



Integrating Building Information Modelling, Lean Construction, And Quality Control: A Study Focused On Chinese Construction Engineering

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Abstract

The present study examines the implementation of building information modelling (bim) in chinese building engineering, explaining how technological innovation has transformed project execution and addressed issues facing the industry. The research emphasises bim as an internet-connected technology that is gaining significance in the construction industry because to its enhancement of presentation, collaboration, and effectiveness in operation. The study examines how bim enhances the dependability, efficiency, and environmental sustainability of construction projects in china. The results show that bim is a groundbreaking technology that works well to reduce design errors, raise estimate costs, and encourage collaboration between teams from different fields. It makes it easier for everyone to work together, cuts down on project delays, and makes the decision-making process for the building project better. The report also stresses how important it is for huge projects, like creating high-rise buildings and expanding urban recreational opportunities. In these projects, sophisticated design and tight deadlines mean that precision and good management are both important. Excessive costs associated with implementation, a lack of trained specialists, and the lack of completely standardised governing structures are some of the obstacles to broad acceptance that the research reveals, regardless of these benefits. Small organisations may not be equipped to capitalise on every advantage of incorporation of bim due to these constraints. The study found that the use of bim changes the appearance of building technology in china while rendering it more efficient, innovative, and environmentally friendly. To make the most of bim in the long-term, the industry needs consistent learning for workers, new policies, and defined regulations.

Keywords: chinese construction engineering; building information modelling (bim); innovation in engineering; construction industry; project management.

1. Introduction

The term "building information modelling" (bim) refers to a team effort that involves the creation and maintenance of computerised representations of both the physical and operational aspects of constructed resources. From the early stages of development and planning all the way throughout building, execution, and servicing, it facilitates the exchange of knowledge, improves cooperation across multiple fields, identifies creative dispute resolution, and employs technological resources and innovative, information-packed 3d models to help make informed choices. The cutting edge of digital construction methods is bim, which is a major current in the age of the fourth industrial revolution (industry 4.0) (li et al., 2022). An increasingly popular approach in the realm of study and creation in the past few years, bim incorporation into structure planning, constructing, and maintenance procedures aligns with environmentally friendly elements of the built landscape. Bim is a team-based method for conserving, exchanging, and controlling interdisciplinary data across a construction's whole lifespan, from inception to final dismantling. A multifaceted model of the built setting is created using several resources for data and software innovations to appease numerous stakeholders. An all-inclusive digital project of a structure, including geometrical and semantic details like material characteristics and construction component categories is called bim (carrasco et al., 2022). A great deal of automation is possible in the scheduling procedure because to the interconnected nature of this data. Whether a building element is traditionally or computationally made, bim may enhance the design process as well as productivity. By providing a robust method to access



data from a digital representation establishment, bim technology may be useful to proprietors and administrators. Geometric models describing construction components make up bim, which is usually implemented with objects-oriented technology. Vibratory design and evaluation of non-structural components may reach new heights with the application of bim, which increases reliability. The combination of performance-driven seismic modelling with bim digital building technology can make it easier to create sophisticated designs. Bim can improve processes, encourage innovative thought in designing, reduce duplication, raise the expected level of tasks, accelerate development, reduce expenses, and encourage collaboration between different fields in the architectural, engineering, and construction (aec) sector (othman & alamoudy, 2021). Bim alters the significance of building engineering by giving everyone an accessible, digital 3d model that makes it easier to see the project, find problems, and work together. This, in turn, cuts down on mistakes and changes, minimises money and time, and makes things more dependable and secure.

