

ORIGINAL

BIM automation and its relationship with information management at the construction site of the “Ciudad Sol de Collique” Multifamily Megaproject in Lima

Automatización BIM y su relación con la gestión de información en obra del Megaproyecto Multifamiliar “Ciudad Sol de Collique” - Lima

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ABSTRACT

Introduction: the construction industry has been undergoing constant changes, thus influencing the way projects are led today, thus adopting new work methodologies such as BIM or Building Information Modeling. In Peru, “The BIM Peru Plan was born as a political measure of the National Competitiveness and Productivity Plan, recognizing the need for modernization and digitalization of formulation and evaluation systems.

Method: this study was of the type of applied or technological research of substantive sub-level. The level of research was descriptive and correlational. For the research, the population considered multi-family building megaprojects, located in the city of Lima and that are about to implement BIM Automation within their processes.

Results: a positive, but low, correlation was found between digital tools and information technologies and information management with a correlation coefficient of 0,357. A moderate and significant correlation was found between BIM automation processes and information management, with a correlation coefficient of 0,678 and a p-value <0,001.

Conclusion: the study showed a moderate and significant correlation between BIM automation and information management, as well as a positive relationship, although Low-intensity correlation between digital tools and information management. A moderate and significant correlation was found between BIM automation processes and information management, indicating that BIM automation processes significantly improve information management, promoting efficiency in construction execution.

Keywords: BIM Automation; Information Management; Process Optimization; Automation Processes; Digital Tools.

RESUMEN

Introducción: la industria de la construcción ha venido sufriendo constantes cambios, influyendo así hoy en día en la forma de liderar los proyectos, adoptando de esta manera nuevas metodologías de trabajo como el BIM o Modelado de Información de Edificios. En el Perú, “El Plan BIM Perú nace como medida política del Plan Nacional de Competitividad y Productividad, al reconocer la necesidad de modernización y digitalización de los sistemas de formulación y evaluación.

Método: el presente estudio, fue del tipo de investigación aplicada o tecnológica de sub-nivel sustantiva. El nivel de la investigación fue descriptivo y correlacional. Para la investigación se consideró como población a los megaproyectos de edificaciones multifamiliares, que se ubiquen en la ciudad de Lima y que se encuentren

por implementar la Automatización BIM dentro de sus procesos.

Resultados: se encontró una correlación positiva, pero baja, entre las herramientas digitales y tecnologías de la información y la gestión de la información con un coeficiente de correlación de 0,357. Se encontró una correlación moderada y significativa entre los procesos de automatización en BIM y la gestión de información, con un coeficiente de correlación de 0,678 y un valor $p < 0,001$.

Conclusión: el estudio realizado mostró una correlación moderada y significativa entre la automatización BIM y la gestión de la información, así como una relación positiva, aunque de baja intensidad, entre las herramientas digitales y la gestión de la información. Se encontró una correlación moderada y significativa entre los procesos de automatización en BIM y la gestión de información, lo cual indicó que los procesos de automatización en BIM mejoran considerablemente la gestión de información, favoreciendo la eficiencia en la ejecución de la obra.

Palabras clave: Automatización BIM; Gestión de la Información; Optimización de Procesos; Procesos de Automatización; Herramientas Digitales.

INTRODUCTION

The construction industry has been undergoing constant change, influencing the way projects are managed today and leading to the adoption of new working methodologies such as BIM or Building Information Modeling.⁽¹⁾

Globally, BIM has been recognized for more than fifteen years as a fundamental tool for revitalizing the global economy, which is why many countries have initiated digitization processes in the AEC sector.⁽²⁾ Considering this, and observing the sluggish reality compared to European countries, the BIM GOB Latam Network was formed in Latin America, a cooperation network “with common guidelines, promoting trade and knowledge exchange”.⁽³⁾ According to a study by CAF, the Latin American development bank, the low level of digitization in the construction sector is one of the leading causes of low productivity levels.⁽⁴⁾

In Peru, specifically in the city of Lima, “The BIM Peru Plan was created as a policy measure of the National Competitiveness and Productivity Plan, recognizing the need to modernize and digitize the systems for the formulation and evaluation, execution, and operation of investment projects.” The main goal for 2030 is to make BIM and all its implications mandatory.^(5,6)

In the district of Comas, home to the “Ciudad Sol de Collique” Multifamily Megaproject, which will be part of the sample for this research, and given the problem of massive demand for high-density buildings (15 stories) and the need for rapid delivery, it will be necessary to adopt new ways of working such as BIM, eradicating the traditional design sequence (AutoCAD plans), as this generates, in part, rescheduling in the final delivery of apartments, extending the deadlines from 1 to 3 months, often assuming - on the part of the construction company - penalties of 180 soles per day in favor of the clients, but also the lack of optimization in basic processes and those with the most significant economic impact, such as concrete quality control, means that a better approach to work (reducing the use of paper) will be required in order the technological and quality improvements for a good finished product and thus avoid customer dissatisfaction.

