Hindawi
Complexity
Volume 2021, Article ID 8818296, 9 pages
https://doi.org/10.1155/2021/8818296

Research Article

BIM Adoption and Its Impact on Planning and Scheduling Influencing Mega Plan Projects- (CPEC-) Quantitative Approach

Ahsan Nawaz, Xing Su, and Ibrahim Muhammad Nasir

Institute of Construction Project Management, Collage of Civil Engineering & Architecture, Zhejiang University, Hangzhou 310058, China

Correspondence should be addressed to Ahsan Nawaz; ahsanklasra@zju.edu.cn and Xing Su; xsu@zju.edu.cn

Received 16 September 2020; Revised 9 October 2020; Accepted 17 October 2020; Published 27 January 2021

Academic Editor: Mostafa M. A. Khater

The construction projects in Pakistan have inherent problems of erroneous planning and schedule development. This dilemma has led to the failure of the majority of construction projects in Pakistan. Earlier researches have tried to curtail the increasing spectrum of inaccurate planning and schedule development. But not many research studies have shed light on the major factor of 2D CAD drawings interpretation problems, which are playing a key role in defective planning and scheduling. Moreover, the role of BIM, i.e., Building Information Modeling with respect to efficient planning, has not been also discussed in detail. This study has concluded a positive impact of BIM on effective planning and scheduling in the construction industry of Pakistan. About 210 responses were obtained from experienced construction professionals of Pakistan and tested via regression analysis in order to validate this argument. It has been analyzed that 2D CAD drawings are now getting primitive and 3D technology BIM is taking its place. BIM is an efficient tool for planning and scheduling. With the start of CPEC and Multi-Billion Dollar investment on infrastructure, construction industry of Pakistan needs to uplift its existing standard in order to meet with international requirements. For this purpose, BIM has been recommended. It will not only assist in attaining flawless planning but will also increase the success rate of CPEC projects in Pakistan.

1. Introduction

The world construction industry is rapidly evolving through technological progression, whereas Pakistan's construction industry lacks use of technological tools to enhance its existing construction practices. The construction tools being practiced are all traditional approaches, which predominantly rely on 2D CAD drawings [1–4]. Furthermore, the conventional project delivery methods for construction projects isolate the responsibilities of stakeholders in planning, and other construction phases. Likewise, it acts as a barrier in integrated involvement of stakeholder, i.e., contractors, designers, and project managers during the initial phase of the project. The 2D CAD does not provide an integrated approach. The entire data is represented and formed in isolation by every individual stakeholder. Usually, the architects and designers work at their own respective offices making individual design. This gives birth to many conflicts, which in turn result in major issues during planning and construction phase [5]. The reason for less labor productivity in construction industry is also the conventional method involving fragmented project delivery method, which is supported by 2D CAD drawings [6]. The use of conventional approaches, which include 2D CAD drawings use, has restricted the collaborative roles of all stakeholders in construction phases on a project. It has let the architects, consultants, and contractors work independently, thus hindering the involvement and combined participation of stakeholders in integrated project delivery. This phenomenon has led to the generation of conflicting information and has eventually become the root cause of many issues that result in failure of the project [7].

The construction development plan and review process in the construction industry typically involve the use of paper-based drawings and the expertise of experienced construction planners. These planning and review processes are performed by mentally visualizing spaces. The visualizing capability of some of these planners is commendable. However, different people have varying abilities to accurately visualize construction projects [8, 9]. This results in the development of construction plans that lack schedule reliability and diminishes schedule confidence of the project stakeholders.

The construction management tools used for scheduling include a list of activities represented via bar chart format indicating the sequence and timelines derived from critical path method [10]. This sequence of execution of activities is derived from a detailed study of 2D CAD drawings. The drawback of CPM is that it leads to discrepancy in the interpretation of project schedule and the identification of mistakes of the construction plan [11]. However, advancements in computer visualization technology have provided construction professionals with desktop 3D CAD and 4D CAD tools that help construction planners visualize and review schedules [12]. Usually, the applications of BIM are exercised before the start of construction. It is imperative because information associated with the planning stage provides many benefits for the given project. This initial phase of a project falls into two parts; first, the marketing and design of the projects conceptual features should be addressed; second, planning and designing the project construction [13]. The modern era construction industry has started adopting building information modeling as a mandatory tool. Along with many wonders, this tool has revolutionized the planning and scheduling process in the construction industry. Unfortunately, in Pakistan, this tool is not being practiced owing to lack of expertise. The construction industry of Pakistan is still relying on 2D CAD based systems for planning and scheduling. It is one of the main reasons for faulty planning and scheduling of construction projects [14]. BIM is the most emerging tool being used globally in construction management [15–19].