2. Background of the study

Considering the revolutionising of time-honoured methods for undertaking project preparation, oversight, and implementation, bim has had an immense effect on the field of chinese construction engineering. China encountered difficulties with quality assurance, inefficiency, and cost excesses because of its fast urbanisation and massive construction of infrastructure. By using bim, a digital approach was made available that improved industry-wide interaction, reliability, and efficiency. Better cooperation between parties is a prominent effect of bim in china. Architects, professionals in engineering, and builders can discover design disputes early through the development of an integrated online setting. This reduces inefficiencies and expensive maintenance. Where effectiveness and precision are paramount, such as in the construction of rapid transit systems, aeroplane terminals, and urban gigantic structures, this has been of wonderful use in china (li, 2023). In addition to facilitating enhanced visualisation and experimentation, bim helps teams anticipate problems, optimise operations, and make better decisions. Managing time and money is another important benefit of bim. Bim has increased efficiency and decreased waste by optimising resources, performing precise quantitative calculations, and integrating with lean building methods. Its interoperability with burgeoning innovations including ai, cloud storage, and the internet of things (iot) has improved construction lifecycle administration and continuous surveillance, guaranteeing longevity and profitability in the future. The rapid growth of bim has been influenced by government legislation. The real estate sector is currently in line with worldwide online building regulations thanks to national regulations and prizes that have encouraged enterprises to use bim. However, problems including differences in technical abilities, high start-up costs, and some sector-specific unwillingness to change are still an issue. Despite these problems, bim has generally had an innovative impact on chinese construction engineering. It has made things work better, sped up initiatives, and rendered china more powerful pioneer in the international building industry (chang et al., 2023). Bim and the application of new technologies are making china a leader in building practices that are good for the surroundings and use the latest technologies.

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3. Purpose of the research

The study was inspired by the desire to discover how bim may enhance construction engineering practices in china. The study aimed to examine the feasibility of integrating bim techniques, an online tool for developing, execution, and management, into the workflows of chinese construction projects. The study aimed to evaluate bim's potential to enhance stakeholder participation, minimise errors, reduce costs, and improve project management effectiveness. The purpose of this study was to investigate the application of bim in china to evaluate the industry's effectiveness in addressing the specific requirements of complex and large-scale construction projects in the country. The study aimed to investigate various impediments to bim, including technological limitations, resistance to adaptation, academic prerequisites, and corporate constraints. It also wanted to find out how the social standards and business practices of different project teams influenced how they used and adopted bim. The goal of the research investigation was to shed light on the ways in which bim could improve ecological sustainability, effectiveness, and creativity in china's construction engineering sector. In the endpoint, the study aimed to help professionals in engineering, business executives, and lawmakers improve the performance of construction, efficiency, and productivity by recommending ways for more widespread use of bim approaches.

4. Literature review

The field of 3d virtual administration is rapidly expanding. The rapid advancement of technology has caused an enormous shift in the aec business. One of the technologies that facilitates rapid deployment is synchronised 3d visualisation (ali et al., 2022). This, in addition to teamwork, helps achieve the best possible governance for everyone involved. One of the most significant proposals is the merging of gis with bim and legacy bim; this allows for the creation of flexible, cooperative systems. The use of bim accelerates the collection of information and decreases labour-intensive procedures for construction life cycle assessments (lcas). Yet, systematically comprehending how to include bim into lea is lacking. The goal of earlier research was to establish the groundwork for a comprehensive literature assessment on bim-equipped lca along all three dimensions of idea, technique, and utility (teng et al., 2022). The vast range of the buildings constructed of concrete that were studied were residential, low-rise structures, and built using “autodesk revit” for construction-related modelling. Investigators and designers of software can use the study as a foundation to learn about current developments and deficiencies in this field's expertise. Another study's aim was to document the most prominent technical advances and uses of bim incorporation. According to the findings, engineering has the highest percentage of resources (30.66 per cent), after computer science (20.01 per cent), when it comes to the combination of “geographic information system (gis)” with bim and “historic building information modelling (hbim)” (carrasco et al., 2022). Hbim is an important instrument for the administration, conservation, and rehabilitation of traditional buildings; it involves the application of computer software, digital cameras, and laser scanners to generate 3d digital images of these constructions. By creating a collection of reproducible parametric components reflecting historic features of architecture, hbim aims to tackle the distinct difficulties of historical structures, such as their intricate geometrical shapes and characteristics of materials, in contrast to ordinary bim. Lastly, the findings demonstrated that gis, bim, and hbim offer digital 3d models that have various uses for foundations and



constructions. An additional study's stated goal was to report on the most significant developments in bim models. Sustainable building processes that incorporate iot technologies have received a lot of attention. Researchers also examine issues regarding safety and health on the job location and how they relate to bim for tracking and organising the building process (panteli et al., 2020). In the examination of bim's after-construction uses, latest research in the field of intelligent building management with iot innovations and remodelling tasks are taken into consideration. New developments in standardisation procedures have given rise to incompatibility concerns pertaining to data exchange amongst bim-related technologies.

5. Research question

- What is the impact of bim on chinese construction engineering?

