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Success of Implementing Cloud Computing for Smart Development in Small Construction Projects

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Abstract: The objective of this study is to ascertain the essential elements that contribute to the successful implementation of cloud computing in small-scale construction projects, with the ultimate goal of promoting intelligent development in Malaysia. The construction sector is undergoing rapid transformation, and the integration of cloud computing technology can make a substantial contribution to the achievement of project objectives and the promotion of sustainable development. Nonetheless, there exists a dearth of comprehension regarding the function of cloud computing in minor construction undertakings within the Malaysian context. In order to bridge this gap, a mixed-methods approach was implemented, which encompassed a comprehensive review of the literature, interviews with experts, and a preliminary survey that involved 160 participants. Utilizing the findings of the pilot survey, the process of Exploratory Factor Analysis (EFA) was employed to discern and eliminate nonessential determinants of success. A survey utilizing primary questionnaires was conducted with a sample size of 230 participants. The subsequent analysis of 16 critical success factors was carried out through the application of Structural Equation Modeling (SEM). The findings indicate that there are four fundamental constructs that play a crucial role in the effective execution of a project. These include cost, quality, and time management ($\beta = 0.352$); planning success ($\beta = 0.360$); organizational success ($\beta = 0.351$); and communication and coordination ($\beta = 0.299$). The research results have favorable ramifications for the construction sector in Malaysia. The integration of cloud computing technology in minor construction endeavors has the potential to augment project efficacy and foster sustainable development. This study offers a roadmap for stakeholders in the construction industry to effectively utilize cloud computing technology for smart development by identifying critical success factors.

Keywords: cloud computing; critical success factors; small construction projects; Malaysia; smart development

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1. Introduction

The industry of building is both complicated and dynamic. Projects relevant to the building industry include many interdependent activities and components that substantially impact social, environmental, and community-relevant factors throughout their life cycle. More than 40% of universal electricity production and 30% of emissions of total

Greenhouse Gas (GHG) in emerging and wealthy nations are attributable to building projects. Approximately forty percent of the entire strength and resources of Europe and the United States are used for building [1]. In underdeveloped nations, the sustainability of projects in the building industry is very worrying. There is little doubt that the building sector is crucial in guaranteeing basic living standards in these rapidly developing nations [2]. The data-intensive, highly decentralized, and project-based market nature of the building industry, along with extensive data interchange and processing needs throughout the life cycle of its products, is dependent on several experts and organizations (primarily buildings) [3]. The designing process, building operations, and overall reconstructing process encompass conventional disciplines (architectural, electrical, mechanical, and structural engineering) and several current occupations in topics such as environmental-related science and the study of managing waste. Most vocations have stringent sharing requirements of data [4,5].

The building sector demands the sufficient storage and exchange of information amongst specialists. Allen et al. and Altohami et al. stated that communication and cooperation might be achieved by using information control systems, such as the advent of cloud computing. Structured information communication helps the convergence of several project stages [6,7]. Zuccaro et al. and Zou et al. found that using a shared Internet connection or shared databases may also add to the success of information sharing [8,9]. As a result of the exponential growth of technology, information technology (IT) products and services are accessible worldwide every day [10,11]. Bosch-Sijtsema et al. and CAPM and Eng stated that this phenomenon pressures building managers to develop, implement, and integrate new technical techniques to accommodate these changes [12,13].

Cloud-based data centers' high-performance production processing capability is facilitated through the analysis of enormous amounts of IoT data to give actionable insights. Consequently, Casini and Chen et al. stated that while considering the methods that may be employed to aid in this circumstance, we must examine the advancements and the effect of cloud computing on the building sector [14,15]. Consequently, strategies should be developed for executing the sustainable growth concept and the development of "sustainable building" via the reduction in fragmented data, where data's use is crucial for the execution of all building projects [16,17]. Sustainability may fulfil present demands without compromising future generations' potential. Dantas Filho et al. and Ding et al. stated that sustainable building is implementing a sustainable environment with ecological values and efficient energy use [18,19]. Getuli et al. and Goh et al. found that it is also explained as a starting phase before and after the departure of the building company [20,21]. The building industry should be revolutionized by building innovative and sustainable processes. Fang et al., Garyaev and Garyaeva, and Gavali and Halder stated that to monitor the success of a building project, it is highly recommended that sustainable activities be included from the beginning [22–24].

According to Kochovski et al. and Konikov and Garyaev, giving global remote access to services that compute using web-based information and communication technology (ICT) approaches is how cloud computing may achieve this intended building resilience [25,26]. Cloud computing is now ready to transform internationally, adopting sustainable business practices as a multidimensional strategy for sustainable management, with cost-effectiveness and economics serving as indicators of success for various building projects because of the platform's inherent pay-per-use, sustainability, and availability. Multiple users concurrently use shared server networks to access computing services [27,28]. It provides high-performance computing resources to evaluate large volumes of IoT (Internet of Things) data to provide decision-making-enhancing information. According to Lilis and Kayal and Liu and Tian, cloud computing is a relatively new phenomenon that allows SMBs to address various sustainability issues, such as cost-effectiveness and risk management. It only buys the resources it needs and treats services like a commodity [29,30].

The majority of platforms relevant to cloud computing are suppliers of shared resources. Application administration, measurement content delivery, and preservation costs have been dramatically lowered because servers no longer need to sit idle for extended periods [31,32]. Although past studies have explored cloud computing advantages, more effort has yet to be performed to evaluate the usage of cloud computing in the emerging world's building industry nations. Mandičák et al. and Merschbrock and Munkvold found minimal and exhaustive academic research on using cloud computing in the building sector [33,34]. Work has been carried out on cloud computing strategies of implementation and relevant confidence models. Security becomes more critical when cloud computing is considered. This includes cost-effectiveness, protection and safety, assistance, interoperability, and enforcement. Mukhopadhyay et al. and Mutis and Mehraj stated that, typically, these regulations only apply to the organization [35,36]. Customers have encountered the same challenges, such as with on-site devices and apps. Consumers are now told that data that they own, software, and computing skills will no longer be within their control. According to Nguyen et al. and Noaman and Mohammed, it is suggested that there is a correlation between the deployment of cloud computing and building projects [37,38].

Consequently, our study contributes to the studies on CC as a flourishing research field by investigating the appropriate tools and methodologies for its application in the Malaysian small building sector. Therefore, the overall study question is, "Describe the essential ingredients for utilizing CC in minor building projects in Malaysia or the critical factors relating to the success of CC in little building projects in Malaysia". Consequently, this research aims to analyze CC-building technologies in Malaysia. In pursuing CC implementation, stakeholders in feasible building plans will find this helpful article. This research's outcomes will influence how building projects are executed in Malaysia and other developing countries. The following sections consist of an overview of the relevant research material, accompanied by the application of the research technique. The findings were explained and examined from the perspective of prior research. Important data and suitable recommendations are presented in conclusion. This research might be valuable for stakeholders in sustainable building projects seeking to integrate cloud computing. The results might influence the scope of building projects in underdeveloped countries such as Nigeria and Kenya, where comparable projects have been carried out.

This article discusses the importance of cloud computing in the building industry, its advantages in promoting sustainable building practices, and the need for its implementation in emerging nations. However, there is a lack of extensive academic research on using cloud computing in the building industry, especially in Malaysia. Further research is needed to evaluate the usage of cloud computing in the building sector and develop strategies for its implementation. Additionally, more effort is needed to evaluate the advantages of cloud computing in the building industry and develop relevant confidence models. Finally, research is needed to investigate the correlation between the deployment of cloud computing and building projects.

The introductory section presents a comprehensive perspective on the construction sector, emphasizing the interconnected operations and constituents that impact social, ecological, and communal aspects. The sector's significant requirements for data exchange and processing render it reliant upon multiple experts and organizations. The research subsequently explores the significance of information control mechanisms, such as cloud computing, in augmenting communication and collaboration among experts. The primary objective of the paper is to examine the influence of implementing cloud computing on the small construction sector, with a particular emphasis on promoting smart development. According to the research findings, the implementation of cloud computing has the potential to revolutionize the construction sector by facilitating the adoption of sustainable business practices, enhancing cost-effectiveness, and promoting economic growth as key performance indicators. Nonetheless, this underscores the necessity for strong security and implementation strategies to guarantee the safeguarding of data and confidentiality. This research contributes to the expanding body of literature on cloud computing within the construction industry, particularly in less developed nations, where a more comprehensive assessment of its advantages is required.

2. Related Literature

Multiple research projects have identified smart development difficulties. Transforming corporate sustainability objectives and initiative strategies takes time and effort. According to Noteboom et al. and Núñez et al., it is necessary to balance factors affecting society, the economy, and the environment and their overall sustainability in smart development [39,40]. The development of building industry sustainability has prompted a search for practical methods to incorporate this concept into existing work settings. Oke et al. and Peng stated that key strategic stages might also be influenced by the need to develop the environment and an aspirational morality of social responsibility for businesses adopted by all organizations [41,42]. According to Oke et al. and Petri, Beach et al., in comparison to conventional methods and procedures, the use of cloud computing to perform construction projects could lead to the development of sustainable construction stakeholders who are more cooperative, more unified, and more capable of working together efficiently [42,43]. The building stakeholders can carry out the real-time storage and assessment of data development by using cloud-based technology.

