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A Preliminary Implementation Framework of Building Information Modelling (BIM) in the Algerian AEC Industry

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ABSTRACT

The construction industry is one of the most growing sectors worldwide, it plays a great role in boosting the economy. The construction sector in Algeria has recently witnessed an upward growth, due to the Algerian government's vision to develop economic activity and boost the residential construction market. On the other hand, the Algerian construction market is suffering from the lack of efficiency; projects delay and less quality of projects delivery. It becomes very necessary to find a way to improve these inefficiencies by adopting new approaches and technologies. Building Information Modelling (BIM) is becoming a widespread and common approach in the design, construction and maintenance of building facilities as BIM reduces waste, improves construction quality and enhance collaboration among the construction stakeholders. Hence, it becomes necessary to start gradually introducing BIM to the Algerian construction industry in order to improve its productivity. This paper addresses BIM implementation in the Algerian AEC industry and proposes a preliminary framework towards its implementation. Through a questionnaire survey, we explored the BIM capabilities, BIM awareness and BIM maturity of the Algerian AEC players. Based on the questionnaire findings and literature review, this paper proposes an effective BIM implementation based on both levels of macro-adoption and micro-adoption. The framework developed is based on three main aspects comprise of technology, process and policy. This study is considered as the first implementation framework of Building information modelling in the Algerian AEC industry. The framework proposed will be used as a reference for the Algerian researchers and professionals.

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1. Introduction

Construction is at the highest impact in North African countries. It has seen significant growth and offers interesting opportunities for all players in the industry (African Review, 2017). Governments are focusing on different sectors such as urban construction to strengthen their economics, especially in Algeria, where there is an increasing demand for infrastructure and housing (Panzeri, 2016). Governments around the world have recognised the inefficiencies affecting the construction industry in general and have recommended and mandated the practice of Building Information Modelling (BIM). Several factors for better BIM implementation have been discussed in previous research.

A number of authors discussed BIM implementation as a technology and a combination between software knowledge and skills (Miettinen & Paavola, 2014) while others see that investing in IT infrastructure with education and training is a key factor (Lindblad & Vass, 2015). On the other hand, some researchers see change management and elaborating new business models as critical factors for BIM adoption (Lizhu, 2017; Miettinen & Paavola, 2014). People have been identified as one of the important factors for successful BIM implementation such as individual's awareness and willingness (Chen & Li, 2015). Succar et al. (2013) in his research discussed the individual competency and identified it as a key role for successful BIM implementation and the researcher defined individual competency as 'way to put in practice some knowledge, know-how and also attitudes, inside a specific context'. Miettinen and Paavola (2014) defined trust, transparency, effective collaboration, open information sharing, and shared risks and rewards between individuals as fundamental for successful BIM implementation. Furthermore, other researchers see the BIM as a policy aspect that includes mandates, standards and a clear government strategy (Lindblad & Vass, 2015; Miettinen & Paavola, 2014; Yang & Chou, 2018). Government should consider developing BIM education and programs in order to increase the individual competencies, awareness and knowledge (Yang & Chou, 2018).

Several researchers consider encouragement from top management having a positive impact on BIM implementation (Kullathamyothin, 2006). Hence, this study investigates the necessary steps and the key factors for successful BIM adoption. This research introduces a preliminary framework for BIM implementation in the Algerian AEC industry and can be used as a reference for the developing countries that have the identical construction industry environment. This research represents the first initiative of developing a BIM implementation framework for the Algerian AEC industry based on mixed approaches of government-driven and industry-driven.

2. Literature Review

2.1 Applications of BIM

To achieve better BIM implementation, it is vital to demonstrate the use of BIM on a construction project. Rowlinson and Yates (2003) identify that multi-dimensional CAD can be the change agent that drives the construction industry towards relational contract procurement systems and facilitates roles changes toward collaborative design, construction and facility management. They claim that such technology has the potential to integrate client, designers and contractors at the early stage of a project, which improve the decision-making.

Won et al. (2013) demonstrate that BIM adoption can bring more clear benefits and advantages with complex projects. BIM has been adopted for a variety of functions through the project lifecycle. The level of BIM implementation is based on the characteristics of the project, support of management and involvement of different professionals. BIM moves well beyond 2D CAD, ultimately entailing a multi-dimensional process. Various dimensions of BIM use have been categorized according to the implementing process. Dimensions of BIM can be divided into:

- The 3rd dimension is space;
- The 4th dimension is time, i.e. scheduling and sequencing;
- The 5th dimension is cost estimation;
- The 6th dimension is facility management.