6. Research methodology

6.1 Research design

Utilising spss edition 25, the investigator examined the quantitative data. Both the strength and direction of the statistical association were determined using an odds ratio and a 95% confidence interval. The result can be considered statistically significant since the p-value was less than 0.05. We used descriptive statistics to delve into the data. Organised instruments, like surveys, were subjected to quantitative methodologies to confirm the data's validity and dependability.

6.2 Sampling

Identify potential sources of information about bim in chinese building assignments, the investigators in this study employed a purposive sampling technique. The rao-soft software recommended a total of 785 participants for the study. Researchers distributed 1000 questionnaires to people in the construction industry who work for different consulting firms and at different project sites. Out of a total of 898 responses, the researcher was able to remove out 86 with missing or incorrect information, resulting in a final sample size of 812. Because of this, the total sample size is 812.

6.3 Data and measurement

A questionnaire survey was developed to obtain comments from construction industry specialists and served as the primary data collecting method. In the first part, respondents were requested to supply their basic personal details in the initial portion. The second part of the survey used a 5-point likert scale to measure participants' opinions on the degree of cross-bim collaboration. Secondary data was obtained from credible sources, including internet databases and industry papers, to bolster the main findings.

6.4 Statistical software:

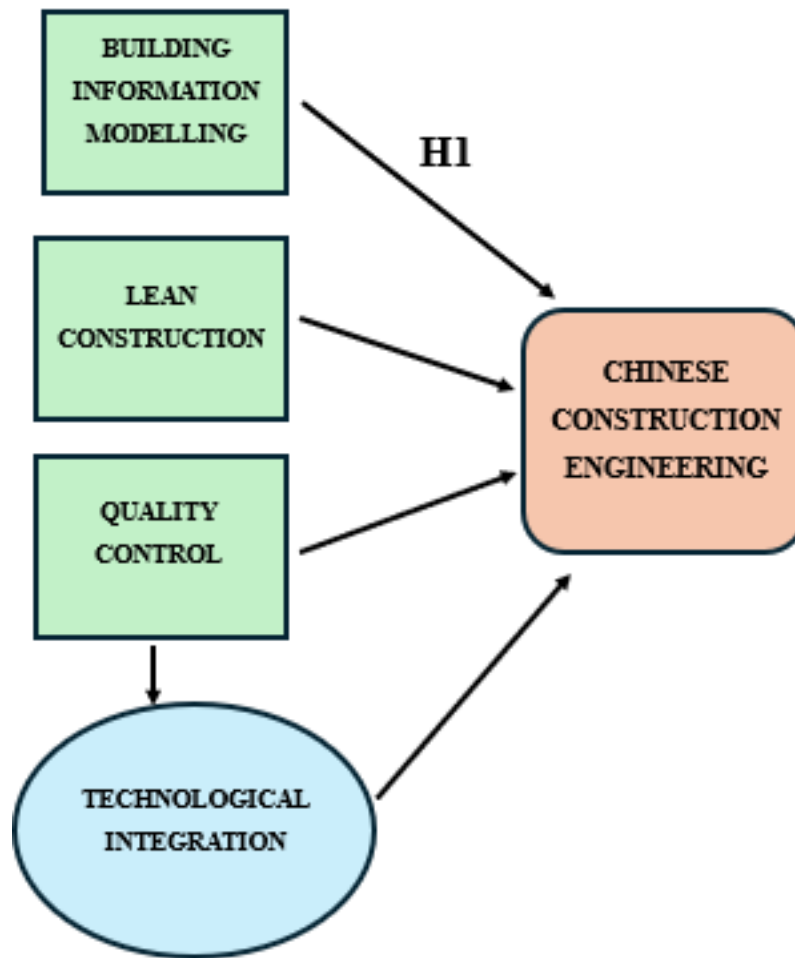
The statistical evaluation was performed employing spss edition 25 and microsoft excel.

6.5 Statistical tools

A descriptive analysis was performed to gain a better understanding of the data. For this study, the researcher used anova to identify variations among the groups and factor analysis to make sure the concept was accurate. Researchers used descriptive statistics to learn more about the patterns, habits, and correlations in the deliberately chosen sample.