Several investigations have suggested that there may have been a rise due to the use of portable devices such as computers, cell phones, and virtual assistants, which can increase the capability for gathering real-time information from the field. This is evident by monitoring a project's sustainable development program, performed by the designed mobile applications [44,45]. According to Oke, Kineber, Albukhari et al. and Petri, Rana et al., a feasible construction strategy is importing information to an MS Excel file using the application [46,47]. However, Zhang and Li and Zhao et al. found that building employees in an office or any other place may access and use building site materials [48,49]. The cloud storage feature of ad hoc self-service is helpful. The adaptability of cloud computing is higher than conventional computer models. In contrast to typical storage methods, Oke, Kineber, Al-Bukhari et al. and Qassim Qwaider stated that people can connect by using technology in an independent environment called cloud computing from any location with network connection [50,51].

In addition, medium- and small-sized businesses may focus mostly on primary money-making and feasible operations and new methods thanks to cloud computing. Oke, Farouk Kineber, Abdel-Tawab et al. and Ryu et al. stated that by creating an effective business model, businesses must achieve their efficacy in enhancing their company's worth over a long period [52,53]. All corporate resources, such as work and time, formerly allocated to the IT department may now be allocated to other crucial business areas. For medium and small-sized firms, the core businesses of which are not IT, it is optional to maintain or update their information systems (ISs). Shahzad et al. and St-Pierre et al. stated that their core industry should be concentrated upon to increase their company's competitiveness and overall performance [54,55].

Furthermore, this motivates them to innovate and explore new business methods. Hongchang Sun, Guo et al. and Hongchang Sun, Wang et al. stated that saving resources increases productivity, enhances operating performance and efficiency, and allows organizations to focus on their core businesses rather than non-core activities such as infrastructure administration and upkeep, allowing them achieve their productivity goals [56,57].

According to You and Feng and Yu, one of the attractive, long-term advantages is the price structure of cloud computing, in which customers give payments for what they use or buy only [58,59]. Using cloud technology reduces investment costs since the user is no longer required to contribute to acquiring IT resources [60,61]. According to Petri, Rana et al. and Huaiying Sun et al., the payment for every used model and scalable characteristics of cloud computing provide undeniable benefits to cloud consumers [46,62]. For medium- and small-scale enterprises in sub-Saharan Africa, cutting the primary cost of establishing IT services relating to infrastructure and lowering running expenses are crucial issues when using the cloud. The use of cloud computing has led to a drop in the licensing costs that medium- and small-scale enterprises (SMEs) must pay to obtain software from technology providers [63,64].

Meanwhile, large data centers are expensive to run since they rely largely on energy, which is notoriously unpredictable in many Asian countries. Crucial to cloud computing is that as per Villefranque et al. and Wang and Chio, the technology is powered by several computers irrespective of readily available hardware utilized for application [65,66]. The flexibility of cloud computing exceeds that of older computer architectures. Instead of relying on a central server to store data, cloud computing users can access and use the system from any location with an internet connection.

CSFs are regarded as actions and processes that must be performed to ensure quality control is properly imposed and executed among building industry stakeholders. However, many researchers only focused on identifying cloud computing CSFs used by building parties; more relevant studies on Malaysia need to be conducted. Creating a Malaysian survey of small building industry stakeholders was a transparent way to address this deficiency and close this gap.

Several research studies have identified challenges related to sustainability in the construction sector, leading to a quest for feasible approaches to integrate sustainable development into current work environments. Cloud computing has been suggested as a potential remedy due to its numerous advantages, including its cost-effectiveness, scalability, and ability to provide instantaneous access to data. The effective adoption of cloud computing within the construction sector is contingent upon the identification and resolution of CSFs that are unique to this particular industry. Table 1 below provides a critical comparison of the pros and cons of approaches evaluated with respect to different parameters of cloud computing implementation in construction.

Table 1. Comparison of observed cloud computing implementation approaches.

Parameter	Approaches	Pros	Cons	References
Cost	Cloud-based project management systems	Reduced infrastructure and maintenance costs	Subscription fees may be costly in the long run	[50,64]
Scalability	Cloud-based servers and virtual machines	Easy and flexible scalability	Limited control over server hardware and software	[29,67]
Security	Encryption and secure communication protocols	Increased data security and privacy	Dependence on the cloud service provider's security measures	[25,39,42]
Collaboration	Cloud-based collaboration tools	Improved team communication and coordination	Potential loss of face-to-face interaction and human touch	[17,22,36]
Accessibility	Cloud-based platforms and mobile applications	Easy access to project information anytime and anywhere	Dependence on internet connectivity and potential network outages	[3,27,68]
Reliability	Cloud-based backup and disaster recovery services	Improved data backup and disaster recovery	Dependence on the cloud service provider's reliability and uptime guarantees	[8,10,21]

The implementation of cloud computing in the building industry is contingent upon several factors, such as cultural transformation, investment in IT infrastructure, and the accessibility of network connectivity and energy, despite the manifold advantages it presents. It is imperative to identify and address critical success factors that are unique to the building industry in order to achieve successful implementation. In order to fill the research gap pertaining to CSFs of cloud computing in Malaysia, a survey was conducted among stakeholders in the small building industry. The objective of our study was to offer valuable perspectives on the critical determinants that can facilitate the effective adoption of cloud computing in the small construction sector.

3. Methodology

The approach followed a step-wise process that needed the careful identification and assessment of CC essential success criteria to accomplish the research-identified objective.

The following flowchart (Figure 1) illustrates the complete research methodology employed to develop a conceptual model that reflects CC's essential success characteristics.

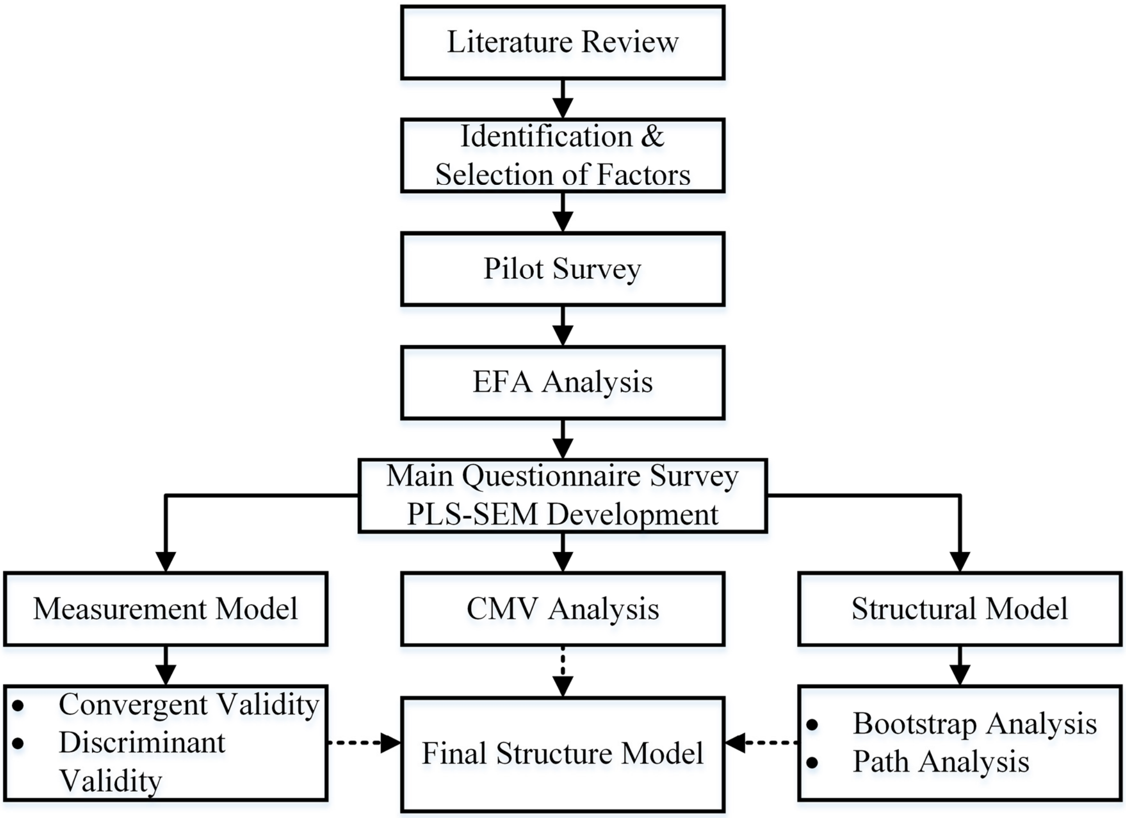


Figure 1. Flow chart of study.

First, a critical literature review was conducted to determine the CSFs for CC use in small construction projects within the context of the Malaysian building sector. CSFs with CC were found and refined via semi-structured discussions with five CC specialists and seven small building project experts in Malaysia. The results from the pilot survey were then subjected to Exploratory Factor Analysis (EFA) and reliance assessments to see if further CSFs could be removed. In conclusion, a questionnaire-based basic survey was carried out. The Confirmatory Factor Analysis (CFA) technique developed a measurement model by executing discriminant and convergent validity to determine the most important CSFs for adapting CC on Malaysian construction industry building projects [69,70].