3D BIM is regarding geometry position, which allows people to detect clashes and coordinate effectively. Geometrical representation could expose the misalignment of drawings of different trades. 4D BIM combines time with geometry information. It could determine when a component can be in a particular position according to schedule. 5D BIM adds cost on 4D BIM. It could identify the cost of any components of the model. Combining space and time, 5D BIM could demonstrate the cost of any object at a position at a particular time. 6D BIM is about the lifecycle of the building. It is about how the building impacts its surroundings and other aspects, which have an impact on the building.

BIM can be used as a tool, a platform and environment (C. Eastman et al., 2011). As a tool, BIM is a task-specific application. It is used for model generation, automatically checking the design for the satisfaction of building specification and customised requirements, and identifying conflicts and clashes by checking the multi-disciplinary model before construction.

2.2 Overview of BIM Implementation

Developed countries such as the USA, UK and Singapore have realised the critical role of BIM to provide improvements in productivity and cost-saving through all phases of the AEC industry (Chew & Riley, 2013; Kaneta et al., 2016; Khosrowshahi & Arayici, 2012).

Table 1 Overview of BIM in developed countries

Country	Revolution in BIM Adoption
The United States of America	• Leader of BIM implementation technology (Chew & Riley, 2013); • 1990's establishment of buildingSMART, formerly called the International Alliance for Interoperability (Edirisinghe & London, 2015); • The National BIM policy program was introduced in 2003, and later in 2007 BIM was mandated in the USA.
United Kingdom	• In the UK, BIM is used in the design and construction fields over the past 20 years; • UK government in 2011 published The Government Construction Strategy and announced its intention to require collaborative 3D BIM on its projects under asset information, documentation and data being electronic by 2016 (Khosrowshahi & Arayici, 2012); • UK has the vision to computerise the construction process through the use of technologies, for this purpose they adopt the UK Digital Built Britain (Eadie et al., 2015).
Singapore	• Singapore has been promoting the usage of BIM since 1997 in the different construction departments and approvals such as building plan and fire safety certifications (Wong et al., 2010); • Singapore wants to establish the world's first BIM electronic submission (e-submission) through The Building and Construction Authority (BCA) (Edirisinghe & London, 2015); • Singapore is putting Mandatory BIM e-submission via Coronet for new building projects over 5,000 m^2 (Kaneta et al., 2016); • It is obliged for architects and consulting engineers to use BIM for design. However, the quality and density of the design drawings as the output of BIM are not always enough (Kaneta et al., 2016).
Australia	• Building information modelling (C. Eastman et al., 2011) has emerged in Australia, particularly in 2011, after the UK Government recognised the tangible benefits of using BIM; • In February 2016, Infrastructure Australia recommended that the Australian government should make the use of BIM as mandatory for the design of large-scale complex infrastructure projects (Bimcrunch, 2016); • The Department of Planning, Transport and Infrastructure (DPTI) have developed BIM guidelines for government agencies, consultants and contractors (McAuley et al., 2017); • The Department of Defence recognises BIM benefits and plans to integrate BIM and IPD into its projects soon (McAuley et al., 2017).
Japan	• BIM implementation in Japan is not always encouraged with top-down consensus (Kaneta et al., 2016); • MLIT (Ministry of Land, Infrastructure, Transport and Tourism) published BIM Guideline in 2014 after MLIT selected three pilot projects from the public sector in 2010 (Kaneta et al., 2016).

Several efforts have been made through programs and policy mandating BIM adoption. It is necessary to understand the different efforts developed worldwide in order to learn from the past experiences and acquire a global knowledge about the steps that have been taken and the necessary transformation that should be adopted in order to implement BIM successfully. Table 1 illustrates a global overview of BIM implementation in developed countries and defines the approaches and technology adoptions strategies that have been developed in order to achieve efficiency, economic benefits and unification of practices (Lindblad & Vass, 2015; Miettinen & Paavola, 2014)

2.3 BIM Frameworks

Several frameworks have been developed worldwide in order to facilitate BIM implementation. This study proposes a preliminary BIM implementation framework based on three main aspects, technology, process and policy. This section represents a review of the different frameworks developed worldwide.

The framework presented by Succar (2009) describes the domains of BIM knowledge and their interrelationships. These domains are 'BIM fields', 'BIM maturity stages' and 'BIM lenses' where 'BIM fields' identifying domain 'players' and their 'deliverables', 'BIM stages' identifying the implementation maturity level, and 'BIM lenses' to investigate the depth and breadth to identify, assess and qualify BIM fields and BIM stages. Bin Zakaria et al. (2013) in his research has developed the concept of BIM implementation based on four main components which are: organisational culture (organisational readiness to change and adopt new technology), people (knowledge and experience), technology (adopting new technology) and finally, government recognition (national BIM standards).