In Pakistan, the concept of BIM is generally known to professionals of construction industry, but its practical use is almost negligible. Hence, this research aims to determine the impact of building information modeling BIM on planning and scheduling of construction projects in Pakistan [14, 20]. Now, since the CPEC has started in Pakistan with a multibillion dollar investment on infrastructure, there is a dire need for Pakistan's construction industry to upgrade its existing engineering standards and practices [21], to cope with the worldwide accepted standards. Therefore, this research also shed light on the benefits of BIM on CPEC projects in Pakistan.

The current construction practices of Pakistan are not as advanced as the worldwide accepted practices. They are lagging behind the world construction industry in terms of technological advancements. There have been many continuous attempts to elevate the existing standards of construction, but unfortunately the implementation and adoption pace are quite slow. This is a main reason why Pakistan's construction industry is not able to cope with the worldwide accepted standards [22]. Moreover, the CPEC (China Pakistan Economic Corridor) has been initiated in Pakistan with about $46 Billion investment on infrastructure, and there is a vivid hope that the construction industry of Pakistan will get the maximum benefit out of it [21, 23].

The purpose of this research is to highlight the importance of BIM in the field of construction in Pakistan. It is aimed that once BIM is implemented through various construction processes, particularly planning, Pakistan's construction industry will be able to cope with the international standards and practices, which shall be adopted by multinational companies working on CPEC.

This study aims to determine the impact of Building Information Modeling (BIM) on planning and scheduling of construction projects in Pakistan.

2. Building Information Modeling (BIM)

BIM involves a self-explanatory 3D model, which assists the engineering professionals, i.e., architects, designers, contactors, etc., to effectively plan, design, and construct [24]. The building information modeling technique is a digital representation of a 3D model, which depicts all its characteristics. This 3D model comprises elements that provide the parametric information along with data attributes. BIM views are consistent; i.e., the user can maneuver through the entire model in one go. These views are integrated with each other, and any change in one view would alter/update all other views simultaneously. This integration feature is a core function of BIM. It is less time-consuming for the designers to visualize and design collaboratively [25]. There is a swift growth and evolution in construction to meet such complex usability, design, and planning. Therefore, more sophisticated technology is necessary, which should be in line with the computer-aided design (CAD), present in BIM [4]. Usually models have better creation of forms and buildings owing to better perfection [26]. BIM involves integration of various stakeholders during the life of a project. The 3D model acts as a common portal where all stakeholders can work simultaneously, and the changes are updated in all domains automatically [27]. The use of three-dimensional model during project life cycle ultimately results in the creation of real-time, dynamic building modeling, which tends to supplement the effectiveness in design and execution. The design and information of all the elements can be extracted from it [25, 28, 29].

3. BIM Integration

BIM deals with a virtual 3D model of a building and integrates all related features (architectural, structural, MEP, etc.) at one place. BIM represents every aspect of a building in a 3D model; hence, this technology does not only help in architectural works but also help in planning, design, quantifying materials, clash detection of different services, etc. AEC industry (i.e., Architecture, Engineering, and Construction) has been chiefly upgraded with emergence of Building Information Modeling around the world. Building Information Modeling (BIM) comprises methodologies that are vital for building design and digitizing the project data in the entire project life cycle [30]. The level of maturity of construction industry in reference to usage of BIM is quite low, as no substantial up gradation has been introduced in the conventional models to give room to new technological advancements [1, 29] (Figures 1–3).

Building information modeling was first tested in prototype projects in the beginning of 2000s [6, 7, 33]. During construction design phase, there are many stakeholders involved at one time. These stakeholders include professional engineers and architects, which are engaged in making building designs, both the structural and the architectural designs. Hence, there is a dire need of a collaborative approach; i.e., all the stakeholders could work on the same platform. This 3D technology allows its users to work simultaneously in a collaborative environment [13, 32]. Initially, it was designed to support engineers and architects through the phase of building design. Later on, more improvement was made on planning, conflicts identification, clash detection, quantity surveying, etc. [18, 19, 34].

BIM comprises 3-dimensional elements having different parameters and attributes. These elements are interconnected with each other. The entire information is stored in these elements. During scheduling process, the duration of activities is calculated based on the basis of quantities derived from these parameters [35]. Market research from National Institute of Building Sciences [4] shows that future building design and construction will increasingly rely on BIM. In order to implement BIM in construction industry, the existing construction practices need to be revamped. In order to achieve efficient results with reduced cost to construct better standard buildings, BIM utilization in construction projects can only be adopted if a radical change in the existing construction practices has occurred [36].