3.1. Structured Literature Collection

Collecting data started with a comprehensive examination of CC CSFs in the existing literature. According to Y. Wang et al. and Wong et al., the major objective was identifying the most important CC CSFs for small building projects [67,71]. In addition, the overall technique was designed to identify the most widely accepted CC CSFs identified by earlier researchers, as a critical evaluation of existing studies is crucial to attaining any outcome. Six sources, consisting of Springer, Web of Science (WoS), American Society of Civil Engineers (ASCE), Science Direct, Multidisciplinary Digital Publishing Institute (MDPI), and Scopus, were consulted for information. Using Google Scholar, only papers published between 2011 and 2022 were searched. These databases are reputable sources of academic literature, and therefore, we considered them appropriate for our study. Research articles were found by utilizing a combination of various key words, with the adaptability of the terms tailored to the study's overall topic [72,73]. We searched for CC CSFs described in past research articles but limited our search to small-scale initiatives. Existing articles were searched using all available keyword combinations from the standpoint of CC CSFs. Table 2 summarizes the collected research and related articles in the databases mentioned earlier.

Table 2. Review process statistics.

Database	Combination of Keywords	Collected Articles	Related Researches
Springer	"Small Building Projects AND CC OR Challenges or Success in CC Adoption in Small Building Projects"	327	54
WoS	"CC Success Factors AND Small Building Projects OR CC Adoption in Small Building Projects"	130	45
ASCE	"Cloud Computing Building OR CC in Small Building Projects OR CC CSFs	156	23
Science Direct	"CC AND Small Building Projects OR CC Success AND Small Building Projects"	153	36
Scopus	"CC Success Factors OR CC CSFs in Small Building OR Cloud Computing Technology"	10	7
Google Scholar	"Cloud Computing OR CC OR Critical AND Success OR Small Building Projects"	390	14
Total		1166	179

Multiple keyword iterations enabled us to obtain 1166 items across all databases. Based on their titles, abstracts, and potential obstacles, 179 papers met the inclusion criteria for this study. To discover CC CSFs in small building projects, we reviewed 179 publications thoroughly. The majority of found success variables shared features with eliminated factors. Upon conclusion of the literature analysis, it was concluded that only 31 difficulties were significant while tackling modest building projects in Malaysia.

3.2. Qualitative Analysis (Interview)

An assessment tool for semi-structured qualitative interviews, including CSFs linked to the application of CC in Malaysia's minor construction projects, was developed. In prior research, a representative sample for a variable semi-structured discussion was reported. Because of the qualitative discussions, the objective remains to compile as much information as possible. However, time also restricts the number of individuals interviewed (Zhang & Li, and Zou et al.).

The smallest sample for questionnaire surveys must be between 10 and 20 [8,48]. However, the number of specialists participating in interviews should range from five to fifty. Therefore, 15 specialists from the small building business in Malaysia presently working on building projects were asked to attend [73,74]. Interviews were conducted with executives and project managers since the application of CC comes within their purview on any building project [75,76]. Due to the absence of three interview subjects, their interviews were conducted online via a conference call, while other interviewees were met in person at their location.

There was complete disagreement among respondents over the CC CSFs, such as insufficient access to resources for making decisions (D1), size of the enterprise (D2), capacity of the business (D3), template structure—essential infrastructure (D4), nature of the business (D5), client's readiness (D6), availability (D7), performance (D8), perceived usability (D9), privacy (D10), and previous realized cost estimates. Out of 31 CC CSFs, only 21 topics covered in the interview were deemed appropriate for additional research by the specialists.

A thorough content analysis was performed using the descriptive qualitative program NVivo, and respondents' statements were categorized [77,78]. The qualitative approach yielded 21 factors, which were then grouped into four primary categories. These characteristics were then utilized to create the final combined framework, which included the previous studies' results and qualitative analysis, as shown in Table 3.

Table 3. Identified success factors from the literature.

Sr. No	Success Factors	References	Status
1	Internal industrial rivalry exerts pressure	[45,68]	Maintained
2	Size of the enterprise	[48,68]	Deleted
3	The capacity of the business	[42,43]	Deleted
4	Template structure—essential infrastructure	[41,46]	Deleted
5	Specialized human capital	[50,54]	Maintained
6	Nature of the business	[52,57]	Deleted
7	Technological advancement	[55,62]	Maintained
8	Eagerness of clients	[41,47]	Maintained
9	Availability	[42,43]	Deleted
10	Dependable data storage	[41,47]	Maintained
11	Performance	[55,57]	Deleted
12	Accessibility cost	[42,43]	Maintained
13	Perceived usability	[53,56]	Deleted
14	Privacy	[43,53]	Deleted
15	Client's readiness	[4]	Deleted
16	Efficient monitoring and control	[2,3]	Maintained
17	Realistic schedule	[1,2]	Maintained
18	Capability to communicate on a variety of levels	[5,6]	Maintained
19	Fulfilling user specifications	[1,2]	Maintained
20	Correctly defining the project	[2,4]	Maintained
21	Ability to better coordinate	[8,44]	Maintained
22	Before the project begins, stakeholders understand the success criteria	[46,50]	Maintained
23	A precise description of what should be done	[52,54]	Maintained
24	Competency of the PM	[55–57]	Maintained
25	Collaboration between PM and owners	[62,63]	Maintained
26	Previous realized cost estimates	[64–66]	Deleted
27	Realistic budget	[60,61]	Maintained
28	Project complexity	[67,68,71]	Maintained
29	Quality control	[48,58,79]	Maintained
30	Process tests	[44,49,59]	Maintained
31	Adequate resources management	[45,48]	Maintained

3.3. Quantitative Analysis (Pilot Survey and Main Survey Questionnaire)

The Construction Industry Development Board estimates that there are about 39,158 small building firms in Malaysia, with 80% continuously operating in minor building projects (CIDB). The 21 CC CSFs found via interviews were the subject of a pilot study. Based on 21 CC CSFs, a preliminary questionnaire with closed-ended questions was developed. According to You and Feng and Yu, a minimum sample size of 150 respondents was determined, whereas the number of pilot survey questionnaires issued was 250 [58,59]. Respondents were from solely Malaysian-based small building firms. Sixty percent of the 250 distributed pilot surveys met the criterion for validity. For information collected from the questionnaire developed, Exploratory Factor Analysis (EFA) was carried out;

EFA examines whether a proposed mix of variables or features is appropriate, as well as the likely fundamental factor structure of a set of variables that have been identified, in exchange for imposing a preconceived structure on data. EFA was an appropriate assessment since the sample size range was 150 to 300, and the number of CC CSFs was determined to be about 21, within the permitted range of 20 to 50 [67,79]. In addition, the sample size (160) should have exceeded the sum of the survey's question count and five respondents (7). (21). As 160 was more than 215 = 105 for this pilot survey questionnaire, the data were qualified for EFA analysis. In addition, the Kaiser–Mayer–Olkin (KMO) and Bartlett's Tests were used to evaluate the sample's consistency and representation, respectively. This test's index ranges from 0 to 1, and scores over 0.6 are deemed adequate for determining the nature of relations among variables. A *p*-value lower than 0.05 is acceptable for Bartlett's Test, which examines data roundness using component assessment. SPSS 24.0 was utilized for the EFA, KMO, and Bartlett's Test.

The minimal sample size for the primary quantitative survey analysis of the questionnaire was 100, while the determined sample size was 230. In total, 18 CC CSFs participated in the preliminary questionnaire study conducted via EFA. To effectively analyze the frequency of replies, demographic information was also gathered. The survey questionnaire was delivered to 500 Malaysian contractor firms carrying out minor building projects. The SEM was conducted for analytic objectives. In the 1980s, SEM was developed to assess hypotheses on the relationships between latent variables and observable data. The measuring framework or model is the initial model in SEM. It employs CFA to expand the model by assessing the accuracy and the dependability of measuring variables compared to established standards, connecting the concepts to the latent elements. By calculating variances, assessing hypotheses, and implementing necessary model modifications, the second structural model assesses the relationships among latent elements. The prototype model may be improved until it can be used to verify the theory by substituting the anticipated causal linkages for the relationship among the element relationships. This study created a theoretical basis for SEM assessment utilizing EFA analysis's conclusions on priorly observed CSFs to CC obtained from the above research review.

Regarding the use of EFA and CFA in the analysis of the quantitative datasets, we used these statistical techniques to reduce the dimensionality of the data and to test the validity and reliability of our research instrument. The EFA was used to identify the underlying factors that contributed to the successful implementation of cloud computing in the Malaysian construction sector, while the CFA was used to confirm the factor structure identified via the EFA. We believe that the use of these techniques strengthened the validity and reliability of our research findings.

4. Results

4.1. Credentials of Respondents

Table 4 details the credentials of the respondents. To summarize, 6.87% were architects, 8.12% were quantity surveyors, 58.12% were civil engineers, 5% were M&E engineers, 17.5% were project managers, and 4.37% belonged to other professions. Many civil engineers participated in the research, which correlates to a more accurate evaluation of CC implementation's CSFs in modest building projects. A total of 50% of respondents were employed by contractor organizations, 43.75% by consultant companies, and 6.25% worked directly with the customer. In total, 23.75% had 0–5 years of expertise in the Malaysian building business, 29.37% had 11–15 years, 8.12% had 16–20 years, and 5% had above 20 years of expertise. Youthful professionals, who are the actual persons addressing the implementation of cloud computing, participated in the survey. In addition, 99.37% of respondents were found to be engaged in minor building projects, while just 0.62% were unrelated to minor building projects in Malaysia.

Table 4. Demographic distribution of respondents.