Succar and Kassem (2015) developed the five conceptual macro-BIM adoption models that help policymakers to assess an existing policy effort or develop a new one. The models consist of Diffusion Areas Model; Macro Maturity Components Model; Macro Diffusion Dynamics Model; Policy Actions Model and Macro Diffusion Responsibilities Model. Furthermore, Kassem and Succar (2017) validated the five models with the participation of 99 experts from 21 countries and (Riitta & Hirvensalo) applied the five models in assessing and comparing the national BIM policies across 21 countries. As the data revealed, the five models enjoy high levels of 'clarity', 'accuracy' and 'usefulness'. The concepts, models and decision proposed support tools for macro-BIM adoption assessment and planning.

Alreshidi et al. (2017) have developed a framework for BIM governance based on 3 main factors 1- Socio-organizational factor, discussing the actors and the team values; 2- Data management and ICT, which is highlighting the security and availability of the information and the ICT usage; 3- process and policy, discussing the policies and process needed for better BIM governance.
The reviewed frameworks will help to develop the preliminary framework for the Algerian construction industry by taking into consideration of the local environment and the current BIM application.

3. Research Methodology

To implement BIM successfully in the Algerian AEC industry, it is essential to investigate the BIM awareness, BIM maturity, BIM readiness and BIM capabilities. Thus, this study carried out a critical literature review about BIM implementation in the construction industry and the BIM implementation framework proposed by previous studies worldwide as presented in Section 2. Furthermore, a survey among architects, engineers and contractors was carried out in order to investigate BIM capabilities, awareness, maturity and readiness. The questionnaire has been distributed and collected in a period of 3 months, by both online questionnaire using Google Form and manually by visiting the respondents in their places.
After identifying the challenges and the best practices of BIM implementation in previous research (Khalid et al., 2020), and investigating the level of awareness, capabilities, maturity and readiness of the Algerian construction industry; the findings from this research form a ground towards developing and proposing a preliminary framework of BIM implementation in the Algerian AEC industry.

The sampling of the respondents was selected based on the Krejcie and Morgan's formula which is stated as follow (Chuan & Penyelidikan, 2006):

$$s = X\ 2NP\ (1-P) \div d\ 2\ (N-1) + X\ 2P\ (1-P) \qquad (1)$$

The architects' sample was 230, contractor's 180 and engineer's 143. The responses were 110 among architects, 44 among contractors and 66 among engineers with respondent's rates of 47.83%, 24.44% and 46.15% respectively (Figure 1).

4. Results and Discussion

4.1 Survey Finding

The questionnaire has been designed based on four sections: background, current practices, the challenges and the best practices. The questionnaire has been validated after a pilot survey conducted. The questionnaire showed consistent content, adequate sampling and compelling content (Khalid et al., 2019).

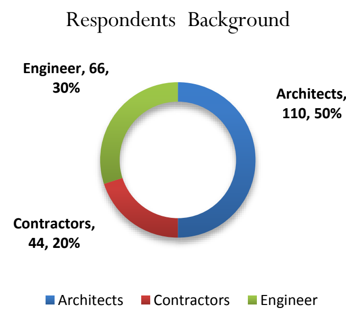

Figure 1 Respondents backgrounds

Figure 2 illustrates the software usage among architects, engineers and contractors during their works. The most used software by architects is CAD (98 users); Revit (72 users); Sketchup (58 users); then ArchiCAD (40 users) and other software such as Tekla, SAP2000, and Navisworks.

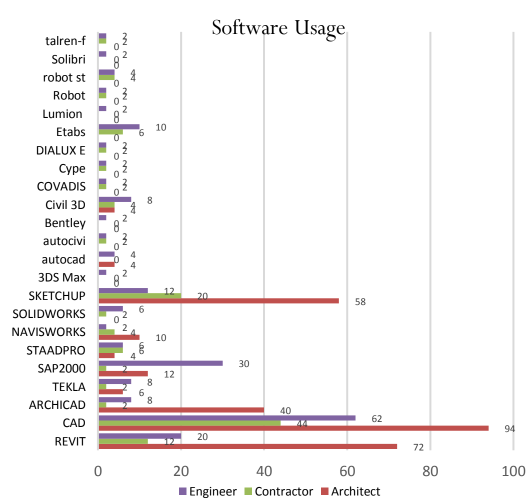

Figure 2 Type of Software usage

The most used software by engineers is CAD (62 users); SAP2000 (30 users); Revit (20 users); SketchUp (12 users); Etabs (10 users); Civil 3D (8 users); Tekla (8 users) and other software such as Solidworks and Navisworks. The most used software by Contractors is CAD (44 users); SketchUp (20 users); Revit (12 users) Staadpro, Etabs (6 users) and other software. Based on the results, the Algerian practitioners are still adopting AutoCAD and SketchUp (traditional method of project delivery) as a tool of design and delivering the project while there is some BIM software usage such as Revit, ArchiCAD and Tekla.

