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Alignment of Construction Procurement Strategies for the Effective Implementation of BIM in the UAE

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Abstract. The effective diffusion of Building Information Modelling (BIM) presents strong potential to evolve the productivity and performance of the construction industry. Implementing BIM effectively requires significant changes in the construction business practices to improve communication, collaboration and sharing information among team members in design, construction and operating phases. The aim of this paper is to investigate the required reformation of current procurement methods in the UAE to enable the effective diffusion of BIM. The paper will present a conceptual framework which illustrates the needed changes in procurement methods being change in the relationship among participants, change in the contractual agreements, sharing the risks and rewards among stakeholders, early involvement of stakeholders, and involvement of new participants. The paper will report the findings of the analysis of four case studies of companies with vast experience in projects that adopted BIM and how it has impacted the procurement approaches adopted. The research findings have articulated that in order to implement BIM process effectively, it is critical for the UAE construction industry to adopt more collaborative relationships and share the risks and rewards among the participants. The findings show that the most important requisite change is for the key players at design stage to collaborate to create an effective BIM model that will save time and cost. Furthermore, contracts should oblige the participants to adopt BIM, identify the level of development in each stage and determine the responsibilities and intellectual property rights of each stakeholder.

1. Introduction

The construction industry is challenged by its stakeholders for its record on quality, productivity and value for money especially when compared to other industries [1,2]. The lack of collaboration and communication among stakeholders is blamed for the decline in productivity [3]. BIM has been considered as a solution of fragmented network of stakeholders and a way to improve the flow of information and data and accelerate the process [4]. The UAE government has realised the importance of BIM, therefore, to improve the performance of the construction industry it has taken steps to implement BIM extensively. In 2013, Dubai government decided to reshape the AEC industry by mandating BIM. The construction industry in the United Arab Emirates (UAE) is dominated by procurement frameworks that have challenged efforts to solve significant problems of low level of

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communication, design errors and clashes, weak flow of information among parties and unauthenticated data for facility management during the operation. McGraw-Hill Construction Research and Analytics [5] argued that BIM has excellent track record of efficient contribution in the evolution of the efficiency and productivity of the construction industry, by improving the collaboration among the project participants and promoting the information-sharing strategies. Hence, BIM has the potential to provide an opportunity to be the catalyst for a major change of the UAE construction industry. Traditional procurement frameworks and practices that have allowed, and even facilitated, low level of integration among stakeholders and poor information sharing have created a barrier for the adoption of innovations that require early engagement of clients, architects, contractors, and their supply chain. Improving project delivery using BIM has necessitate changes to contractual agreement process and, hence, tendering methods. The implementation of BIM demands, right at the onset of the project, clearly defined tasks, responsibilities, and rights, and agreeing the protocols for sharing, owning, and transferring information throughout the project. BIM, a revolutionary technology, and process in the AEC industry, allows project stakeholders identify opportunity to contribute and engage in design, construction, and operation by visualising the building in a simulated environment. Furthermore, it improves the collaboration and encourages the integration by reshaping the relationship between project team to achieve a successful project delivery. Therefore, BIM is considered as a driver for amending the complete construction cycle from design to operation stage. The aim of this research is to investigate how BIM is driving changes to traditional procurement practices in the UAE through the reshaping of the reciprocal interdependencies between project stakeholders and participants.