4. Research Methodology

With the technological advancements, the Building Information Modeling technique is being widely accepted in the world to resolve various issues related to construction. This technique is also very helpful in enhancing the efficiency of planning engineers during the process of schedule development. To highlight the impact of BIM in increasing the precision in planning process, a questionnaire survey was conducted amongst the construction professionals, particularly the planning engineers, project managers, and site engineers in construction industry working on CPEC projects.

4.1. Research Hypothesis

H1: BIM has a positive impact on the planning of construction projects

H2: BIM has a positive impact on the scheduling of construction projects

In this study, BIM is an independent variable, while the planning and scheduling are the dependent variables.

4.2. Dependent Variables. According to the literature review and research hypothesis, there are two dependent variables.

Planning

Scheduling

4.3. Independent Variable. Building information modeling (BIM) is the independent variable of this research. The impact of BIM on the two dependent variables, i.e., planning and scheduling, is measured through this research.

The population of the study were the Construction Professionals working on the CPEC project all over the country. A survey form (Questionnaire) has been formed and sent to the respondents (Population) to collect the data. Overall, 230 responses have been received. These responses have been screened out and evaluated for the analysis led by the statistical tool (SPSS), and the 210 responses have been found to be statistically valid.

5. Results and Analysis

The first step in the analysis was to check the data for any missing value, although, in Google forms, it was made sure that any respondent should not submit the response with any missing information; however, the data collected through hard copy of questionnaire was suspected to have any missing information. In the introductory statement, it was requested from the respondents to fill the complete forms. During analysis, it was found that 210/230 respondents have responded completely. The results for analysis can be seen in Table 1.

The data extracted from 230 respondents was screened through SPSS, and outliers were excluded from it. The box plot tool of SPSS was used for this purpose. Initially, it was checked for outliers, and the results were analyzed. All the outliers visible in the box plots were deleted from the table. Sometimes, it was observed that when some outliers are deleted, some new outliers appeared. So, an optimum solution had to be obtained. It is pertinent to mention here that, for complete data, there was no response exceeding the outer limits of the box plot. All the outliers were present only in the inner fence of the box plot except 20 responses, which means that the data was precise to a good extent. After screening through the box plot, those 20 responses were excluded. The remaining respondents that were used for further analysis were 210 in number.

5.1. Reliability Test (Cronbach's Coefficient Alpha Method). The most common method of determining the internal consistency of data, i.e., reliability, is the Cronbach's Coefficients Alpha method. It is the most commonly used method to check the reliability of data when questions are asked on Likert scale. If Cronbach's Coefficient Alpha value is equal to or higher than 0.7, this means that the data is reliable for analysis [37]. Its higher value indicates that the data is consistent and reliable for analysis. A full-scale reliability test was performed on the collected data. The analysis results can be seen in Table 2. The last row of Table 2 is the overall reliability of the collected data. The reliability coefficient "Cronbach's Alpha value" is 0.755. This value is higher than the threshold, which is usually 0.70. It is

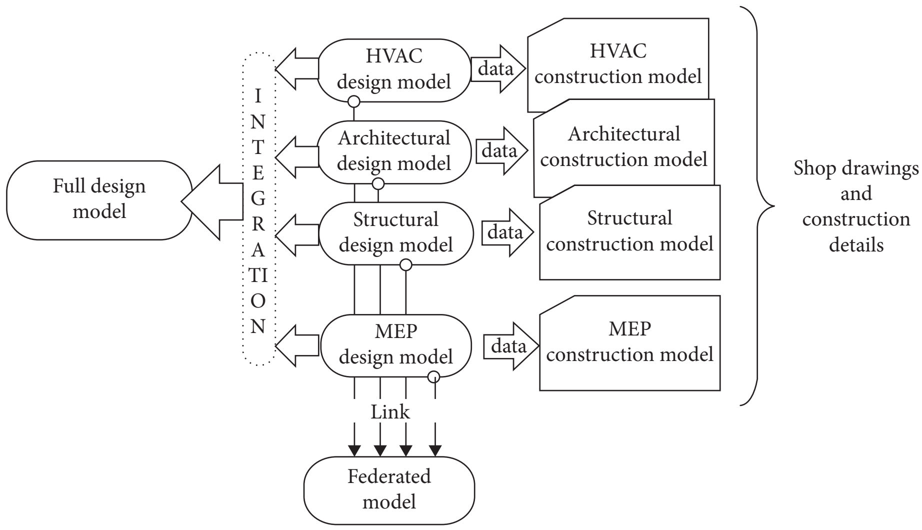


Figure 1: Diagrammatic representation of model definitions [19, 31, 32].