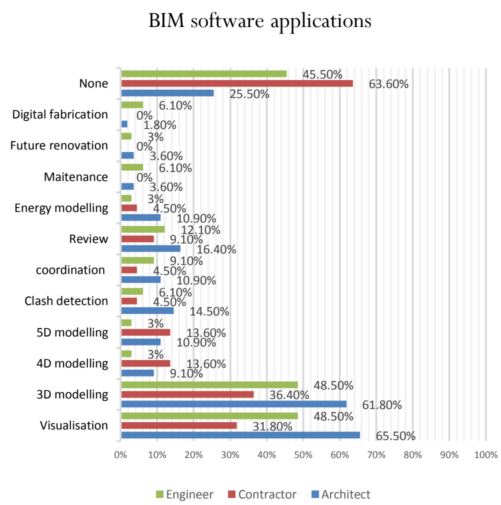

Figure 3 BIM software application

The respondents have been asked about their BIM application and in which stage they use it in order to investigate the exact usage of BIM software (Figure 3). It is observed that the most BIM application among architects are 65.5% for project visualisation; 61.8% for 3D modelling; 9.1% for 4D modelling; 10.9% for 5D modelling; 14.5% for clash detection; 10.9% for coordination; 16.4% for construction review; 10.9% for energy modelling; 3.6% for maintenance; 3.6 % renovation; 1.8% for digital fabrication. Furthermore, the most BIM application among engineers are: 48.5% for project visualisation; 48.5% for 3D modelling; 3% for 4D modelling; 3% for 5D modelling; 6.10% for clash detection; 9.10% for coordination; 12.10% for construction review; 3% for energy modelling; 6.10% for maintenance; 3% for renovation; 6.1% for digital fabrication. Finally, the most BIM application among contractors are: 48.50% for project visualisation; 48.50% for 3D modelling; 3% for 4D modelling; 3% for 5D modelling; 6.10% for clash detection; 9.10% for coordination; 12.10% for construction review; 3% for energy modelling; 6.10% for maintenance; 3% for renovation; 6.1% for digital fabrication.

Figure 4 shows the BIM usage stages among architects, engineers and contractors. The most usage of BIM among architects is in concept design (50.9%); technical design (43.6%); developed design (41.8%). Other usages such as preparation and brief (25.5%); 21.8% in construction and 9.1% in handover and operation. Moreover, the most usage of BIM among engineers (36.4%) is on technical design; 30.3% in concept design; 27.3% in construction; 24.2% in developed design; BIM in the other stages is less used such as preparation and brief (18.2%), handover and closeout (9.1%); operation (6.1%). Furthermore, the most usage of BIM among contractors is in construction and concept design (36.4%); developed design (31.8%); technical design (27.3%) on the other hand BIM among contractors is less used in the rest of the stages such as handover and closeout (22.7%) preparation and brief (4.5%).

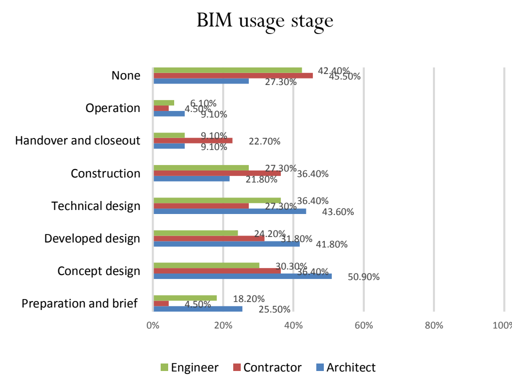

Figure 4 BIM usage in the construction project stage

The results shown previously could summarise that the usage of BIM software in the Algerian construction industry is more on the 3D modelling and 3D visualisation since the BIM software tools are timesaving in terms of generating the 3D models and able to visualise the design and present it to the client, and with few usages in the other application such as 4D, 5D modelling and clash detection.