2. Literature Review

BIM have been defined as a digital simulation of physical and functional characteristics of a building and is a source of shared information about a building, forming a reliable basis for stakeholders to make decisions during the life cycle of a building from its design stage to its demolition [6]. Furthermore, Hardin [7] describes BIM as a virtual construction of a building that consists of smart information in a single source file shared among team members and improves the communication and collaboration among the participants. Bolpagni [8] argues that the aim of BIM is to improve the workflow through the integration of the team members. Azhar *et al.* [9] point out that BIM presents a new paradigm in the AEC industry that improves integration of the roles of participants on a project and promotes the efficiency and harmony among team members. Likewise, Love *et al.* [10] argue that BIM is a tool and process for project management to deliver beneficial project outcomes by improving the collaboration among the stakeholders and reduces the time required for documentation. BIM has significant benefits for project sponsors by ensuring that the project requirements are achieved through early design assessment, decreasing the financial risk by obtaining estimation of reliable cost, 3D rendering and walkthrough animation to improve the project marketing [9,11]. In addition, the Stanford University Center for Integrated Facility Engineering pointed out that owners yield numerous benefits from implementing BIM, such as accurate cost estimations, the elimination of up to 40% of unbudgeted change, the reduction of up to 10% of the contract value through clash disclosure and reduction of up to 7% of project time. That could increase the return on investment by around 16% [12]. Architects and engineers obtain worthy advantages from BIM such as improving the design through visual simulation, achieving less errors and conflicts in design stage and improving the coordination in particular with the specialist consultants, where they can combine their specific portion of work with the visualised model to clarify the conflicts [13]. Implementing BIM by contractors and sub-contractors improves the project delivery performance, whereas BIM has the tools to improve the accuracy of cost estimation and calculation of material quantity, realises the design errors early through clash detections, follows proper onsite activities, enhances the site safety planning and improves the communication and collaboration among the project stakeholders. In addition, BIM improves the productivity of the work due to the clarity of information as the activities will not be on hold till the team members receive the clear information [12]. It also assists in producing accurate bill

of quantities that minimises overpayment to suppliers and sub-contractors; on the other hand, it improves the cooperation between contractor and sub-contractor that reduces the time of project delivery [14].

2.1. BIM and Procurement Methods

For decades the construction industry has been facing problems related to the segregation of design and construction, lack of integration and communication among stakeholders, changing client's priorities, requirements, and uncertainties. BIM is a new process that has the potential to reform the method of involving stakeholders in projects to deliver better outcomes. A procurement strategy in the construction industry is defined as an organisational structure that designates and specifies the liabilities and authorities to people and firms and determines the relationships among various elements during the construction process [15]. It is also a process in which the clients' requirements and objectives are elicited throughout the project life cycle [16]. In addition, it has been defined as a collective process for the achievement of mutual benefit, where it adds value to the clients and profits for the participants through contractual structure [17]. BIM can present a firm platform for effective and improved cooperation among parties, and it allows the sharing of risks and outcomes among stakeholders [18]. Hence, BIM could offer a potential solution for the current fragmentation in the construction industry [7]. It also reduces the cost of inadequate interoperability [4] and drives innovation in the procurement and delivery strategies. The effective adoption of BIM requires the contractual relationships to move towards a closer collaboration and more efficacious communication and reform the current delivery process [19]. In 2011, the National Building Specifications (NBS) in the United Kingdom revealed on the basis of a survey that 90% of users adopting the BIM process demand an essential change in the current delivery process in the industry, which seeks to change organisational cultural, behavioural and operational changes [20].

Transforming current procurement methods to make them compatible with BIM adoption will face many challenges, where it demands organisational restructuring [7], and the firms are accustomed to the traditional process and structure; hence this resistance to change will hinder the ongoing process [20]. It is argued that the lack of awareness of BIM benefits creates uncertainties and concerns for stakeholders to reform the procurement methods [19]. In addition, organisational restructuring requires ground-level changes in the structure such as redesigning the workflow and new distribution of the liabilities which would raise concern with senior management as to cost and ability to deal with such change. In addition, it is expected that the transition phase to a new structure would increase anxieties due to unclear definition of responsibilities [11,21].

2.2. BIM AND TRADITIONAL PROCUREMENT METHODS

To understand the implications of BIM on the procurements methods, it is critical to evaluate the impact of the required changes outlined earlier on current process in terms of information sharing, relationship among stakeholders and early involvement of participants. Even though the construction market in the UAE is the most buoyant construction market in the Middle East, still the Design-Bid-Build (DBB) is the most preferable procurement method used here, owing to the lack of firms that can handle both the process design and the construction [22]. Adoption of BIM in DBB faces a critical problem at tender phase as the model provided by the owner would not be part of official tender documents, and thus the bidders cannot depend on any data extracted from the model [23]. Liu and Hsieh [24] argued that tender documents should be modified to contain the BIM model further to 2D drawings in order to support the adoption of BIM. In addition, contents of the BIM model need to be accurate to enable bidders develop competent bids [25]. The client would benefit from more accurate and reliable bids and less risk of later claims [26]. In addition, BIM assures the conformity between the BIM model and 2D drawing due to the correlation among all documents [8]. Tenderers would also benefit from BIM implementation by understanding the intricacy of the project swiftly – thanks to 3D model improvements [23]. Meanwhile, bidders can extract abundant information from the BIM model to provide fast and accurate price evaluation. There are many limitations in adopting BIM with the