Category	Classification	Frequency	%
Profession	Architect	11	6.87%
	Quantity Surveyor	13	8.12%
	Civil Engineer	93	58.12%
	M&E Engineer	8	5%
	Project Manager	28	17.5%
	Other	7	4.37%
Organization	Contractor	80	50%
	Consultant	70	43.75%
	Client	10	6.25%
Experience in the Malaysian Building Industry	0–5 Years	38	23.75%
	6–10 Years	47	29.37%
	1–15 Years	54	33.75%
	16–20 Years	13	8.12%
	Over 20 Years	8	5%
Experience in Small Building Projects	Yes	159	99.37%
	No	1	0.62%

4.2. Frequency Level of Cloud Computing in Small Construction Projects

Figure 2 depicts the frequency of CC deployment in minor building projects. Following deployment, the reactions were measured across five levels. In total, 43% of respondents reported extremely poor CC adoption in minor building projects in Malaysia, according to the data. In addition, 28% of respondents reported a low, 6% a moderate, 10% an elevated, and 13% a more elevated level of CC application in minor building projects in Malaysia. A total of 71% of respondents disagreed with deploying CC in minor building projects, compared to 23% who approved. Based on the data, major CC implementation in minor building projects must be present in Malaysia. There should be a shortened timeline for modern building technology deployment in underdeveloped nations such as Malaysia. From the standpoint of primary research, it was discovered that the small building sector in Malaysia still needs CC. This validates the study gap and gives sufficient comparative conclusions from prior research in which CC application was discovered to be quite low in modest construction projects.

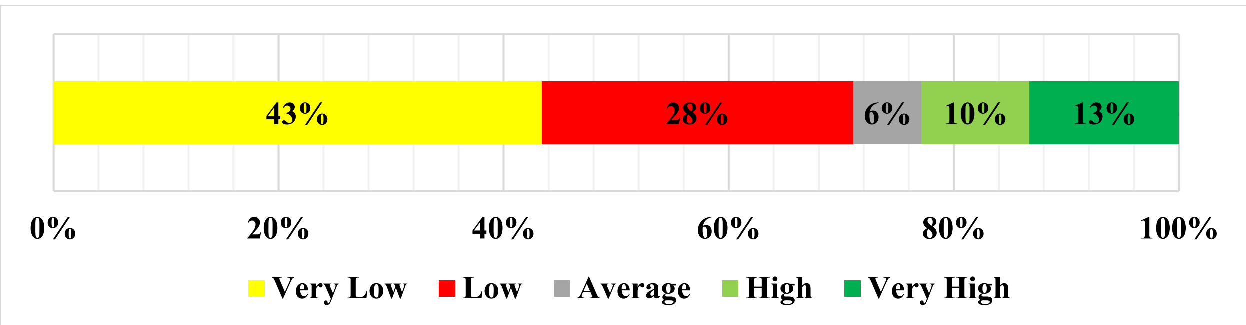


Figure 2. Level of cloud computing implementation in small building projects.

4.3. Factor Analysis of Critical Success Factors

According to recent studies, 21 CC application CSFs were identified, and the results support the statistically significant data acquired from the survey. However, the potential of a comparable effect on each success criterion must be considered. EFA could resolve this issue and classify CSFs into subgroups that are realistically possible to describe with minor building projects in Malaysia. Before carrying out the study and obtaining subgroups of CSFs, the suitability for EFA analysis was evaluated [25,26]. An EFA will be undertaken when the sample size is between 150 and 300. In addition, the sample size for a quantitative survey must be bigger than the product of the sum of the number of inquiries and the number of replies to every inquiry. A total of 105, less than the sample size of 160, were involved in this investigation [20,21]. In a factor analysis, the variables must be between 20 and 50, with a minimum of 20 and a maximum of 50. The conditions for the factor analysis were satisfied; consequently, the factor analysis was undertaken on 21 variables matching CC CSFs, eliminating the possibility of erroneous findings. It was determined that the ratio of subjects to variables was 8.90:1. A ratio larger than 5:1 was necessary, and the factor analysis findings are validated further on in the paper.

The sample adequacy and sphericity of 21 variables were evaluated using the Kaiser–Mayer–Olkin (KMO) and Bartlett's tests. The KMO test indices range between 0 and 1, with adequate scores of more than 0.6 indicating the inter-variable interaction type [19]. Good factor analysis findings, which measure the sphericity of data, need a significance level of lower than 0.05 for Bartlett's Test. The results of both tests using SPSS 24.0 are provided in Table 5 below. The KMO index was determined to be 0.858, more than 0.6 and adequate. The significance of Bartlett's Test was determined to be 0.000, which is less than 0.05, suggesting that EFA could have been used to create a subgroup of variables for this research.

Table 5. KMO and Bartlett's test results.

Kaiser–Meyer–Olkin Measure of Sampling Adequacy.		0.858
Bartlett's Test of Sphericity	Approx. Chi-Square	858.730
	Degrees of Freedom	210
	Significance	0.000

EFA evaluation was carried out utilizing principal component analysis (PCA), and component structure was derived for the 21 variables. To obtain a rotated component structure, Varimax rotation was performed. In Table 6 of the EFA findings, four components had Eigenvalues larger than 1. The Scree Plot in Figure 3 demonstrated that the variables analyzed had the same tendency. The five groups' total variance was 55.399%, larger than 50%, and indicated acceptable components. A minimum of 0.4 was the factor loading threshold level employed to obtain rotational component structure findings.

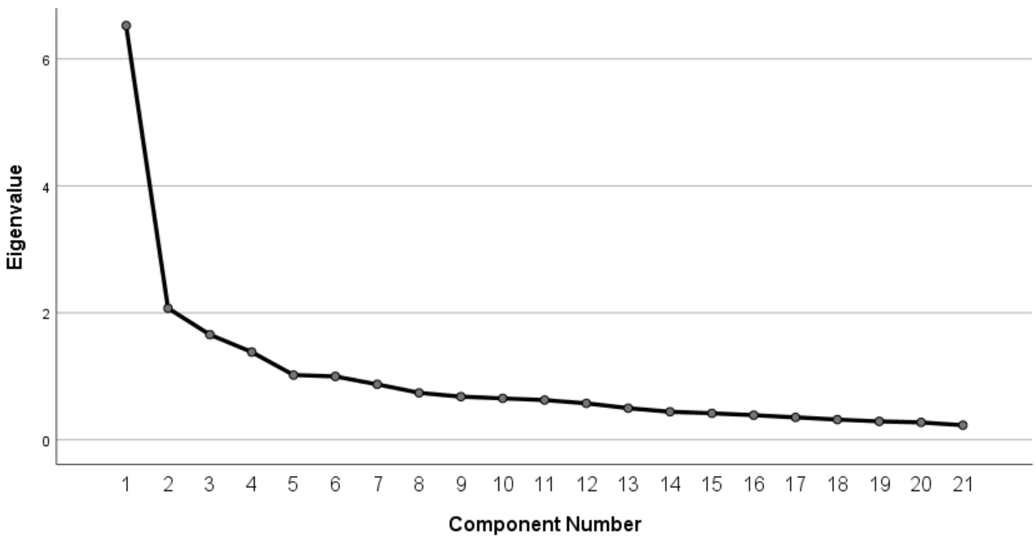


Figure 3. Scree Plot results.

Table 6. Factor loadings based on PCA with Varimax rotation.

Variables	Component				Cronbach Alpha
	1	2	3	4	
SF6	0.811				0.878
SF8	0.798				
SF7	0.771				
SF17	0.770				
SF19	0.735				
SF13					
SF1		0.765			0.837
SF4		0.726			
SF2		0.708			
SF3		0.702			
SF14		0.692			
SF18		0.664			
SF15					
SF12			0.816		0.775
SF9			0.771		
SF16			0.756		
SF21					
SF10				0.798	0.710
SF11				0.791	
SF20				0.646	
SF5				0.445	
Eigen Value	3.518	3.474	2.340	2.302	
% Variance	16.753	16.541	11.144	10.961	

Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalization. Variables SF21, SF15, and SF13 were excluded because of loading values less than 0.4.

After studying the EFA-obtained component structure, four subgroups were created depending on the number of components. Their names were communication and coordination; time; cost; and quality management, organizational success, and planning success. As indicated in Table 7, the matching average of every CSF in the subgroup was utilized to compute the average for every grouping. The conclusive position of CC CSFs was determined according to a score of the average subgroup, as described below.

Communication and coordination (mean = 3.34, position = 1): The top-positioned subgroup includes success factors relevant to interaction and collaboration, which are building workers' experiences when applying CC in minor building projects in Malaysia. Under this subgroup, 28.015% of the variation is addressed. This subgroup's particular items are SF12, "ability to better coordinate"; SF9, "capability to communicate on various levels; and SF16, "collaboration between PM and owners". The overall impact of communication and coordination success is potent in influencing the adoption of CC in minor projects in Malaysian buildings. Indeed, tiny construction firms needed to be able to acquire innovative innovation following the COVID-19 outbreak. In this situation, it becomes critical to have better communication and coordination to implement CC. Also, Malaysia's workforce is varied, as most employees employed by smaller construction firms come from neighboring countries such as Bangladesh and India. [16,17]. Having a varied staff makes it exceedingly easier for construction firms to manage if they have proper coordination, creating a major success factor of CC implementation.