At this stage it may be concluded that the Algerian market has a mixed combination of usage; some respondents are still in Pre-BIM stage (BIM level 0) where they are relying on CAD and sketches drawing, the information at this stage is generated manually (Succar et al., 2012; Tekla, 2019). On the other hand, other respondents use BIM software for modelling and visualisation, at this stage (BIM stage 1/ BIM Level 1) each discipline uses their own software to generate their own deliverables (3D geometries, 2D out of these 3D geometries, quantities, specifications, and analytic models) (Succar et al., 2012; Tekla, 2019). Very few respondents use BIM software for other dimensions of modelling (4D/5D/Clash detection) which could be assumed more as individual initiatives. Regarding the usage of BIM software in the building life-cycle, it may be concluded that the usage is still at the design stage and less usage at the construction stage and very few in the facilities management.

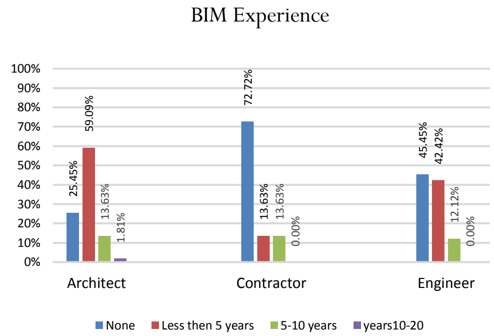

Figure 5 BIM experience

Figure 5 illustrates the experience of using BIM from different respondents in order to measure the BIM novelty in the Algerian market. Based on the results it can clearly be observed that BIM experience among the majority of the architects (59.09%) is less than 5 years, 13.63% of architects have between 5 to 10 years of experience, 1.81% among them have between 10 to 20 years of experience. In the context of BIM experience among the majority of the engineers (42.42%) is less than 5 years; 12.12% among them have between 5 to 10 years of experience. BIM experience among 13.63% of contractors is less than 5 years; 13.63% among them have between 5 to 10 years of experience. As a conclusion, the BIM usage in the Algerian construction market is still at an infancy stage, with most of the respondents have less than 5 years of experience.

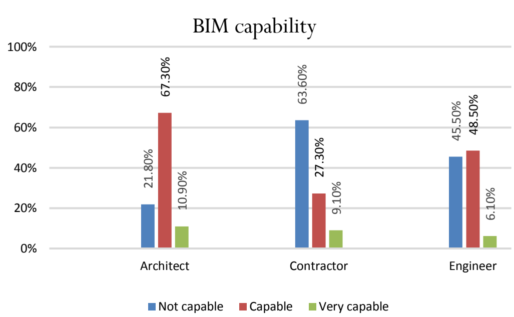

Figure 6 BIM capability

Figure 6 illustrates the BIM capabilities and the respondents have been asked about their points of view (very capable, capable and not capable) in order to investigate their levels of readiness. Twenty one point eight percent (21.80%) of architects see themselves are not capable; 67.30% of them consider themselves capable; while 10.90% claim that they are very capable. Fourty five point five percent (45.50%) of engineers see themselves are not capable; 48.50% of them consider themselves capable; while 6.10% claim that they are very capable. Sixty three point six percent (63.60%) of contractors see themselves are not capable; 27.30% of them consider themselves capable; while 9.10% claim that they are very capable. This result could illustrate that architects and engineers have more capabilities to implement BIM than the contractors, because of the nature of work, architects and engineers used to use BIM software for design and calculations while contractors based on printed paper and 2D drawings to perform the construction tasks.

In this section (Figure 7), the architects, engineers and contractors' BIM awareness were measured. The respondents showed a good BIM awareness since most of them have read some research about BIM (22% for architects, 34% for contractors and 30% of engineers) or have a good idea about its concept (14% for architects, and 13% of engineers) or differentiate between BIM software and BIM technology (23% for architects, 20% for contractors and 22% of engineers) or master BIM software (35% for architects, 23% for contractors and 25% of engineers). The findings from the survey illustrate in general the current practices of BIM implementation in the Algerian construction industry; the findings provide an overall understanding of the BIM capabilities, BIM maturity and BIM awareness. In order to achieve a better understanding and develop the adequate BIM implementation framework for the Algerian AEC industry, it is necessary to relate the challenges of BIM implementation with its current practices. The challenges and the best practices have been discussed in previous research based on the three aspects of technology, process and policy. The technology and process aspects covered the micro-adoption (organisation level) while the policy aspect covered both the macro-adoption (industry level) and micro-adoption; the macro-adoption was carried in order to investigate the role of the government in promoting the BIM implementation at the industry level (Khalid et al., 2020).