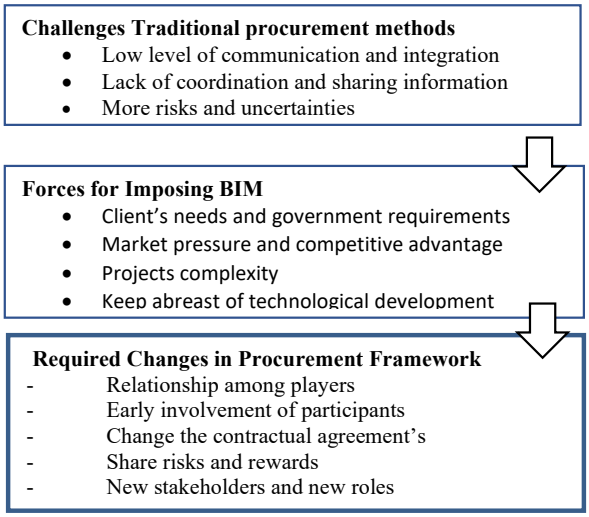
DBB delivery method. First, the involvement of a contractor after the design stage reduces utilisation of BIM process, in particular, the coordination and collaboration among participants, which otherwise is the main aim of BIM [11]. Moreover, learning the process is mandatory for participants to maximise their potentials of BIM. Where BIM is in its infancy trying to find contractors, consultants and clients with BIM experience is rare, and the awareness of BIM benefits still limited. Subsequently, contents of the BIM model might not be able to carry enough data to provide reliable price [25].

After investigating the drivers and challenges in DBB procurement frameworks for the effective diffusion of BIM the research can, therefore, investigate the opportunities for change in DBB procurement to harness the benefits of BIM (Figure 1). The implementation of BIM has become imperative in the UAE's AEC industry due to the government strategy to implement BIM widely through making it mandatory for the projects depending on their scale. The context the paved the way for the development of this strategy is dominated by a construction process that has lost its ability to effectively to deliver significantly better performing projects.

3. Research Methodology

This research will examine behavioural and organisational issues, as well the legal aspects, relevant to the required change in roles and responsibilities at DBB projects. The research adopted a case study approach to enable exploratory, descriptive, and explanatory research [27] in order to analyse relationships, behaviour and processes. Consequently, a set of semi-structured questions have been prepared for face-to-face interviews. The interview questions aim to examine current practices that have improved on locally established procurement methods and, hence, allow the development of innovative procurement frameworks capable of exploiting the benefits of BIM.

Four case studies *(in this paper due to limited space we will only analyse 2 case studies)* based on four projects where BIM was adopted, as a process and not as a drawing tool, across the life cycle of the project. This sample would enable the research to investigate how procurement frameworks were adapted to enable the effective deployment of BIM. The sample selection was challenging as BIM is relatively new to the UAE market and most of the projects still use BIM as a drawing tool and not as a process. The selection process unveiled examples of the failure to effectively adopt BIM in the UAE. Cleveland Clinic Abu Dhabi – owing to the involvement of many suppliers of medical equipment at construction stage, stakeholders kept changing their requirements that have significantly impacted the design process. The contractor was not able to update the BIM model as fast as he could do in the 2D CAD; therefore, to meet the deadline of the project delivery BIM was discontinued. Similarly, project of W Hotel & Residence in Palm Dubai adopted the BIM process at its onset but at the construction stage the client, on the advice of investment advisers, demanded changes in the design. Faced with the pressures of such demands the project team, lacking the expertise and experience in the use of BIM, felt they could not respond confidently to the required changes and decided to discontinue the BIM process and revert to more familiar tools and processes. Therefore, the selected case studies have adopted BIM process from design stage till the completion of the project.