A lack of knowledge and implementation, i.e., the non-application or partial use of BIM technological tools, can lead to inefficient information management or a false level of technological and business maturity, as the complexity of projects, deadlines, and scope becomes increasingly apparent.⁽⁷⁾

The modeling of all construction elements, plans, and the extraction of information from different specialties through a planning table in Revit, all of which are done manually, as well as the non-digitization of details regarding the control and supervision of the work at the appropriate time, will be tedious to cope with when the information packages required by the projects themselves have to be generated in large quantities and at the same time.⁽⁸⁾

For these reasons, the authors of this research set themselves the following objective: To establish the relationship between BIM automation and information management on the construction site of the “Ciudad Sol de Collique” Multifamily Megaproject in Lima.

METHOD

This study was a substantive sub-level applied or technological research project, as it was conducted to address problems related to the practice or production of processes. The level of research was descriptive and correlational in nature. The method used in the study was descriptive, of the survey subtype, and the data collection technique applied for statistical analysis was also the survey and documentary analysis. This research was carried out from January 2024 to September 2024.

For the research, the population considered was multi-family building megaprojects located in the city

of Lima that are currently implementing BIM automation within their processes. The implementation of BIM automation in the “Ciudad Sol de Collique” multi-family megaproject, located in the Comas district of Lima, was considered a non-probabilistic sample.

Among the main variables studied, the following were analyzed: BIM Automation and Information Management.

To evaluate the reliability or homogeneity of questions or items, it is common to use Cronbach’s alpha coefficient when dealing with polytomous response alternatives, such as Likert scales, which can take values between 0 and 1, where 0 means zero reliability and 1 represents total reliability. Among the non-parametric methods is Spearman’s correlation analysis, which aims to examine the direction and magnitude of the association between two quantitative variables, that is, the intensity of the relationship between the variables, in any association, not necessarily linear. It also allows us to identify whether, as the value of one variable increases, the value of the other variable increases or decreases, and provides a correlation coefficient that quantifies the degree of association between two numerical variables.

The general ethical principles of research were respected, particularly the practice of integrity, ensuring that the data was not manipulated. Another principle was respect for individuals, as the information was presented alongside the assessment and personal judgments collected during the questionnaires.

RESULTS

Table 1. Normality test between digital tools and information management

	Shapiro-Wilk		
	Statistic	gl	p
Digital tools and information technologies	0,882	20	0,019
Information management	0,834	20	0,003

With p-values equal to 0,019 and 0,003, both less than 0,05, it is determined that the data for both variables do not follow a normal distribution. Therefore, Spearman’s Rho correlation coefficient was used.

Table 2. Relationship between digital tools and information technologies and information management

			Digital tools and information technologies	Information management
Spearman’s Rho	Digital tools and information technologies	Correlation coefficient	1,000	0,357
		Sig. (two-tailed)		0,123
		N	20	20
	Information management	Correlation coefficient	0,357	1,000
		Sig. (two-tailed)	0,123	
		N	20	20

With a Spearman’s Rho correlation coefficient of 0,357, it can be stated that there is a low-intensity positive relationship between digital tools and information management on site at the “Ciudad Sol de Collique” Multifamily Megaproject in Lima.

Table 3. Normality test between BIM automation processes and information management

	Shapiro-Wilk		
	Statistic	gl	p
Automation processes in BIM	0,895	20	0,033
Information management	0,834	20	0,003

With p-values equal to 0,033 and 0,003, both less than 0,05, it is determined that the data for both variables do not follow a normal distribution. Therefore, Spearman’s Rho correlation coefficient was used.

With a Spearman’s Rho correlation coefficient of 0,678, it can be stated that there is a moderate positive relationship between the BIM automation processes and the on-site information management of the “Ciudad Sol de Collique” Multifamily Megaproject in Lima.

Table 4. Relationship between BIM automation processes and information management				
			BIM automation processes	Information management
Spearman's Rho	BIM automation processes	Correlation coefficient	1,000	0,678**
		Sig. (two-tailed)		0,001
		N	20	20
	Information management	Correlation coefficient	0,678**	1,000
		Sig. (two-tailed)	0,001	
		N	20	20

Note: **. The correlation is significant at the 0,01 level (bilateral).

Table 5. Normality test between process optimization and information management			
		Shapiro-Wilk	
	Statistic	gl	p
Process optimization	0,853	20	0,006
Information management	0,834	20	0,003

With p-values equal to 0,006 and 0,003, both less than 0,05, it is determined that the data for both variables do not follow a normal distribution. Therefore, Spearman's Rho correlation coefficient was used.

Table 6. Relationship between process optimization and information management				
			Process optimization	Information management
Spearman's Rho	Process optimization	Correlation coefficient	1,000	0,667**
		Sig. (two-tailed)		0,001
		N	20	20
	Information management	Correlation coefficient	0,667**	1,000
		Sig. (two-tailed)	0,001	
		N	20	20

Note: **. The correlation is significant at the 0,01 level (bilateral).

With a Spearman's Rho correlation coefficient of 0,667, it can be stated that there is a moderate positive relationship between process optimization and information management in the construction of the "Ciudad Sol de Collique" Multifamily Megaproject in Lima.