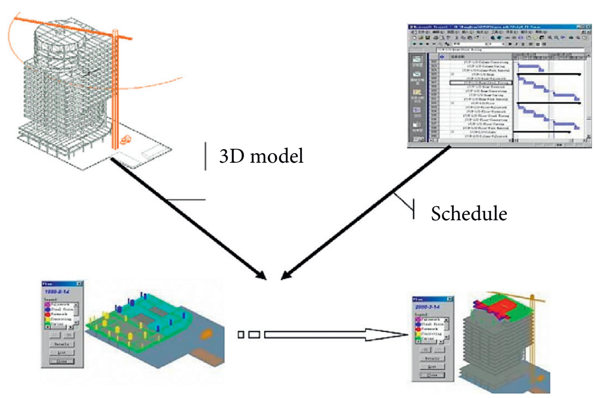
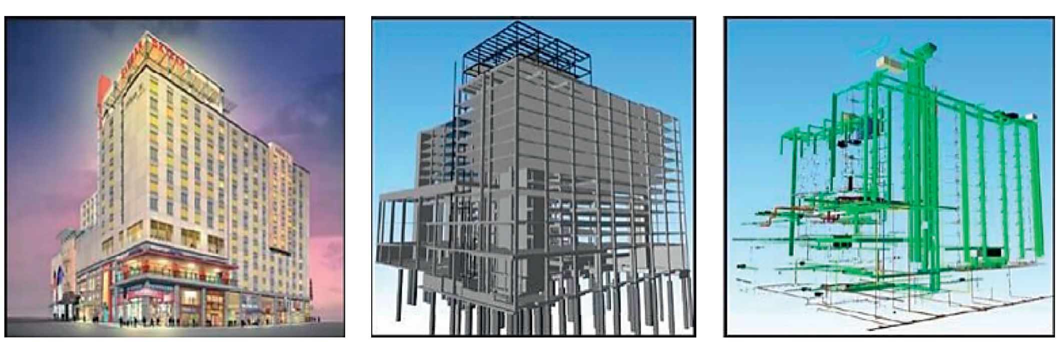


Figure 2: 4D concepts [14, 33].



(a) (b) (c)

Figure 3: 3D models of BIM [14]. (a) Architectural model. (b) Structural model. (c) Plumbing.

concluded from this analysis that the collected data is reliable enough and its results can be generalized on the target population.

5.2. Correlation. Correlation analysis is a method of statistical evaluation used to study the strength of a relationship between two variables. Researchers can test the hypothesis of study by performing correlation analysis. This analysis will help us determine the significance of the relationship of all three variables. The results of the correlation analysis are shown in Table 3.

The significance of relation between all the variables is less than the threshold value of 0.05, which means that the variables have a significant relationship. It is also revealed that the value of correlation between the variables is positive

Table 1: Missing values.

Missing values										
Element	CAD1	CAD2	CAD3	CAD4	CAD5	CAD6	CAD7	CAD8	CAD9	CAD10
Valid	210	210	210	210	210	210	210	210	210	210
Missing	0	0	0	0	0	0	0	0	0	0
Element	BIM1	BIM2	BIM3	BIM4	BIM5	BIM6	BIM7	BIM8	BIM9	BIM10
Valid	210	210	210	210	210	210	210	210	210	210
Missing	0	0	0	0	0	0	0	0	0	0
Element	BIM11	BIM12	BIM13	BIM14	BIM15	BIM16	PL1	PL2	PL3	PL4
Valid	210	210	210	210	210	210	210	210	210	210
Missing	0	0	0	0	0	0	0	0	0	0
Element	PL5	PL6	SC1	SC2	SC3	SC4	SC4	SC5		
Valid	210	210	210	210	210	210	210	210		
Missing	0	0	0	0	0	0	0	0		

Table 2: Reliability test.

Elements	No of items	Cronbach's alpha
BIM	16	0.737
Planning	6	0.724
Scheduling	5	0.707
Overall	**37**	**0.755**

Table 3: Correlation analysis between BIM, planning, and scheduling.