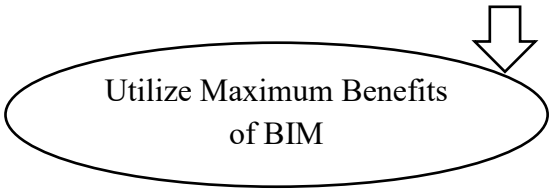


Figure 1: Research Conceptual framework

4. Findings and Discussion

The interviewees were project managers, contract managers or equivalent with a minimum of 15 years of experience in BIM projects. Moreover, respondents were carefully selected to ensure they have been involved in decisions related to BIM use and the adopted procurement framework. The interview questions were developed to explore the driving forces of imposing BIM, the ability to reform the current procurement methods, examine the ability of the UAE market to implement BIM with innovative procurement methods and test to what extent the transformation of procurement methods will improve the BIM implementation to utilise the BIM benefits.

4.1. Case Study 1

This is an airport project with contract value around US$3 Billion to build 5 buildings with built-up area around 7000 m² and the duration of the project is 49 months. The project has been procured through DBB contract. The project adopted BIM where the main stakeholders in this project have a vast experience in BIM projects. The client has mandated the adoption of BIM in the contract on the recommendation of the project management firm and consultant. Therefore, the contractor obliged sub-contractors to implement BIM and issue the shop drawings from the BIM model to improve the coordination and deliver accurate BIM model to facilities management team. The interviewees did not believe that DBB is exemplary procurement method to be used in BIM projects, as it "lacks coordination, communication and confidence among participants". Nevertheless, DBB was the chosen procurement methods (FIDIC Contract) due to the type of this project and the environment of the construction industry in the UAE that is mostly adopting the DBB method in the public sector projects. Thus, few modifications are required in the DBB method to make it suitable for the BIM adoption to ensure high level of communication, coordination, and collaboration among stakeholders, thereby ensure successful project delivery.

The awarded contractor, being more experienced in the BIM projects than the consultant, was not satisfied with the quality of the BIM model which has been created by the architects and did not want to take any responsibility about the data based on a model created by others. Therefore, the contractor created a new model at tender stage, a 6-month task, which he believed is better than the risk of relying on data produced by parties in a market tat is yet to mature. The discussion with interviewees further revealed that improvement in the relationship among participants in the beginning was not an easy task. However, over time the participants accepted that cooperation would reflect positively on the project performance. Two factors have played a significant role in bringing about a change in this relationship. First, the participants gained experience in the BIM projects and accepted that collaboration is critical to delivering a BIM project successfully. Second, since the BIM model was created by a contractor which seem to convince the stakeholders that a collaborative working relationship is critical to their ability to meet their contractual responsibilities. FIDIC contract was modified to include clauses that determine the liabilities, workflow of the information and intellectual property rights. Although the model has been created by the contractor, but as stated in the contract the final model will be owned by the client to be used in O&M and will pay for that.

Implementation of BIM in this project faced many challenges as both the client and the facilities manager lacked the knowledge of BIM, thus failing to realise the requirements of the BIM process. Furthermore, government authorities are not yet familiar with the BIM process, to issue the work permissions like 'No Objection Certificate', the concerned firms have to transfer the issued drawings

to 2D CAD format which is a huge waste of time. Even though the BIM implementation is a mandatory requirement from government, its requirements are not clear, and the reviewers are lack the BIM understanding. In addition, many stakeholders, particularly sub-contractors, are not yet ready to adopt the BIM this has led to delays in submitting the shop-drawings which cast their shadow on the project schedule. Nevertheless, they have been pushed and supported by main contractors to implement BIM. In some cases, the main contractor accepts 2D CAD shop- drawings, to avoid delays, on condition that the model to be updated later with the approved BIM version.
Regarding existing standard for of contract the interviewees expressed their concern that the risks and uncertainties of the DBB contract need to be distributed equitably and not leave the contractor carrying the main risk of BIM implementation.

4.2. Case Study 3

This project is to construct a museum containing a complex network of pavilions, plazas, alleyways, and canals, evoking the image of a city floating over the sea. The project was awarded to build the museum in 64,000 square meters with built-up area of 24,000 square meters with a contract value of US$653 million. The project was awarded to a joint venture (JV) contract consisting of two firms with very high reputation in mega projects. The BIM process has been adopted in the project life cycle, and the project has been procured through the DBB method. This case study has been constructed through two separate interviews conducted with a project manager representing one of the main contractors, Interviewee (D), and an operation manager representing the steel structure sub-contractor, Interviewee (E).