7. Conceptual framework



8. Result

• Factor analysis

Factor analysis's (fa) primary objective is to unearth hidden factors within exposed data. Evaluations typically rely on regression coefficients when clear graphical or diagnostic indications are unavailable. Analysis focusses on possible observable linkages, vulnerabilities, and violations. The kaiser-meyer-olkin (kmo) test is used to assess datasets that have been acquired through numerous regression analyses. Results demonstrate that both the theoretical model and its sample parameters provide accurate predictions. The data can reveal the presence of duplicates. Reducing the proportions makes the information clearer. From 0 to 1, kmo provides the researcher with a value. If the kmo value is between 0.8 and 1, then the sample size is considered adequate.

According to kaiser, these levels are considered appropriate: the following approval conditions have been set by kaiser:

An appalling 0.050 to 0.059, well below the usual range of 0.60 to 0.69. The typical range for middle grades is between 0.70 and 0.79.

A quality point score between 0.80 and 0.89. The interval from 0.90 to 1.00 astounds them.

Table 1: examination of kmo and bartlett's sampling adequacy

According to the kaiser-meyer-olkin scale: 0.874



The results of bartlett's test of sphericity are as follows:

3252.968 is the approximate chi-square value

190 is degrees of freedom (df); sig = 0.000.

Table 1: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.874
Bartlett's Test of Sphericity	Approx. Chi-Square	3252.968
	df	190
	Sig.	.000

In general, this renders it easier to implement criteria for sampling. The investigators utilised bartlett's test of sphericity to evaluate whether the correlation matrices were statistically significant. When the kaiser-meyer-olkin value is 0.874, it means that the sample is large enough. A p-value of 0.00 is produced by bartlett's sphericity test. Since bartlett's sphericity test returned a positive result, researchers can conclude that the correlation matrix is not original.

❖ Independent variable

• Building information modelling (bim):

Bim is characterised by multiple forms: as an approach and technology that serves as a tool for manufacturing visualisation and workflow assistance, as an innovation that can work in three or more dimensions, as an instrument to visualise objects and exchange understanding, and most importantly, to guarantee improved performance. Bim represents the initial digital model of a construction that is metaphorical, which underpins both its potential and its overall nature. In the past, digital instruments such as computer-aided design (cad) relied on geometrical and graphical fundamentals to replicate traditional representations of matter (olanrewaju et al., 2022). Designs for floors in cad use sections of line and other comparable graphic components, much like their paper counterparts. By conceptually arranging visual basic information into definitions of building components and locations, users can recognise them in it in the same way as in analogue depictions. Originally developed almost twenty years ago, bim is a way to differentiate between 2d drawings and more knowledge-rich 3d models used in architecture (ali et al., 2022). Its proponents regard it as a saviour for complicated initiatives due to its capacity to fix mistakes prior to the design phase and precisely organise building. The fundamental advantage of bim is the precise geometrical description that represents construction elements in a data-integrated setting. By offering a collaborative, smart virtual platform for project preparation, design, and management, bim helps all parties involved in a project, from proprietors and builders to designers and architects, work together more effectively and get effective results.



❖ **Dependent variable**

• **Chinese construction engineering:**

Significant transition has occurred in the field of chinese construction engineering during the past few years, encouraged by the rapid expansion of the economy, urbanisation, and international goals of the country. China has risen to the position as an international pioneer in the construction of infrastructure, particularly succeeding in massive initiatives such as rapid transit networks, motorways, suspension bridges, high-rise structures, and smart towns (li, 2023). The sector is characterised using contemporary constructed techniques, large-scale construction using prefabricated components, and a rising reliance on new technologies like bim, artificial intelligence (ai), and machine learning. This innovation has made projects more successful, ensured consistency, and made people more responsible for our surroundings. Building industry of services also played a big element of china's "belt and road initiative (bri)," which has brought chinese know-how and building materials to markets all over the world (xia et al., 2023). Chinese engineering in construction has focused on meeting the needs of homeowners, bringing infrastructure up to date with contemporary requirements, and reaching ecologically sound goals by using energy-saving technology and sustainable building methods. The industry, on the other hand, has had a lot of challenges, such as a lack of workers, higher building costs, and the need to find a balance between speed, quality, and safety (li et al., 2020). To cut down on carbon emissions, the industry also needs to maintain moving towards international standards for sustainability and use more eco-friendly methods. China's ability to combine new technologies, extensive training, and productive worldwide engagement ensures that that nation keeps upsetting an example on construction and designing throughout the globe.