Correlation analysis			
	BIM	Planning	Scheduling
Pearson correlation BIM	1	0.513**	0.353**
Sig. (2-tailed)		0.0001	0.0001
N	210	210	210
Pearson correlation BIM	0.513**	1	0.286**
Sig. (2-tailed)	0.0001	0.0001	0.0001
N	210	210	210
Pearson correlation BIM	0.353**	0.286**	1
Sig. (2-tailed)	0.0001	0.0001	
N	210	210	210

**Correlation is significant at the 0.01 level (2-tailed).

and the correlation values are within the threshold limits of 0.3 to 0.85. The maximum value 0.513 is among BIM and project planning, which means that they have a strong correlation with each other.

5.3. Regression. Linear regression is a data analysis technique that is used to establish a statistical relationship between two variables. In this analysis, one variable is considered to be an explanatory variable or independent variable. and the other is considered to be a dependent variable. In this research, Building Information Modeling (BIM) was considered the independent variable, and its impact was observed on two dependent variables, i.e., planning and scheduling. The two research models have been tested based on the linear regression. The liner regression analysis was performed over these two models (hypothesis), and the results are listed below.

5.3.1. The Impact of BIM on Planning. The linear regression analysis was conducted on the independent variable, i.e., BIM, and its impact was checked on the dependent variable, i.e., Planning. The analysis results obtained can be seen in Table 4.

The adjusted R square values from Table 4 show that the 26% variability of Planning (dependent variable) is accounted by the Building Information Modeling (BIM), which is an independent variable in this case. From Table 5 F test shows that the model is significant, and the model is a good fit as the p value is 0.0001, which is less than the threshold value 0.05. So, from Table 6 we have beta coefficients that are used to transform the regression equation

$$\text{planning} = 1.780 + 0.539\,(\text{BIM}). \quad (1)$$

The above equation shows that, due to one unit increment in "BIM," there will be $(1.780 + 0.539 \times 1.0) = 2.319$ unit increment in "Project Planning." This means that if we

Table 4: Model Summary regarding impact of BIM om planning (model summary).

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.513[a]	0.263	0.260	0.26660

[a]Predictors: (constant), BIM.

Table 5: ANOVA impact of BIM on planning (ANOVA[a]).

Mode-l	Sum of squares	Df	Mean square	F	Sig.
Regression	5.283	1	5.283	74.335	0.0001[b]
1 residual	14.783	208	0.071		
Total	20.067	209			

[a]Dependent variable: planning. [b]Predictors: (constant), BIM.

Table 6: Linear regression showing impact on planning (coefficients).

Mode-l	Unstandardized coefficients		Standardized coefficients	t	Sig.
B	B	Std. error	Beta		
(Constant)	1.780	0.285		6.245	0.0001
1					
BIM	0.539	0.063	0.513	8.622	0.0001

[a]Dependent variable: planning.

change 1.0 unit of BIM, the project planning will vary 2.319 units.

5.3.2. The Impact of BIM on Scheduling. Afterwards, the liner regression analysis was conducted on the independent variable, i.e., BIM, and its impact was observed on the dependent variable, i.e., scheduling. The analysis results obtained can be seen in Table 7.

Regarding the adjusted R square values from Table 7, it is found that the 12% variability of scheduling (dependent variable) is accounted by the Building Information Modeling (BIM), which is an independent variable in this case.

From Table 8, F test suggests that the model is significant, and the model is a good fit as the p value is 0.0001, which is less than the threshold value 0.05. So, from Table 9, we have beta coefficients that are used to transform the regression equation

$$\text{scheduling} = 3.473 + 0.199\,(\text{BIM}). \quad (2)$$

The above equation shows that, due to one unit increment in "BIM," there will be $(3.473 + 0.\ 199 \times 1.0) = 3.672$ units increment in efficiency of "Project Scheduling." This means that if we change 1.0 unit of BIM, the project scheduling will vary 3.672 units.

6. Research Summary and Concluding Remarks

The study was done to investigate the impact of BIM on project planning and scheduling. For this purpose, an instrument was developed, and data was collected from the targeted population (construction Professionals) working on different CPEC projects. The responses collected from respondents were first screened for missing values and outliers. No missing values were found; hence, all the responses are considered for further analysis. Only 20 responses were screened out as outliers based on the box plot. The reliability test, named Cronbach's Alpha, was conducted in order to check the reliability of data. The value 0.755 is more than the threshold value (0.7), and this confirms that the data is valid for further analysis [38]. The findings are also in line with the findings of other researchers like "Hussain & Choudhry" (2013). The significance of the relation between the variables is 0.000, which is less than the threshold value of 0.05. This reveals that the relationship between the variables depicted from the research model is significant.