The pressure from the client was the main force behind the adoption of the BIM process in the project, as the client had sufficient knowledge about the BIM process through extensive experience in prior projects. Besides, the contractor is also one of the pioneers in implementing BIM in the UAE and the Middle East, as they had been adopting BIM in all their projects since 2009. The top management of the contractor has realised the perceived benefits of BIM in terms of high level of coordination, accurate pricing, and market advantage to win more tenders with less cost and more profits. However, the steel structure sub-contractor adopted BIM only because there is a compulsion in the contract and, hence, they employed a BIM consultant to help them meet this requirement.

The project was procured using DBB with BIM implementation in all the stages. However, the interviewees did not believe that DBB was the proper procurement method for implementing BIM, as one of its most critical defects is that the stakeholders are not involved from the design stage.
In this project, this shortcoming was overcome to some extent. Where, due to complex nature of the steel structure for the museum it was necessary to involve the steel structure sub-contractor from the design stage to create a BIM model with high level of coordination and free of errors.

Therefore, DBB procurement method was modified to enable the adoption of BIM. In this project, the steel structure sub-contractor was appointed at the design stage, and it was agreed, in the contract, that the sub-contractor will work under the main contractor in the construction stage.
The contractor's point of view that implementing BIM with DBB requires changes in the process to allow most of the stakeholders to be involved in the design stage, especially sub-contractors. Evidently, their input changed the design of the project, for example, installation of an AC machine demanded special conditions in terms of size, location, and the surrounding environment; consequently, efforts and rework were saved, and higher level of coordination was achieved.

The steel sub-contractors pointed out that their involvement in the design stage was very beneficial for the whole design, and it allowed them to detect conflicts between their design and the different disciplines earlier before commencement of the construction stage. The representatives of the contractor confirmed that they received a very well-developed BIM model, at tender stage as per the agreement between the consultant and the client. Nevertheless, the contractor stated that to prepare their proposed bid they relied only on 2D drawings and used the BIM model for clarification. Because the implementation of BIM in the UAE is still in its infancy and there is still a lack of trust among stakeholders, so they cannot depend on the data extracted from a model created by another

organisation. However, the developed model was beneficial in pricing stage and has been evolved since winning the project to be used in the construction stage and delivered at the end of the project for the operation and maintenance.

The agreement of this project was issued based on the FIDIC (1st Ed, 2000), and clauses for BIM were added to determine the liabilities, relationships, workflow of the information. The early involvement of a number of sub-contractors' imposed clauses in the contract. Where, those sub-contractors are hired by the client and they will work under main contractor umbrella, and 10% of the agreement between client and sub-contractor will be paid for the main contractor to inspect the work of sub-contractor. Regarding the intellectual property rights, it has been stated in the contract that the final model will be owned by the client to be used in O&M.

The interviewees argued that the relationship among participants in the DBB is not convenient with BIM adoption owing to lack of confidence, communication, and cooperation. However, in this project the main stakeholders were aware of BIM process and ample experience, hence they know that it requires high level of collaboration and trust and sharing of the information to deliver the project successfully. Moreover, involving sub-contractor in the design stage improved the cooperation among stakeholders and assisted in sharing information. As the sub-contractor was hired earlier, the sharing of the information with the consultant improved the design and assisted in avoiding the clashes. The contractor highlighted that owing to lack of awareness about BIM in some stakeholders particularly sub-contractors, the project faced many challenges, which resulted in delay of submitting shop-drawings and hence delay in the execution of the project. Because most of the sub-contractors, particularly local sub-contractors, were not familiar with the BIM process and had lukewarm response towards BIM adoption. Therefore, the contractor accepted 2D CAD shop-drawings to remain within the timeline of the project, thereby hindering the full utilisation of BIM.

Moreover, there are no obvious clauses in the contract to oblige all stakeholders to work through BIM process. The interviewees claimed that the current agreement demands amendment to make it compatible with the BIM adoption in terms of determining the responsibilities and the required inputs from each stakeholder, and most of the current contracts are copied from prior projects due to lack of awareness from client about the essential requirements from each stakeholder in each stage.