Organizational success (mean = 3.24, position = 2): The second-positioned subgroup includes CSFs relevant to the organization's success, which building workers experience implementing CC in minor projects building. This subgroup accounts for 6.041% of the variance. Certain contents for this subgroup are: SF1, "internal industrial rivalry exerts pressure"; SF4, "eagerness of clients"; SF2, "specialized human capital"; SF3, "technological advancement"; SF14, "a precise description of what should be done"; SF18, "adequate approach to resources required for decision-making". Organizational success is positioned second because most difficulties in small building projects are due to influence-making management controls, so CC is the tool which helps to control errors occurring because of non-influential management. The CC implementation fully supports small construction firms' approaches now in use. In addition, the research proves to improve CC implementation in Malaysia's small building sector. This is because the present situation will fluctuate dramatically after 2020, and the building's current protocols may only occasionally function. In addition, Fang et al. and Garyaev and Garyaeva stated that internal industrial rivalry exerts pressure and contributes to increasing the productivity of small building projects [22,23]. The customer's desire is also essential to preserving the project's effectiveness at a tight cost, as they occasionally request the installation of CC. The ineffective management of project operations is another factor contributing to the HR challenges. It will increase the demand for CC implementation and put duties on small construction companies that must be stronger and physically equipped.

Cost, quality, and time management (mean = 3.136, position = 3): The third-positioned subgroup includes CSFs relevant to proper time management, quality assurance, and cash flow management success on building sites of small Malaysian projects. This subgroup accounts for 5.847% of the variance, with the following components in particular: SF6, "accessibility cost"; SF8, "realistic schedule"; SF7, "efficient monitoring and control"; SF17, "realistic budget"; and SF19, "quality control". According to Dantas Filho et al. and Ding et al., the risk of delay, poor quality management, and inappropriate cost flow always exist, due to which, the success of a small building project's judgement process for the responsible person may become imprecise and even ambiguous [18,19]. The strategy's effectiveness can be aided by deploying CC since small building enterprises need more access to budget, reliability, and timekeeping.

Planning success (mean = 2.85, position = 4): The fourth-positioned subgroup includes planning success relevant to the case of inappropriate planning that building players face in minor works of building in Malaysia. This subgroup describes 5.665% of the variance, and particular items are SF10, "fulfilling user specifications"; SF11, "correctly defining the project; SF20, "process tests"; and SF5, "dependable data storage". When a small building project's execution goes differently than planned, it significantly impacts vendor cooperation and creates an unfavorable atmosphere among the diverse stakeholders. Employees in building projects do not want to alter surroundings, which directly contributes to increased planning challenges, claim Y. Wang et al. and Wong et al. [67,71]. This group explains that implementing CC in building projects causes successful building planning to beat planning difficulties in small building projects in Malaysia.

Four subgroups were discovered using the average squared analysis impacting the success of CC in minor building endeavors in Malaysia. The assessment offered specific knowledge of each subgroup's position in effectively adopting cloud computing.

Table 7. Average score positioning of critical success factors of cloud computing.

Categories	Code	Parameters	Average	Subgroup Mean	Position
Cost, Quality, and Time Management	SF6	Accessibility cost	3.07	3.136	3
	SF8	Realistic schedule	3.21		
	SF7	Efficient monitoring and control	3.15		
	SF17	Realistic budget	3.00		
	SF19	Quality control	3.25		
Organizational Success	SF1	Internal industrial rivalry exerts pressure	3.17	3.23	2
	SF4	Eagerness of clients	3.29		
	SF2	Specialized human capital	3.22		
	SF3	Technological advancement	3.34		
	SF14	A precise description of what should be done	3.01		
	SF18	Adequate access to decision-making resources	3.35		
Communication and Coordination	SF12	Ability to better coordinate	3.43	3.34	1
	SF9	Capability to communicate on a variety of levels	3.31		
	SF16	Collaboration between PM and owners	3.29		
Planning Success	SF10	Fulfilling user specifications	2.81	2.85	4
	SF11	Correctly defining the project	2.78		
	SF20	Process tests	2.65		
	SF5	Dependable data storage	3.18		

4.4. Main Questionnaire

4.4.1. Common Method Bias

Common method bias describes the analysis variation in findings (or error) as attributable to the measuring technique instead of the measurement representative constructs. Common method bias may be characterized as the cross-over between variances attributed to constructs and those attributed to measuring instruments [68,79]. The test for common method bias is crucial when assessing data obtained by self-administered procedures, such as surveys. In certain situations, data from self-reports might be overstated, harming the inquiry outcomes and generating complications. Due to the self-reported and single-source nature of the data in this research, it is crucial to address these issues to identify any potentially biased information. One of the most effective approaches for assessing partial data is the one-factor test. Common method bias is the measurement of errors that affect the investigation's validity. It refers to a systematically varying inaccuracy relevant to measured and anticipated variables.

It is tested by utilizing the Harman single-factor test, which displays several structural metrics. This research used the single-factor test to assess the conventional approach's variance. If all factors' variability values are smaller than fifty percent, the usual bias strategy does not affect the data. As shown in Table 8, the primary set of variables covered 27,814% of the complete variance; hence, as the common technique variance is lower than 50%, it could not affect the outcomes.

Table 8. Variance and cumulative variance observed in common method bias.

Total	% Variance	Cumulative %
5.841	27.814	27.814

4.4.2. Measurement Model

Figure 4 is presenting the initial framework presenting all variables. Figures 5 and 6 are the outcomes of model after exclusion of insignificant factors. Estimate of indicator reliability; cr—composite reliability; AVE–average variance extracted; and discrimination validity are part of a measurement model's assessment. The PLS technique analyzes the weighting route, average data measurement, variance 1, maximal iterations of 300, and weight criterion of 1.0. In most cases, an external load between 0.40 and 0.70 must only be eliminated if doing so significantly improves the AVE and composite reliability. Table 9 shows that all of the items in the model fit had extreme loading values greater than 0.70. If the number was more than 0.70, it warranted additional study. Composite reliability (cr) was evaluated under all external loads, which was more than 0.70. The model's subcomponents had acceptable cr values (Table 9). Acceptable convergent values in a model's constructs are often indicated by AVE values of more than 0.50, a common measure for verifying convergent validity [45,58]. Table 9 indicates that this test was passed for the model components.

Table 9. Model, validity, and reliability statistics observed for all constructs.

Constructs	Assigned Code	Loadings		Cronbach Alpha	Composite Reliability	AVE
		Initial	Final			
Cost, Quality, and Time Management	SF17	0.84	0.84	0.878	0.911	0.671
	SF19	0.816	0.816	-	-	-
	SF6	0.831	0.831	-	-	-
	SF7	0.806	0.806	-	-	-
	SF8	0.803	0.803	-	-	-
Organization Success	SF1	0.751	0.764	0.822	0.875	0.584
	SF4	0.793	0.790	-	-	-
	SF2	0.710	0.724	-	-	-
	SF3	0.760	0.772	-	-	-
	SF14	0.694	Deleted	-	-	-
	SF18	0.746	0.769			
Planning Success	SF10	0.830	0.832	0.755	0.858	0.669
	SF11	0.794	0.834	-	-	-
	SF20	0.758	0.786	-	-	-
	SF5	0.542	Deleted			
Communication and Coordination	SF12	0.844	0.844	0.775	0.87	0.69
	SF9	0.796	0.796	-	-	-
	SF16	0.852	0.852	-	-	-

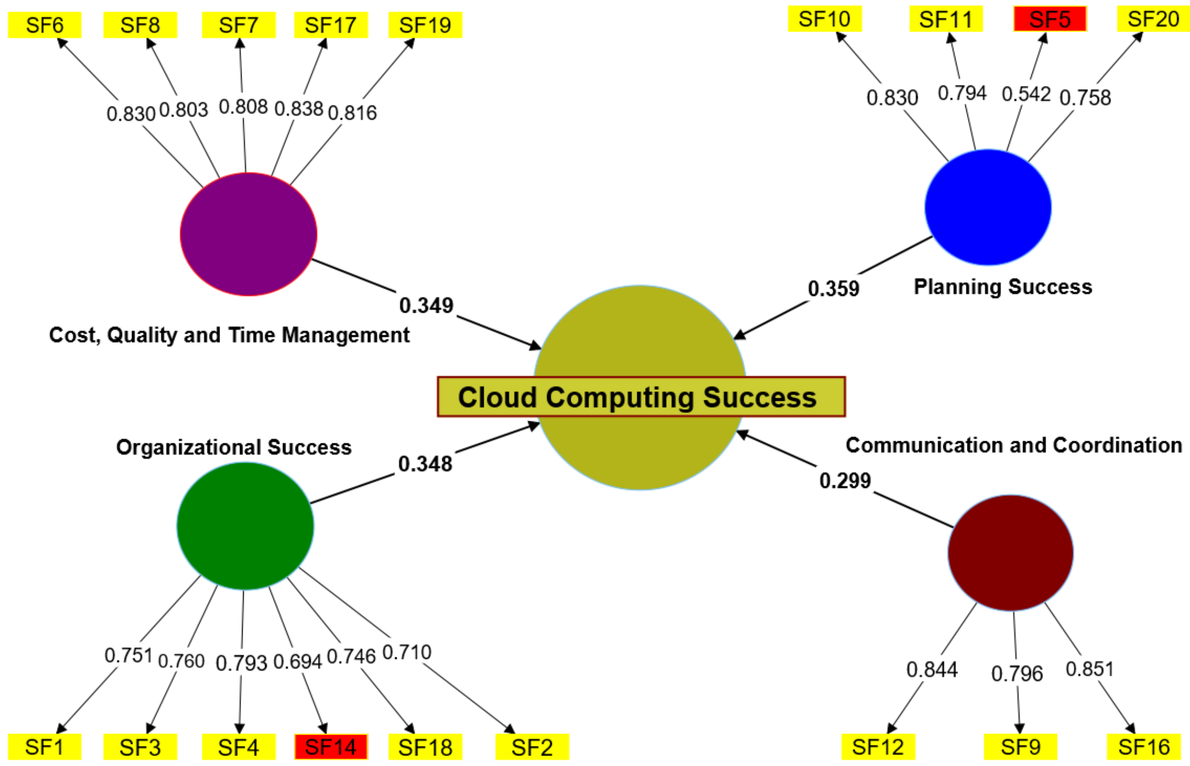


Figure 4. Cloud computing success model with path coefficients.