The sign of the correlation value of positive or negative shows the direction of the relationship. For our results, the positive sign of the correlation value yielded from the analysis results confirms our hypothesis and shows that there is a positive relationship between the variables. Acceptable range for the correlation between the variables is 0.30 to 0.80. If the value is less than 0.30, this represents that the relationship is somewhat weak between the variables. 0.30 value is considered to be boundary of the weak relationship and considerably strong relationship [39].

Similarly, the value of 0.80, which is the upper limit, represents that if the value is more than 0.80, the relationship is very much obvious. Our value of BIM and planning relationship is 0.513, whereas for BIM and scheduling, it is 0.353, which falls within the acceptable range. The value represents that the relationship is acceptably strong between the variables. This validates our ANOVA model. From the linear regression amongst BIM and planning, the value of adjusted R square is 0.263, which represents that the dependent variable (planning) is 26.3% explained by the independent variable (BIM). From the linear regression amongst BIM and scheduling, the value of adjusted R square is 0.125, which represents that the dependent variable, i.e., scheduling, is 12.5% reflected by the independent variable (BIM).

Table 7: Model Summary regarding impact of BIM on Scheduling (model summary).

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.353[a]	0.125	0.120	0.15619

[a]Predictors: (constant), BIM.

Table 8: ANOVA impact of BIM on scheduling (ANOVA[a]).

Mode-l	Sum of squares	Df	Mean square	F	Sig.
Regression	0.722	1	0.722	29.592	0.0001[b]
1 residual	5.074	208	0.024		
Total	5.796	209			

[a]Dependent variable: scheduling. [b]Predictors: (constant), BIM.

Table 9: Linear regression showing impact on scheduling (coefficients).

Mode-l	Unstandardized coefficients		Standardized coefficients	t	Sig.
B	B	Std. error	Beta		
(Constant)	3.473	0.167		20.795	0.0001
1					
BIM	0.199	0.037	0.353	5.440	0.0001

[a]Dependent variable: planning.

From ANOVA in Table 5, we note that the significance of the model is 0.000, which is less than the threshold value of 0.05. This represents that the model on which this particular study is based is significant. The analysis reveals the equation as Planning = 1.780 + 0.539 (BIM). The relationship between the selected variables, i.e., BIM and planning, can be understood by this equation. The equation also depicts that if we change BIM by 1 unit, the corresponding impact on the planning of construction projects will be 2.319 units. From ANOVA in Table 8, we note that the significance of the model is 0.000, which is less than the threshold value of 0.05. This represents that the model on which this particular study is based is significant. The analysis reveals the equation as Scheduling = 3.473 + 0.199 (BIM). The relationship between the selected variables, i.e., BIM and scheduling, can be understood by this equation. The equation also depicts that if we change BIM by 1 unit, the corresponding impact on scheduling of construction projects will be 3.672 units.

It has been observed that, in Pakistan, 2D CAD drawings are being mostly used in construction industry. Though these drawings are conventionally in practice, they are not compatible as compared to the advanced 3D technologies available in the world. Furthermore, the enhancement in planning of construction projects has a very significant relationship with the implementation of BIM. It means that if BIM is practically implemented in construction industry of Pakistan, then it can surely uplift the effectiveness project planning. Subsequently, it will result in the improvement of various other processes as well. Similarly, the scheduling of construction projects in Pakistan can improve tremendously with the implementation of BIM in construction projects. The visualization effect of BIM is the core trait, which has a direct impact on increasing the efficiency of schedule development. The current status of implementation of BIM across construction industry of Pakistan is almost negligible. This is the reason why the construction projects are bearing time and cost losses, which could have been avoided by slight introduction of technological advancements.

CPEC is going to be the biggest economic activity of this region. Such massive influx of investments demands more productive tools to be used for construction projects. BIM, being the most cutting-edge technology, has been recommended via this research to be practiced in construction domains, in order to cope with the requirements of mega construction projects of CPEC. This will help in enhancing project success rates and will have a positive impact on the country's economic growth.

Currently, the most critical point the project managers are facing is the faulty planning and scheduling. This research will eventually help the project managers in attaining to better efficiency in planning of their projects. As a result of this research, if BIM is practically used in the construction industry in Pakistan, it will directly be beneficial to managers. This study aims to be considered as a contribution to help project managers in Pakistan.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

The authors are thankful to the site engineers, project managers, planning engineers, and other technical staff working on the CPEC projects for making our research study possible on time. The authors acknowledge their efforts and the quality time given to their team while collecting the data. This research was fully funded by the China Scholarship Council of Zhejiang University and National Natural Science Foundation of China (71971196).