The contractor expects that soon client will hire a third party, like BIM specialist or BIM management, to control the BIM model in all processes and ensure that each stakeholder is adding the required data. In addition, the contractor confirmed that the critical problem faced in this project and all the other projects that are implementing BIM with DBB is that all the stakeholders are not hired from the design stage, so a design which otherwise should be final goes through various changes over a span of time after the stakeholders come into the scene. Consequently, the tasks are repeated and there is wastage of time that is ultimately reflected on the cost. Therefore, it is necessary to transform the DBB procurement method to allow an early involvement of the stakeholders to elaborate the transparency and collaboration. The interviewees rightly stated that though the main aim of implementing BIM is to save the cost, but by implementing BIM with DBB, the model is recreated at every stage at the cost of client's money and stakeholders' time, thereby costing all the stakeholders far more than executing a project without BIM. In addition, the relationship among stakeholders needs to be more collaborative than adversarial through sharing the rewards among stakeholders, thus promoting the cooperation, and reducing the risks and uncertainties. The representative of the contractor stated that the stakeholders can work in a cooperative environment and can save a huge amount of money; this saving can then be shared at the end of the project to improve the collaborative environment.

5. Conclusions and Further Research

This study revealed that there are many forces that have pressured the AEC firms in the UAE to adopt BIM, and the most efficient force being the pressure from the government, by imposing the implementation of BIM as a compulsory requirement. Furthermore, the pressure from clients by imposing the implementation of BIM in the contracts is forcing the firms to adopt BIM. However,

there is a crucial need to escalate the level of awareness about BIM, as the awareness about BIM among clients is at a moderate level which is not sufficient in the long run. Another force driving change was the complexity of the projects which had increased due increasing complexity of buildings that has created a more complex network of stakeholders. However, the implementation of the BIM process has been restrained due to the incompatibility of traditional processes adopted in traditional project delivery methods. In addition, the most popular procurement methods, DBB, has prevented the early engagement of key players, such as subcontractors. It can be concluded that to adopt BIM process correctly there are few changes required in the framework of procurement methods to address relationship among project stakeholders, early involvement of participants, revising contractual agreements, encouraging sharing risks and rewards, allow the involvement of new stakeholders and entertain the creation of new roles.

One of the main changes required is the contractual agreement to oblige all participants to adopt BIM, identifying the liabilities and responsibilities of each stakeholder upon inaccurate inputs, specifying the required inputs of each entrant in the model in each stage and identifying the intellectual property rights and the owner of the model. However, it has been confirmed that client is the final owner of the BIM model as he is paying for every nut and bolt of the project, and he will be the one to use the BIM model in O&M. In addition, the contracts should determine how to involve main participants at the onset of a project. The firms can use the contract forms developed by several organisations, such as AIA, AGC and DBIA, and modify them according to the UAE market requirements. Involving participants in the design stage will absolutely change the responsibility matrix and require sharing risks, wherein all stakeholders will participate collaboratively to create a single model that will be used in all the stages. In addition, the procurement method should also contain sharing of rewards to enhance the cooperation among the stakeholders, like the saving in the cost can be shared between stakeholders.

Concurrently, with the implementation of BIM, new firms will appear in the market taking the responsibility for the execution of the BIM process and control the flow of data and the model accessibility. Nowadays, new participants are being involved in the construction process, such as BIM consultancy, which is hired by the client to prepare employer information requirements and create the central data environment, and BIM manager, who is responsible for the coordination among inputs of each entrant. Therefore, the procurement method should identify their position in the procurement hierarchy and their relationship with other stakeholders. Although the most effective current procurement method used with BIM adoption is D&B because only one organisation is responsible for the design and construction and the integrated relationship among the participants enhances the cooperation and increases the level of coordination. However, it requires changes in the agreements to force sub-contractors to adopt BIM with predefined standards.

On the practical grounds, the DBB method is the most popular procurement methods used in the UAE. It assures best price for the client but demands many changes in order to be convenient with BIM adoption. The most crucial change is involving participants earlier to create an accurate model from the onset of a project, else recreation of the model from scratch in every stage will reduce the chances of harnessing benefits of the BIM process in terms of saving time and cost.

Generally, the BIM process has a huge potential in improving the AEC industry in UAE, but for the participants to avail the BIM benefits, the process has to be modified in accordance with BIM adoption. As the clients carry the main responsibility of changing the process, because they are leading every process of the project, so to achieve the project objectives, they have to improve the efficiency of the project delivery method.

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