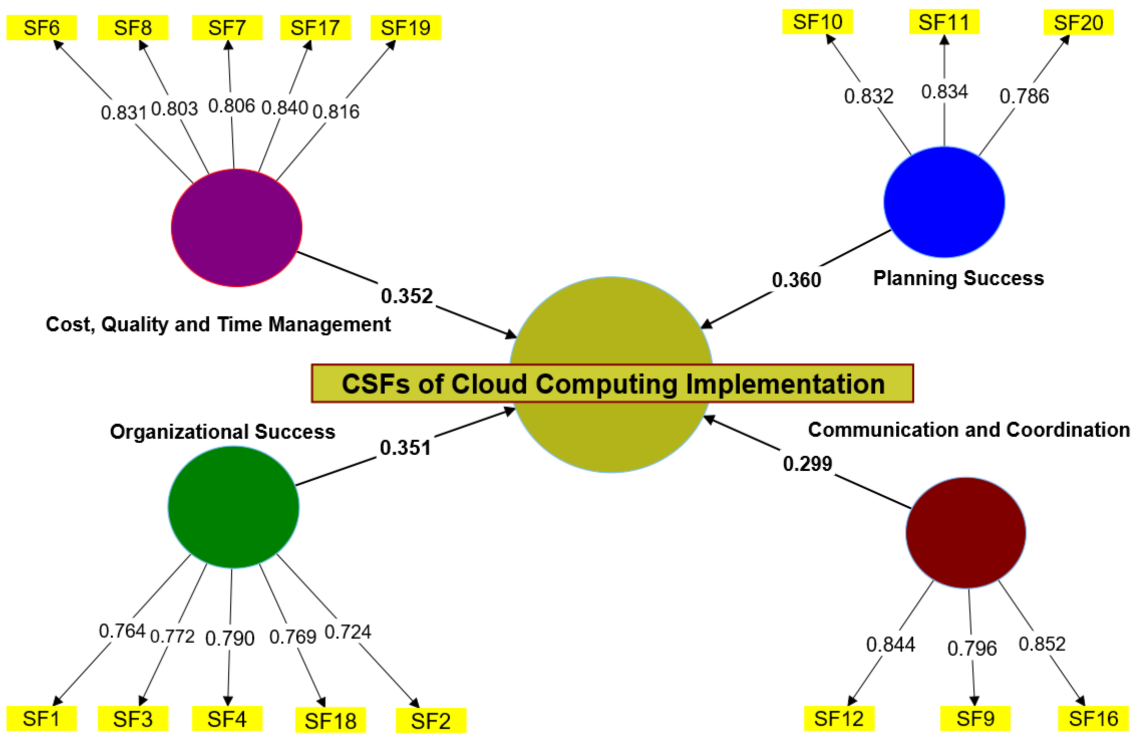


Figure 5. Cloud computing success model indicating path coefficients after exclusion.

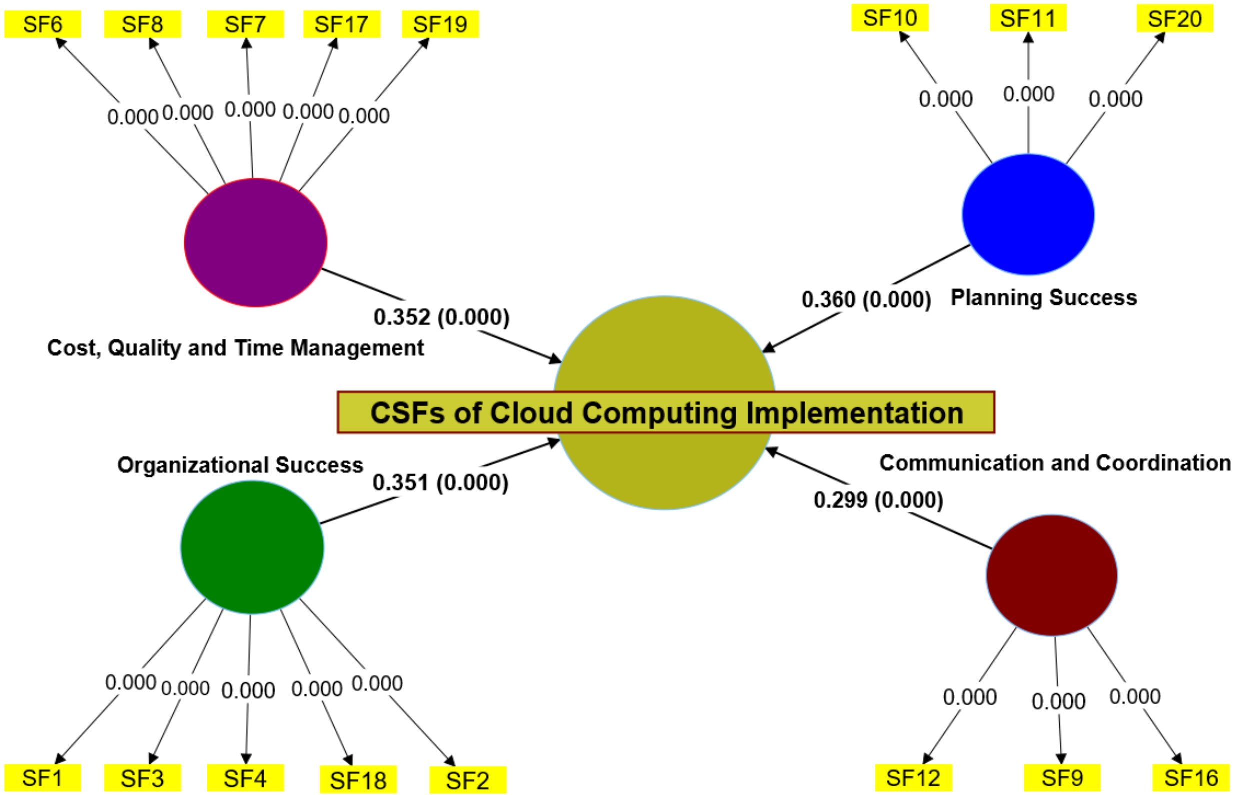


Figure 6. Cloud computing success model indicating path coefficients and *p*-value after bootstrapping analysis.

Discriminant validity refers to the degree to which one concept differs from other constructs in terms of the benchmarks that have been established. As a result, the model's discriminant validity suggests the existence of special constructs capable of capturing phenomena poorly captured by the model. The present study assessed HTMT and the cross-loading criterion for discriminant validity under Fornell Larcker's (1981) criteria. The square AVE root of each building could be evaluated to the correlations between them to establish the discriminating building's reliability. For the AVE to be larger than the correlation between latent variables proposed by Fornell and Larcker [60,61], the under root must be greater than the correlation. The discriminant validity of the measurement model is shown in Table 10 (HTMT criteria) and Table 11 (Fornell and Larcker criteria).

Table 10. HTMT analysis.

	Communication and Coordination	Cost, Quality and Time Management	Organizational Success	Planning Success
Communication and Coordination				
Cost, Quality, and Time Management	0.39			
Organizational Success	0.41	0.464		
Planning Success	0.395	0.55	0.543	

Table 11. Fornell and Larcker criteria.

	Communication and Coordination	Cost, Quality and Time Management	Organizational Success	Planning Success
Communication and Coordination	0.831			
Cost, Quality, and Time Management	0.321	0.819		
Organizational Success	0.332	0.403	0.764	
Planning Success	0.313	0.459	0.445	0.818

The second method used in this study, the pass criteria, was used to evaluate discriminating validity. This method aims to determine whether there ought to be a difference in the indication loading on each latent construct across a given line. This means the principal build indicator or item load must be greater than loading on secondary or tertiary buildings. Table 12 shows that almost all latent variables were loaded (factors), which was greater than the loading of every other construct, row by row. There was a lot of one-dimensionality in the results for each factor.

Table 12. Factor loadings for all success factors involved in model.