References

[1] Z. A. Memon, N. A. Memon, and A. H. Chohan, "The use of inforamtion technology techniques in the construction industry of Pakistan," *Mehran University Research Journal of Engineering & Technology*, vol. 31, 2012.

[2] M. P. Nepal, S. Staub-French, J. Zhang, M. Lawrence, and R. Pottinger, "Deriving construction features from an IFC model," in *Proceedings of the Annual Conference of the Canadian Society for Civil Engineering 2008: Partnership for Innovation*, vol. 1, pp. 426–436, Curran Associates, Inc, New York, NY, USA, 2008.

[3] H. Penttilä, M. Rajala, and S. Freese, "Building information modelling of modern historic buildings," 2007.

[4] D. Prowler, "Whole building design: the role of buildings and the case for whole building design," *National Institute of Building Sciences*, vol. 32, 2012.

[5] D. K. Smith and M. Tardif, *Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers*, John Wiley & Sons, New York, NY, USA, 2009.

[6] C. Sun, S. Jiang, M. J. Skibniewski, Q. Man, and L. Shen, "A literature review of the factors limiting the application of BIM in the construction industry," *Technological and Economic Development of Economy*, vol. 23, pp. 764–779, 2017.

[7] J. F. Teran, "Building modelling from antiquity to our day," *Journal of Building Information Modeling*, vol. 23, 2008.

[8] A. Nawaz, X. Su, Q. M. U. Din, M. I. Khalid, M. Bilal, and S. A. R. Shah, "Identification of the H&S (health and safety factors) involved in infrastructure projects in developing countries-A sequential mixed method approach of OLMT-project," *International Journal of Environmental Research and Public Health*, vol. 17, no. 2, p. 635, 2020.

[9] A. Nawaz, A. Waqar, S. Shah, M. Sajid, and M. Khalid, "An innovative framework for risk management in construction projects in developing countries: evidence from Pakistan," *Risks*, vol. 7, no. 1, p. 24, 2019.

[10] E. A. Poirier, S. Staub-French, and D. Forgues, "Measuring the impact of BIM on labor productivity in a small specialty contracting enterprise through action-research," *Automation in Construction*, vol. 58, pp. 74–84, 2015.

[11] G. Lee, H. K. Park, and J. Won, "D3 City project - economic impact of BIM-assisted design validation," *Automation in Construction*, vol. 22, pp. 577–586, 2012.

[12] A. TomeNa and P. MatČjNaak, "The impact of BIM on risN management as an argument for its implementation in a construction company," *Procedia Engineering*, vol. 85, pp. 501–509, 2014.

[13] E. A. Poirier, D. Forgues, and S. Staub-French, "Understanding the impact of BIM on collaboration: a Canadian case study," *Building Research & Information*, vol. 45, no. 6, pp. 681–695, 2017.

[14] R. M. M. Khan, *The Impact of BIM on Planning & Scheduling of in Pakistan*, Bahria University Islamabad, Berlin, Germany, 2020.

[15] D. Russell, Y. K. Cho, and E. Cylwik, "Learning opportunities and career implications of experience with BIM/VDC," *Practice Periodical on Structural Design and Construction*, vol. 19, no. 1, pp. 111–121, 2014.

[16] A. Adhikari and C. W. Keung, "The impact of BIM on quantity surveyor's role: the contractor perspective," in *Proceedings of the 11th International Cost Engineering Council (ICEC) World Congress and the 22nd Annual Pacific Association of Quantity Surveyors (PAQS) Conference (ICEC-PAQS Conference 2018)*, pp. 18–20, London, UK, 2018.

[17] T. D. Oesterreich and F. Teuteberg, "Looking at the big picture of IS investment appraisal through the lens of systems theory: a System Dynamics approach for understanding the economic impact of BIM," *Computers in Industry*, vol. 99, pp. 262–281, 2018.

[18] Y. Chen, D. John, and R. F. Cox, "Qualitatively exploring the impact of BIM on construction performance," in *Proceedings of the ICCREM 2018: Innovative Technology and Intelligent Construction; American Society of Civil Engineers Reston*, pp. 60–71, London, UK, 2018.

[19] D. Bryde, M. Broquetas, and J. M. Volm, "The project benefits of building information modelling (BIM)," *International Journal of Project Management*, vol. 31, no. 7, pp. 971–980, 2013.

[20] K. Hussain and R. Choudhry, "Building Information Modeling (BIM) uses and applications in Pakistan construction industry," in *Proceedings of the 13th International Conference on Construction Applications of Virtual Reality*, pp. 294–305, London, UK, 2013.

