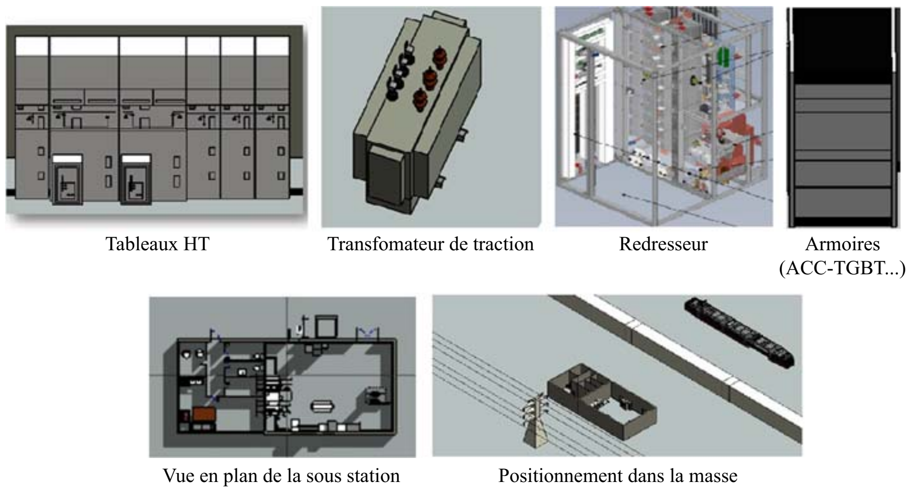


Figure 5.
Layout of 3D model of ONCF electrical substation project

the quality of works, prefabrication. These experiences have also shown that the use of BIM is not just a technological transition, but a revolution in the project management process, which requires several key success factors (participation of all, engagement, change management and adoption the collaborative approach). Visualization, collaboration and conflict elimination are the three main chapters where the benefits of BIM can be organized. In fact, there is a lot of intersection between these chapters, but they have been chosen as the main ideas around which all the benefits can be better understood. Visualization primarily addresses the benefits to an individual and enhances his or her personal understanding through the use of BIM. The collaboration refers to the cooperative action of several members of the team, which is encouraged

Project name	ONCF 40 electrical substations
Project owner	ONCF
Company	Colas Rail
Country	Morocco
Probable delivery year	2018
Benefits	Working on a unique 3D model has allowed design teams from different disciplines to work together and better. The usual round trips and incomprehension between disciplines have given way to more effective collaboration; Collaboration; time saving; cost optimization; prevention of conflicts between networks; building before building; optimization of facility management; improvement of the quality of works; prefabrication
Risks	The BIM integration speed differs from one discipline to another. While architectural and structural aspects were more likely to adopt the approach, other disciplines have encountered problems, especially related to interfaces with other dedicated software; The addition of the planning and budget dimensions has complicated the tasks in the studies. Objects must be drawn in such a way as to take these dimensions into account
Limitations	Studies on the BIM model took longer as it required redrawing everything, including topographic acquisition. The advantage of integrating BIM in the sketching phase shows its relevance; One of the difficulties encountered was to redesign mechanical and electrical equipment. Not all equipment providers are on BIM logic. Hence the interest of integration when defining contractual obligations; In the absence of local standards, railway standards or object libraries, it was necessary to draw everything; The team members and the client are wondering about the implementation schedule and fear that the integration of the BIM will delay the progress of the project (because they did not understand firstly the investment of time to build the BIM modeling and secondly that this modeling started when the project had already started for months). This reflects the misunderstanding around BIM: It is not a simple 3D design process, but a management approach that should accompany the project from the idea and throughout the entire life cycle of the infrastructure
References	Bensalah *et al.* (2018b)

Table VI.
Project file ONCF electrical substation

and facilitated by BIM. Conflict elimination mainly concerns project-related benefits, such as conflict reduction, waste, risks, costs and time. This confirms the result of the literature on the subject (Bensalah *et al.*, 2017; Nuttens *et al.*, 2018; Borrmann *et al.*, 2016).

They also allowed us to illustrate the risks (status and appropriation of the BIM model, lack of standardization of versions or software and lack of understanding of the basics of planning and specifications). These risks are also identified in the literature (references) and are the subject of works and consultations (Lu *et al.*, 2017; Borrmann *et al.*, 2016; Bensalah *et al.*, 2018d) to minimize them.

Our work has shown several limitations: lack of feedback, lack of adaptability and convergence of tools, lack of maturity on railway projects that have implemented BIM. These limitations are similar to those found in the literature (Singh *et al.*, 2011; Bensalah *et al.*, 2018b), but they are accentuated in the rail because of the delay in the use of BIM.

Conclusions – perspectives

In this paper, after having given an overview of the development of the railway construction market (especially in Morocco), we have seen that this sector is promising, but at the same time it faces major challenges: budget, management of time, lost productivity, etc. We exposed BIM, its development, its advantages as a tool and process to pilot large projects in a collaborative way, from the idea phase to the operation and maintenance phase. The integration of BIM into rail is becoming a global trend. This integration requires government decisions and a maturation of technology and tools. The authorities of some developed countries studied (Sweden, UK, France, Germany) in the railways, at different stages of implementation, are adopting BIM in the process of setting up new railway projects. This political impulse is still behind in southern countries, such as Morocco. The trend and the data collected indicate an adoption between 2020 and 2030 of BIM in all/some AEC projects in developed countries. This will have an impact on other countries that will soon be doing the same, especially in the railway sector to adopt the BIM.

The case study of real projects incorporating BIM confirms the results of the literature review. The benefits of integrating BIM into rail projects are multiple and proven: cost control, decision support, avoids extra work due to design errors, improves detection of interface problems, improves planning of vision, help with prefabrication and facility management, etc. Finally, the BIM process is able to overcome delays in procedures slowing the development of the construction industry in many countries, especially in Morocco, because of the slowness of design (or downright bad design). Ultimately, the application of the BIM process in railway infrastructure requires constant improvement. This concerns the development of libraries and the models available to all users in order to encourage the development of this methodology and, consequently, its use of information throughout the life cycle of an infrastructure work.

From this paper, we can identify interesting lines of research for our research project to integrate.

BIM into railway projects:

- Standardization of the stages and phases of rail project management by integrating BIM, a comparative study of cases.
- Technological development and software tools to integrate rail libraries, special and normative constraints of large linear projects.

These themes, which are not very rich in literature, can make a major contribution to the successful integration of BIM in the railway sector, especially in developing countries.

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