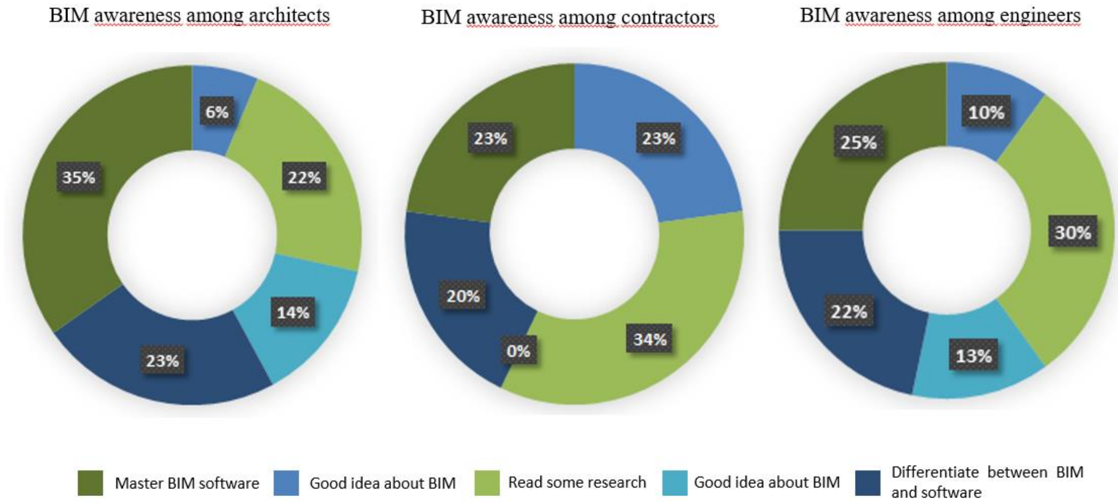

Figure 7 BIM awareness.

4.2 Developing the Framework

Several frameworks have been developed worldwide focusing on promoting and improving BIM implementation in the construction industry based on three main pillars (technology, process and policy). These frameworks have properly addressed the necessary BIM variables. Hence, in this research, a preliminary framework has been developed based on the main BIM pillars (technology, process and policy). In this study, the framework covers both the macro-adoption and the micro-adoption in order to understand the current construction environment and to identify the push-pull relationship between the government and the construction players. The factors of BIM implementation differ from a market to another. It is crucial to investigate in-depth the nature of the Algerian construction environment in order to ensure an efficient combination between the three main pillars of BIM implementation. Hence, the findings from the questionnaire survey, literature review and previous research (Khalid et al., 2020) serve as a guideline to develop the BIM implementation framework within the Algerian market.

Previous research has discussed the various factors affecting the BIM implementation worldwide, as it was agreed by many of them that technology aspect remains the basis. Mastering BIM as a technology requires training and awareness as a start since it helps to increase the technical know-how (C. M. Eastman et al., 2011; Rotimi et al., 2019; Zhao et al., 2015). Training and awareness remain essential for Algerian architects, engineers and contractors due to the lack of knowledge about BIM as a whole process. Through the data from the questionnaire survey, it has been noticed that there is a variety of software being used in the Algerian market, such as Revit, ArchiCAD and Tekla but its usage remains restricted to the 3D modelling and visualisation. On the other hand, the Algerian practitioners claim that they are aware and capable of BIM as a whole process. This explains the misunderstanding of the BIM concept as BIM is about mastering the technology, process and policy. Training and awareness are considered as the key factor for a start of BIM implementation as previous researchers suggest (Rotimi et al., 2019).

BIM process is considered as the second pillar of BIM implementation. Based on the survey findings, the Algerian players are still based on the traditional method of work process and there is a need to shift for BIM level 1 work process as a preliminary step. BIM level 1 needs a usage of standards such as BS 1192:2007 and adopting a common data environment (NBS, 2014) in order to ensure a smooth information production and a better projects coordination. Furthermore, in order to implement BIM as a process there is a need to establish an effective change management strategy, enhancing communication and collaboration and identifying the roles and responsibilities. As Soh and Markus (1995) further suggest in their IT implementation model to internal process and practices, a thoughtful review of the process change strategy is demanded. In the implementation of BIM, some case studies recorded the importance of changing the delivery process, justifying the need to incorporate the activity to produce/author 3D BIM model and 3D model-oriented process flows as evidenced in (C. M. Eastman et al., 2011; Matthews et al., 2018; Olatunji, 2011). Furthermore, in order to ensure effective communication between the different disciplines and team members, the current methods of communication and collaboration should be analysed to produce flow diagrams. This methodology will lead to prescribing the work modelling techniques such as communication flow modelling, physical environment modelling and culture modelling to examine and understand the current practices (Ahmed & Kassem, 2018; Arayici et al., 2011). The flow diagram will form a good basis for discussion among the team members at the organisational level or the industry level. Moreover, to adopt BIM successfully it's important to identify the key roles and responsibilities of the team. According to Wilkins and Kiviniemi (2008) and Alreshidi et al. (2017), the implementation of BIM requires a definition of team roles and responsibilities. The definition depends on overall team relationships, the level of BIM implementation and the types of