	Communication and Coordination	Cost, Quality, and Time Management	Organizational Success	Planning Success
SF12	0.844	0.312	0.214	0.254
SF9	0.796	0.258	0.285	0.226
SF16	0.852	0.232	0.327	0.297
SF17	0.276	0.84	0.363	0.434
SF19	0.285	0.816	0.357	0.398
SF6	0.246	0.831	0.35	0.416
SF7	0.244	0.806	0.291	0.319
SF8	0.264	0.803	0.278	0.298
SF2	0.226	0.203	0.724	0.273
SF1	0.225	0.287	0.764	0.266
SF3	0.216	0.342	0.772	0.405
SF4	0.34	0.351	0.79	0.427
SF18	0.248	0.334	0.769	0.303
SF10	0.351	0.443	0.46	0.832
SF11	0.176	0.351	0.297	0.834
SF20	0.219	0.315	0.312	0.786

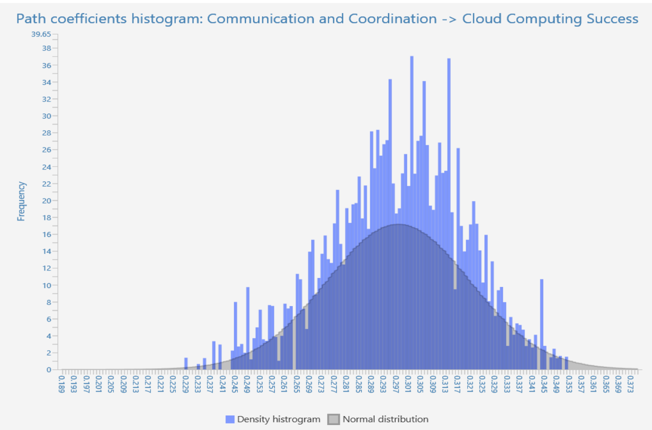
4.4.3. SM-Path Analysis

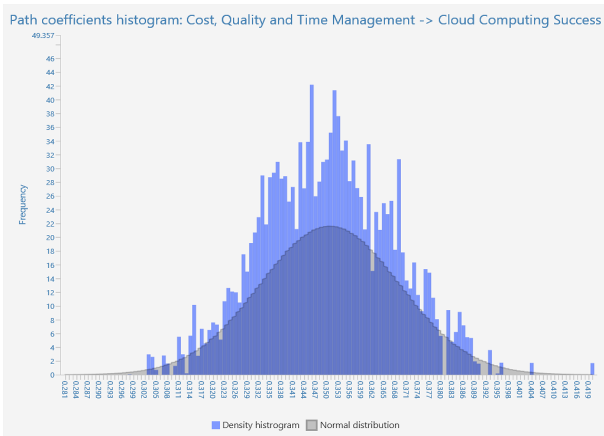
Path examination is a type of linear regression method. It is the chosen approach for management and social science analysis. Path analysis is also the dominant strategy for concurrently analyzing complex research interactions. SEM can assess the associations among variables; subsequently, the model is validated. The structural model provides a detailed explanation of the relationships between the research variables. The outcomes illustrate the link between exogenous or self-dependent factors and endogenous or dependent factors. Structural model (SM) evaluation is mainly concerned with the fitness of the overall model, with its hypothesized factors estimations, dimensions, route, and significance. The research link was verified based on the study objective in the concluding part. Following the study framework of this model, PLS-SEM 4 was used to explore the influence of CC CSFs on the communication and coordination; time, cost, and quality management; organizational success; and planning success of small building projects in Malaysia. Figure 5 depicts the corresponding SEM model. Figure 6 illustrates how the bootstrapping technique was used to assess the significance of the null hypothesis in the model. In the arbitrary reassessment of the original information, the ramping method was applied to provide samples identical to the initial facts. This process assesses the reliability of statistics and also predicts the importance and accuracy of the observed path coefficient.

Figures 3 and 4 show the standardized path coefficients (β), *p*-values, and path significance assessments for the endogenous construct. The bootstrapping approach was used to obtain the *p*-values in Table 13. The data revealed a statistically significant relationship between communication and coordination; cost, quality, and time management; organizational and planning success; and cloud computing success. These data indicate that planning success and cloud computing had a favorable and statistically significant effect (β = 0.360, $p < 0.001$). Cost, quality, and time management significantly impacted cloud computing, showing a significant path coefficient after the planning construct (β = 0.352, $p < 0.001$). Similarly, followed by the planning and cost quality management, the organization's success positively affected cloud computing implementation, as shown in Table 13 (β = 0.351, $p < 0.001$). The final construct shows the positive relationship between communication and coordination and cloud computing, as mentioned in Table 13 (β = 0.299, $p < 0.001$).

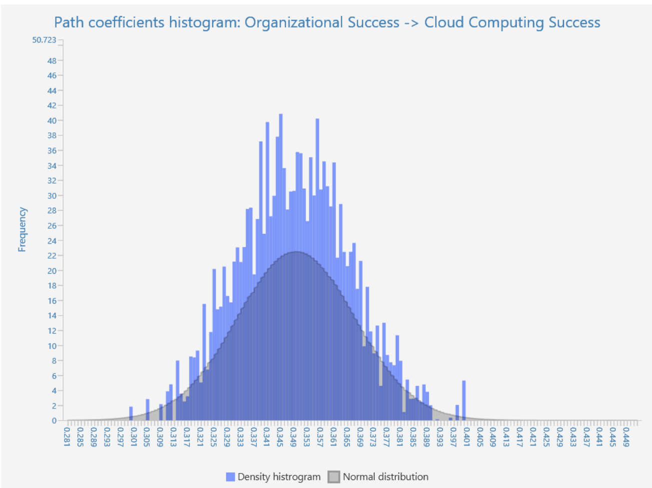
Table 13. Path analysis results with frequency histograms.

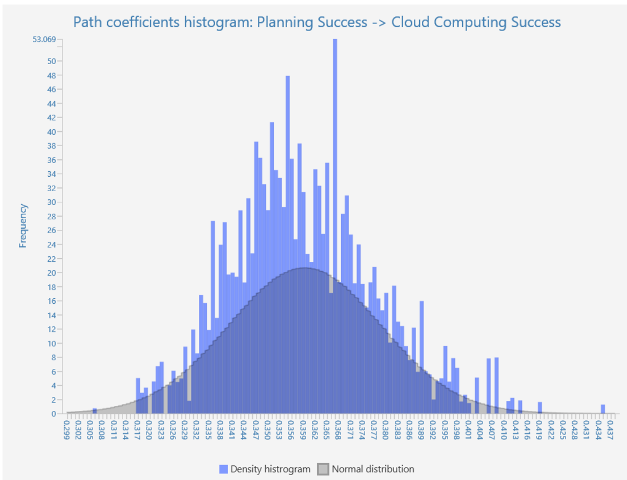
Pathway	β	SE	t-Value	*p*-Value	VIF
Communication and Coordination -> CC—Cloud Computing	0.299	0.023	12.879	<0.001	1.201
Cost, Quality, and Time Management -> CC—Cloud Computing	0.352	0.018	19.068	<0.001	1.388
Organizational Success -> CC—Cloud Computing	0.351	0.018	19.766	<0.001	1.376
Planning Success -> CC—Cloud Computing	0.360	0.019	18.631	<0.001	1.437





Path coefficients of communication and coordination and cost, quality, and time -> cloud computing.





Path coefficients of organizational success and planning success -> cloud computing.

5. Discussion

The modeling of all success factors related to cloud computing was carried out to ensure that only significant factors were included in the final model, which suited the small building projects in Malaysia. Certain factors in the findings could only be justified by comparison with existing studies. The main aspect of the overall findings was to provide unique aspects of cloud computing success factors that only relate to minor building projects in Malaysia. The following discussion provides a detailed critical review of findings and relevant evidence from existing research that contribute positively to the development of cloud computing in successful small building projects in Malaysia.

From the pilot survey results, the construct with the highest mean was "communication and coordination" (mean = 3.34, position 1). SF12, "ability to better coordinate", was found to be the main reason for which the highest mean was observed. According to T. Wang et al. and Y. Wang et al., there is evidence that cloud computing significantly improves communication, allowing team members to communicate effectively and coordinate [60,71]. The findings follow those of Wong et al. and You and Feng. Still, they indicate that the participants prioritized the communication and coordination outcomes of choosing cloud computing for building projects [58,67]. They also relate to the research implications of existing research, where future challenges include communication and coordination in the small building industry. The behavior shows the ability with which successful outcomes can be produced by developing cloud computing for building projects. At the same time, its more critical advantage in terms of coordination is highlighted by participants. This indicates how the overall scenario can be efficiently utilized to show the critical relevancy of cloud computing and the success factor of battle coordination in small building projects in Malaysia.

The lowest mean was observed in the case of the "planning success" construct (mean = 2.85, position = 4). SF20, "process tests", was found to be the main reason for which the lowest position was observed for the respective construct. According to Yu and Zhang and Li, it is evident that the process test is one of the prominent features of cloud computing. Still, it may only sometimes be useful for building work as it separates the site from the work needed to be completed in an online environment [48,59]. According to Zhao et al., certain difficulties are always present in achieving the plan's success because process tests can only be conducted partially due to the various factors involved in the building industry [49]. The behavior confirms the construct's validity in terms of positioning and its significance for the Malaysian building industry. With more implications of cloud computing in the later stages of the project management life cycle adopted in small building projects, participants gave the lowest position to respective constructs. While the planning stage is at any initial level, the cloud computing implications remain limited to documentation work and only translate to further practical work in implementing the design and resolving changes during practical building work. This is the reason why the pilot survey effectively justified the positioning of factors. It is further unique in Malaysia because, in small building projects, more importance is given to the coordination aspect than improving the planning. This can be highly useful in developing the implications of this research when possible outcomes can be constructed for the development of small building projects in Malaysia.