[21] W. Hao, S. Mehmood, A. Shah, A. Nawaz, M. Atif, and S. M. Noman, "The impact of CPEC on infrastructure development , A-double mediating role of project success factors & project management," *Revista Argentina de Clinica Psicologica-Scimago*, vol. 33, pp. 737–750, 2020.

[22] A. Fatima, M. Saleem, and S. Alamgir, "Adoption and scope of building information modelling (BIM) in construction industry of Pakistan," in *Proceedings of the 6th International Conference on Structural Engineering and Construction Management*, pp. 90–99, London, UK, 2015.

[23] W. Hao, S. M. A. Shah, A. Nawaz et al., "The impact of energy cooperation and the role of the one belt and road initiative in revolutionizing the geopolitics of energy among regional economic powers: an analysis of infrastructure development and project management," *Complexity*, vol. 2020, p. 1, 2020.

[24] Z. Z. Hu, J. P. Zhang, M. Lu, M. Cao, and S. D. Gao, "Simulation and optimization of prefabricated steel-structure installation operations," in *Proceedings of the 1st International Construction Specialty Conference*, Calgary, Canada, 2006.

[25] B. Koo and M. Fischer, "Feasibility study of 4D CAD in commercial construction," *Journal of Construction Engineering and Management*, vol. 126, no. 4, pp. 251–260, 2000.

[26] T. H. Y. Li, S. T. Ng, and M. Skitmore, "Evaluating stakeholder satisfaction during public participation in major infrastructure and construction projects: a fuzzy approach," *Automation in Construction*, vol. 29, pp. 123–135, 2013.

[27] W. Kymmell, "Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations (McGraw-Hill Construction Series): Planning and Managing Construction Projects with 4D CAD and Simulations; McGraw Hill Professional," 2007.

[28] D. Bouchlaghem, H. Shang, J. Whyte, and A. Ganah, "Visualisation in architecture, engineering and construction (AEC)," *Automation in Construction*, vol. 14, no. 3, pp. 287–295, 2005.

[29] K. I. Gidado, "Project complexity: the focal point of construction production planning," *Construction Management and Economics*, vol. 14, no. 3, pp. 213–225, 1996.

[30] S. Bhuskade, "Building information modeling (BIM)," *IRJET-International Research Journal of Engineering and Technology*, vol. 2, pp. 834–841, 2015.

[31] W. Smits, M. van Buiten, and T. Hartmann, "Yield-to-BIM: impacts of BIM maturity on project performance," *Building Research & Information*, vol. 45, no. 3, pp. 336–346, 2017.

[32] B.-G. Hwang, X. Zhao, and K. W. Yang, "Effect of BIM on rework in construction projects in Singapore: status quo, magnitude, impact, and strategies," *Journal of Construction Engineering and Management*, vol. 145, no. 2, p. 04018125, 2019.

[33] S. Ugochukwu, S. Akabogu, and K. Okolie, "Status and perceptions of the application of building information modeling for improved building projects delivery in Nigeria," *American Journal of Engineering Research*, vol. 4, pp. 176–182, 2015.

[34] K. Ku and M. Taiebat, "BIM experiences and expectations: the constructors' perspective," *International Journal of Construction Education and Research*, vol. 7, no. 3, pp. 175–197, 2011.

[35] J. Tulke and J. Hanff, "4D construction sequence planning–new process and data model," in *Proceedings of the CIB-W78 24th International Conference on Information Technology in Construction*, pp. 79–84, Maribor, Slovenia, 2007.

[36] T. Cerovsek, "A review and outlook for a "Building Information Model" (BIM): a multi-standpoint framework for technological development," *Advanced Engineering Informatics*, vol. 25, no. 2, pp. 224–244, 2011.

[37] W. Hao, S. Mehmood, A. Shah, A. Nawaz, M. Qasim, and A. Souhail, "COVID-19 epidemic spread and the impact on public health & safety Policy: an analysis of the adoption of preventive measures and effective Management: evidence from Pakistan," *Revista Argentina de Clinica Psicologica-Scimago*, vol. 22, pp. 722–736, 2020.

[38] M. F. Sattar, S. Khanum, A. Nawaz et al., "Covid-19 global, pandemic impact on world economy," *Journal of Technology and Social Science*, vol. 11, pp. 165–179, 2020.

[39] A. Nawaz, X. Su, S. Iqbal et al., "Validating a phenomenological mathematical model for public health and safety interventions influencing the evolutionary stages of recent outbreak for long-term and short-term domains in Pakistan," *Complexity*, vol. 2020, p. 1, 2020.