• **Relationship between bim and chinese construction engineering:**

The use of bim has changed the face of construction engineering in china, from planning to management to execution. High-tech instruments that boost productivity, cut expenses, and raise quality are in high popularity due to china's enormous building projects and fast urbanisation. The requirement is satisfied by bim, which integrates digital 3d representations with project information to improve the visualisation, simulation, and coordination of building procedures for every stakeholder involved. Bim has improved communication and cooperation between chinese construction industry professionals (chen et al., 2023). It minimises disagreements about design and construction mistakes by allowing contemporaneous exchange of data and identification of conflicts, which in turn minimises complications and price excesses. China is actively promoting green building methods and superior growth, thus this fits in perfectly with their goals. Public structures, skyscrapers, and public transportation have been the primary targets of the government's efforts to encourage bim use through rules, laws, and pilot initiatives (lu et al., 2021). Bim has been instrumental in the chinese construction industry's rapid pace of creativity, especially with the incorporation of ai, the iot, and prefabrication. If chinese individuals take smart building locations and agile building practices as an example, bim is being increasingly integrated with them to boost efficiency and security. It also helps with lifetime administration by making sure that digital representations are still useful for keeping facilities running smoothly. But there is compatibility between bim and chinese construction engineering (li et al., 2024). Bim delivers the digital foundation for modernisation, while the chinese construction sector supplies the size and speed to propel bim's development. The world's standards for innovative and efficient building are about to be redefined by this alliance.

To investigate the relationship between bim and chinese construction engineering, the researcher formulated the following hypothesis considering the previous discussion:



- *“ h_{01} : there is no significant relationship between bim and chinese construction engineering.”*
- *“ h_1 : there is a significant relationship between bim and chinese construction engineering.”*

Table 2: H_1 ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	63,853.843	321	9983.713	1057.813	0.000
Within Groups	428.742	490	8.856		
Total	64,282.585	811			

The findings of this study are quite substantial. There is statistical significance below the 0.05 alpha threshold, as indicated by the f value of 1057.813 and a p-value of 0.000. The findings indicates that the *“ h_1 : there is a significant relationship between bim and chinese construction engineering”* has been accepted, and the null hypothesis has been rejected.

9. Discussion

According to the results, bim was an important development for chinese construction engineering. The online environment that bim provided which include combined engineering, scheduling, and implementation, improved the effectiveness of the project, minimised mistakes, and enhanced communication among stakeholders. The system enabled the early identification of conceptual disagreements, which decreased the need for expensive changes and interruptions, ultimately leading to better project integrity and faster delivery dates. Furthermore, the study found that there were further benefits when bim was integrated with lean building concepts along with quality monitoring processes. Utilisation of resources, waste reduction, and workflow effectiveness were all enhanced by combining bim's information-based technique with lean approaches. Improved building quality was guaranteed by built-in quality control methods in bim systems, which allowed for compliance evaluation in immediate terms. When used together, these strategies helped the industry become more transparent, responsible, and long-lasting. But cultural and managerial problems made it hard to fully use bim. Researchers discovered that certain impediments include an unwillingness to adapt, high initial costs, and varying degrees of technological comprehension. Due to these issues, businesses increasingly understand that they need better legislative frameworks, financial backing, and training chances for encouraging broad adoption. The study also found that combining bim with lean concepts and good quality control might make chinese building engineering far more modern and useful. By combining traditional methods with new technologies, the construction business was able to improve its competitiveness, environmental awareness, and creativity on a global and local scale.

10. conclusion

The research concluded that the integration of bim in chinese construction technology resulted in a significant revolution in the delivery of projects, efficiency, and collaboration. Researchers found that bim provided a structured way for people to share information. This cut down on



misconceptions and project postponements. By using bim, the chinese construction sector was able to solve several persistent issues. This also led to better funding, more accurate products, and less risk. The results also showed that the use of bim was in line with the national tendency towards enhancement and technological advances in building methods. It has been shown that chinese construction companies who use bim are better equipped to reach their objectives for long-term development and stay profitable in both domestic and global markets. Although these had been early barriers, the benefits of using bim slowly outweighed the problems, that included high costs for execution, a lack of experienced professionals, and resistance to change. In short, this study demonstrated that bim would play a big role in shaping the future of chinese construction technology by stimulating new ideas, making work more efficient, and supporting eco-friendly practices. The campaign made people think that using bim was an important move towards achieving advancements in the field while simultaneously making sure that it keeps growing.

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