Unique behavior was observed in the case of the exclusion of SF13, "before the project begins, stakeholders understand success criteria"; SF15, "competency of the PM"; and SF21, "adequate resources management" from EFA results after Varimax rotation. According to the latest research, it is evident that stakeholders only sometimes understand success criteria because their demands are very dependent on their requirements and expectations from the project. T. Wang et al. and H. Wang and Du showed that cloud computing cannot provide 100% predictions because it still depends on evolving technologies. Therefore, the stakeholders can only sometimes be sure about the success criteria [60,61]. This justifies the exclusion of factor SF13. Similar is the case with the competency of the product management team, as the cloud computing technology is comparatively better but still needs to be advanced to the level at which other technologies cannot provide more benefits. According to Y. Wang et al. and Won et al., it cannot provide effective competency to project management practices in response to small building projects where cloud computing is already difficult to adopt due to its high initial cost [68,71]. Further, it is observed that resource management can only partially be controlled with cloud computing as it relates to different factors that depend on supply performance and external market behavior. The procurement of resources can only partially be improved with the help of resource management, and this factor was excluded while justifying its insignificance in Malaysia's small building projects.

The "cost, quality, and time management" construct (CR = 0.878, CV = 0.911, AVE = 0.671, $\rho = 0.000$, $\beta = 0.352$, VIF = 1.388) involved SF6, "accessibility cost" (loading = 0.831); SF8, "realistic schedule" (loading = 0.803); SF7, "efficient monitoring and control" (loading = 0.806); SF17, "realistic budget" (loading = 0.840); and SF19 "quality control" (loading = 0.816). According to Afolabi et al. and Allahvirdizadeh et al., it is evident that cloud computing ultimately improves accessibility costs and provides a realistic schedule, encompassing the study's funding [2,5]. The case is similar with Allen et al. and Altohami et al., where efficient monitoring and control are found to be critically related to improvements in project success when implementing cloud computing [6,7]. The unique behavior is how it is observed in the case of a realistic budget and quality control, where it is effectively only related to small building projects in Malaysia. Cloud computing is expected to do more for Malaysia's small building projects to maintain a realistic budgeting process and provide better management control. According to Armstrong et al. and Bello et al., this is significant in the sense of making the product successful because ultimately, when the management is more confident about the budget in a small building project, then it will also be easier for them to achieve success and adopt sustainable quality measures [10,11]. This can lead to maintaining the competitive advantage while allowing the appropriate impact on the overall project. For this reason, including all the factors in the final structural model is justified.

The "organizational success" construct (CR = 0.822, CV = 0.875, AVE = 0.584, $\rho = 0.000$, $\beta = 0.351$, VIF = 1.376) involved SF1, "internal industrial rivalry exerts pressure" (loading = 0.764); SF4, "eagerness of clients" (loading = 0.790); SF2, "specialized human capital" (loading = 0.724); SF3, "technological advancement" (loading = 0.772); and SF18, "adequate access to decision-making resources" (loading = 0.769). According to Bosch-Sijtsema et al. and CAPM and Eng, it is found that implementing cloud computing may have certain advantages in terms of maintaining internal industrial rivalry control, for which it is identified as a key success factor for organizations involved in small building projects in Malaysia [12,13]. In the people management contacts, the research also shows evidence of the eagerness of clients that can effectively contribute to improving the potential success of an organization in small building projects. The need for specialized human capital is also evident in global small building projects, which has similar implications for Malaysian small building projects. The technological advancement is also similar to Qassim Qwaider and St-Pierre et al. It is also justified in developing better outcomes for a project as cloud computing is a relatively new technology for the small building industry [50,55]. The unique aspect of this construct is entirely related to the inclusion of a factor that ultimately improves access to decision-making resources with cloud computing, as it is identified as important for cloud computing in small building projects in Malaysia. It can be effectively justified by making appropriate decisions in the project while also contributing to the organization's success, which is prominently justified in Malaysia's small building industry.

The "communication and coordination" construct (CR = 0.755, CV = 0.858, AVE = 0.669, $\rho = 0.000$, $\beta = 0.299$, VIF = 1.201) involved SF12, "ability to better coordinate" (loading = 0.844); SF9, "capability to communicate on a variety of levels" (loading = 0.796); and SF16, "collaboration between PM and owners" (loading = 0.852). According to Hongchang Sun, Wang, et al. and N. Sun et al., it is evident that cloud computing can effectively provide communication outcomes at various levels of a project to the management team of small building projects [56,63]. It can be effectively related to developing projects in which better communication control can be implemented while maximizing construct validity in the context of Malaysian small building projects. Distinctive features are observed in improving coordination and collaboration between product managers and owners. Because these factors have only been identified in Hongchang Sun, Guo, et al. and Huaiying Sun et al. from the perspective of large-scale building projects, finding them important justifies the scenario in which Malaysia's building industry is evolving [57,62]. Therefore, the possible implications of implementing cloud computing for project success in communication and coordination will ultimately provide leverage for potential business benefits and effective control over the challenges in the working environment of small building projects. This can be attributed entirely to the various aspects of small building projects in Malaysia while also being justified by the study's findings that small building projects in Malaysia will achieve project success through cloud computing.

The "planning success" (CR = 0.755, CV = 0.870, AVE = 0.690, $\rho = 0.000$, $\beta = 0.360$, VIF = 1.437) construct involved SF10, "fulfilling user specifications" (loading = 0.832); SF11, "correctly defining the project" (loading = 0.834); and SF20, "process tests" (loading = 0.786). According to Hongchang Sun, Wang et al., N. Sun et al. and Y. Wang et al., it has been identified that cloud computing is linked with maximizing user specification fulfilment, and the same indication is given by the construct of planning success [56,63,71]. In response to overall planning success and its possible implication for minor building projects in Malaysia, it is identified that cloud computing contributes to the project's success from the perspective of user specifications. However, different results are produced in the scenario of correctly defining the project and process test. Its unique aspect can be utilized effectively to develop project outcomes related to the benefit of small building projects in Malaysia. This is why effective planning improvements may be recommended for minor building projects in Malaysia to establish better outcomes. At the same time, it is also related to understanding how it can effectively provide a competitive advantage to small building projects. Overall, there is significant differentiation concerning existing studies, which can contribute to positive implications in theory and practice.

The present study provides a comprehensive comprehension of the fundamental factors that contribute to the efficacious implementation of cloud computing technology in small-scale construction projects. The results offer a conceptual structure that can direct scholars in examining the implementation of cloud computing in additional emerging nations. Furthermore, the theoretical framework can act as a basis for future research endeavors aimed at investigating the protocols and strategies utilized in the implementation of cloud computing in the construction industry. The study offers a roadmap for future research on the development of cloud computing solutions in other areas of construction by identifying the fundamental constructs that are critical to the successful execution of projects.

The study has noteworthy practical implications for stakeholders operating within the construction sector of Malaysia. The results provide guidance for project managers and other interested parties to effectively adopt and execute cloud computing technology. The incorporation of cloud computing technology has the potential to augment project efficacy, refine project strategizing, and elevate communication and coordination amongst team constituents. Moreover, the implementation of cloud computing technology has the potential to promote sustainable development through the enhancement of financial efficiency and output quality, while simultaneously mitigating project irregularities and substandard quality. The adoption of critical success factors, as identified in this study, can enable stakeholders in the construction industry to attain project objectives and facilitate astute development in Malaysia.

6. Limitations

The study's limitations primarily pertain to the sample size and its representativeness. The research was carried out using a limited sample size of 250 professionals from the construction industry. Despite attempts to achieve a varied sample, it is plausible that certain viewpoints and experiences may have been omitted. Furthermore, the research specifically concentrated on minor construction endeavors within Malaysia, and the outcomes may not be transferable to more extensive or intricate projects, or to other geographic locations or societies with distinct contextual and cultural backgrounds. Moreover, the research was predicated on self-reported information and subjective evaluations of the success criteria for cloud computing, which could potentially have introduced biases or discrepancies in how the respondents comprehended and reacted to the survey inquiries. The study concluded without delving into the technical facets of cloud computing implementation or tackling probable hindrances or constraints linked to data security, confidentiality, and availability. The aforementioned constraints imply that forthcoming investigations ought to encompass more extensive and heterogeneous populations, scrutinize cloud computing in varying project classifications and scenarios, and delve into technical and ethical implications with greater thoroughness.

7. Conclusions

To summarize, the utilization of cloud computing within the construction sector has experienced significant growth. However, there remains a need for developing nations, such as Malaysia, to enhance their adoption rates. The present research showcases the capacity of cloud computing to tackle the challenges of substandard quality and irregularity in minor construction undertakings by identifying the factors that contribute to its success via principal component analysis. The findings validate the concept that the utilization of cloud computing is linked to the achievement of project objectives, as it has the potential to enhance project planning, coordination, information exchange, teamwork, financial efficiency, output quality, and temporal efficiency. Further investigation is required to examine the implementation strategies and protocols of cloud computing within the construction sector. The present study establishes a theoretical structure for subsequent investigation by demonstrating that the adoption of cloud computing has a significant and advantageous impact on the achievement of small-scale construction endeavors. The results underscore the necessity for further investigation into the implementation of cloud computing in the small building enterprises of Malaysia, with the aim of extending its adoption within the locality. The findings of this study have the potential to impact forthcoming small-scale construction initiatives in Malaysia, as they may motivate project stakeholders to adopt and implement cloud computing in a proficient manner, with a focus on achieving success.

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