BIM tools that are used. As a BIM process it's essential to consider all the factors. Moreover, the Algerian practitioners are facing several challenges related to BIM process such as the challenges to establishing a new workflow to move from the CAD process to BIM process (Khalid et al., 2020). Tackling these aspects will firmly lead to a smooth BIM implementation in the Algerian market.

BIM policy is considered as the third pillar of BIM implementation. As mentioned before, based on the current practices and the survey findings, the Algerian construction market is still based on the traditional method of work process where there is a lack of introducing BIM in the contractual environment, and lack of government initiatives and support to start implementing BIM gradually. It is necessary to establish a well-defined policy at both macro and micro adoption in order to insure a complete BIM implementation. In this research, the policy aspect has been categorised into two main levels, macro-level which consist of the government vision and role to push the BIM implementation and the micro-level which consist of changing the contractual environment. Succar and Kassem (2015) suggest that establishing national BIM policy, standards, guidelines, mandates and regulatory bodies are crucial for a better BIM implementation. Hore and Thomas (2011) added that top management support and awareness is a critical factor that should be taking since it is considered as the main driver for BIM implementation. Moreover, introducing gradually BIM in the contractual environment is crucial as mentioned by C. M. Eastman et al. (2011), Deutsch (2011) and Dao and Chen (2020). Several project delivery methods are suitable for BIM implementation but the use of Design and Build is seen as important to exploit BIM benefits to the fullest. The flexibility of the Design and Build approach offers a changing process flow and enables the integration of construction information earlier in the design process. In Algeria, there is a lack of government efforts and lack of the adequate contractual environment to promote the BIM implementation. Furthermore, there is a lack of research and frameworks about the effective way to implement BIM in the Algerian market. Hence, this research's objective is to propose a preliminary BIM implementation framework.

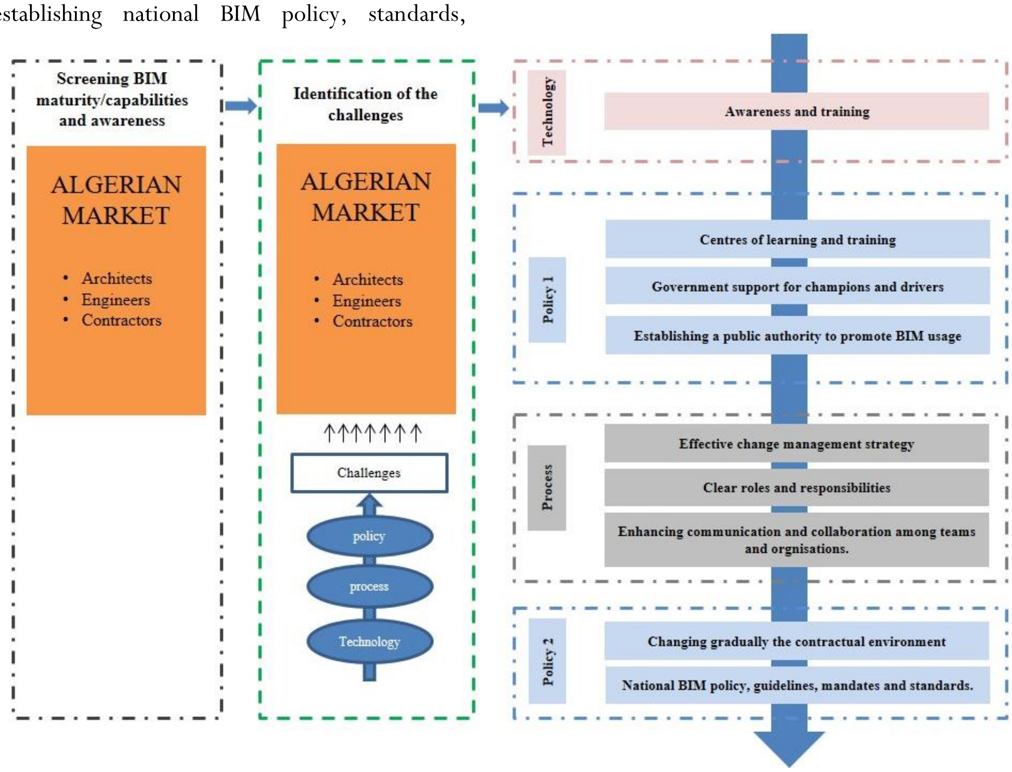

Figure 8 Preliminary framework of BIM implementation in the AEC construction industry

In this research the questionnaire survey illustrates the BIM maturity, BIM capability, BIM awareness and BIM experience of the Algerian practitioners; by combining these factors with the findings from the literature review and the previous research published by the author that highlights the challenges and the best practices (Khalid et al., 2020), this study comes up with the necessary steps of BIM implementation as illustrated in figure 8. Starting with a general screening of the BIM maturity level; BIM capability and level of BIM awareness, then identifying the challenges and the best practices, and finally proposing the necessary steps to implement BIM effectively.

There are two major approaches for promoting BIM applications in different countries, government-driven (government issue a series of policies to lead the BIM implementation) and industry-driven (the industry players are active in BIM implementation and government take limit actions)(Yang & Chou, 2018). This study proposes a mixed approach where the industry and government will work in parallel in order to promote the BIM implementation. This approach is the most convenient for the current Algerian construction environment. These steps are as followed:

- **Technology:** Awareness and training in order to increase the knowledge in terms of BIM benefits, and impact on the project's cost, time and quality. Furthermore, increase the BIM competency of the Algerian architecture, engineering and construction industry. This could be done by the private centres of training such as software and BIM learning centres.

- **Policy 1:** This includes government support for champions and drivers and establishing a public authority to promote BIM usage at the market level. These steps take place in order to spread and ease the awareness and the learning process. The necessary support for individuals and organisation who are motivated and enthusiastic to implement BIM plays an enormous role in leading and spreading the BIM. These steps will lead the organisations and individuals to acquire the necessary knowledge and prepare for the next step related to the process. This step will lead to ease of the transition procedure and help the organisations for their change strategy.

- **Process:** At this level, the organisations should start an effective change management strategy, elaborate a clear communication and collaboration plan, and identify the key responsibilities and roles. All the team members should have a clear vision about the required change and the new method of sharing the information with an effective collaboration and communication plan, it is all about the individual and team members personal transition, they should embrace and learn the new way in order to deliver the expected results. The change will be successful if the required guides and steps are clear and the necessary actions are defined. At this level of maturity and implementation, the government could start mandating and oblige all the construction players to implement BIM within their organisations.

- **Policy 2:** At this stage, after the efforts made through spreading the BIM knowledge, education and training and the change management, it becomes necessary to start changing gradually the contractual environment, elaborating a national BIM policy, draw effective guidelines to mandate and standardise the usage of BIM implementation in the Algerian AEC industry. Introducing BIM in the contractual environment will push forward the different players to start implementing BIM. It helps to identify the BIM requirements and documentation, risk allocation, insurance due to any potential failures and identify intellectual property and ownership. Finally, establishing national guidelines and a clear strategy towards BIM implementation, it will serve as a guideline and a government driver for BIM implementation since the adequate environment have been already set. Furthermore, it will function as a reference for all the construction players.

5. Conclusion

The BIM concept and technology have been applied in practice worldwide and the great benefits of BIM application in the AEC industry are gradually being revealed. In order to effectively implement BIM in a construction market, it is necessary to assess the BIM maturity and capabilities of its players, this will give an insight about the readiness and the level of competency among the different stakeholders in order to know in depth their strength, weaknesses, opportunities and threats.

This paper illustrated in-depth the current BIM maturity and investigated the BIM capabilities and awareness of the Algerian market. The finding proposes a preliminary framework towards BIM implementation based on previous theories and questionnaire survey findings, starting with the technology aspect such as training and awareness, then policy aspect such as BIM drivers support and motivation, followed by process aspects such as change management and finally, changing the contractual environment and elaborating a national BIM policy and mandating BIM usage.

The preliminary framework illustrates the general steps towards BIM implementation, besides, other aspects need to be considered and discussed in details such as people and educational programs. The reliability of the framework is based on previous theories and models adopted based on the surveying findings to be adequate to the local environment. The proposed framework shall be further validated by the Algerian BIM players and it can be adapted for other countries with the similar context and construction environment.

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