DISCUSSION

Starting with the way in which digital tools and information technologies relate to information management on the construction site of the "Ciudad Sol de Collique" Multifamily Megaproject in Lima, a positive but low correlation was found between digital tools and information technologies and information management. A correlation coefficient of 0,357 suggests that, although digital tools contribute to improved information management, their impact is limited. Digital tools include software or technological devices used to facilitate communication, storage, and data processing on-site. The low intensity of the correlation may be due to incomplete implementation, lack of integration between tools, or limited use of these technologies compared to more comprehensive approaches such as BIM. This implies that, although digital tools support information management, the impact is not decisive. Technologies such as document management software, for example, improve organization but do not necessarily change the way information is collected and managed as a whole. Factors such as staff training and system interoperability can limit the positive effect.

These results are similar to those of Kramer's⁽⁹⁾ study, which also highlights the implementation of digital tools in transforming construction processes, such as the use of platforms like PlanGrid and ACC Build, which enable the review of documentation and optimization of workflows. Improvements in traceability and efficiency are also observed in his study. In addition, the survey by Hayacc et al.⁽¹⁰⁾ analyzed the use of BIM tools in reviewing projects in public administration, finding a significant positive correlation between digital tools and improvements in review times and technical documentation. Both studies conclude that digital tools are helpful, but they are not the only factor in improving efficiency.

However, the low intensity of the correlation in this study is likely due to a lack of complete integration or

suboptimal use of digital tools. Although these technologies facilitate access to and management of information, they are insufficient on their own for significant improvement without interoperability with other tools and processes, as mentioned in other studies that combine BIM with different technologies, such as IoT and RFID.

Regarding the correlation between BIM automation processes and information management on-site in the “Ciudad Sol de Collique” Multifamily Megaproject in Lima. A moderate and significant correlation was found between BIM automation processes and information management, with a correlation coefficient of 0,678 and a p-value < 0,001. This result shows a stronger correlation than the previous one, with a coefficient of 0,678, implying a more significant relationship between BIM automation processes and information management. The p-value of less than 0,001 reinforces confidence in the existence of a statistically significant association. Therefore, automation processes in BIM involve not only three-dimensional modeling but also the integration of data from different sources, allowing specific repetitive or high-risk tasks to be automated. The moderate correlation indicates that these processes are effective in improving the capture, analysis, and management of information on the job site.

This is because automation in BIM facilitates more consistent and accurate information management processes, as it reduces manual intervention and minimizes errors in data transfer. The greater the automation, the better the integration and access to critical information for real-time decision-making, which optimizes project execution.

In this regard, the results presented are in line with those of Oyewole et al.⁽¹¹⁾ as these researchers also found that automation processes and the use of advanced technologies (IoT, drones, sensors) improve efficiency in information management and project execution. This finding is consistent with the one presented, which shows that automated processes improve data capture and subsequent management. There is also the study by Zárate⁽¹²⁾ who validated the impact of programming on information management with BIM, finding improvements in data extraction and model auditing. Both studies highlight that automated processes within BIM increase efficiency and accuracy.

Continuing with the association between process optimization and information management in the construction of the “Ciudad Sol de Collique” Multifamily Megaproject in Lima, it was found that process optimization has a moderate positive correlation with information management, with a coefficient of 0,667. This means that as operational processes are optimized, information management improves significantly. The p-value < 0,001 indicates that this relationship is statistically significant. In other words, when processes are optimized, a more organized and efficient work environment is created, where information moves more quickly and efficiently. Improvements in operational processes generate more coherent information flows, reducing delays and minimizing errors, which explains the moderate correlation between the two factors. Therefore, process optimization involves implementing strategies and practices that aim to eliminate inefficiencies and enhance coordination among different activities on the job site. This could include standardizing procedures, improving coordination between teams, and reducing downtime, which has a direct impact on how information is managed and flows.

In this regard, studies with similar conclusions were found, such as that of Chumbiray⁽¹³⁾ who also identified significant improvements in time and process optimization following the implementation of a new BIM-based workflow. Both studies agree that process optimization is related to direct improvements in information management. There is also the study by Kramer⁽⁹⁾ whose author observed a considerable improvement in workflows and process standardization with the implementation of digital tools. The optimization of internal processes resulted in improved coordination and information management.

Therefore, process optimization enhances information management by eliminating redundancies and facilitating more effective communication among different project teams. The similarities between the studies show that optimization not only improves times, but also the quality and consistency of the information processed.

Finally, regarding the relationship between BIM automation and information management on the construction site of the “Ciudad Sol de Collique” Multifamily Megaproject in Lima, automation through the use of Building Information Modeling (BIM) has a moderately positive relationship with improved information management. The correlation coefficient of 0,612 implies that, although it is not a strong relationship, there is a considerable association between the use of BIM and the improvement of information management processes. The p-value of 0,004, which is lower than the typical significance level of 0,05, suggests that the probability of this correlation being random is extremely low, so it can be confidently stated that BIM automation improves information management.

In this sense, BIM, as a process automation tool that allows real-time data integration and three-dimensional visualization, facilitates the collection and use of information more efficiently and accurately. This type of technology is likely to contribute to reducing errors and improving coordination in the project, which in turn directly impacts the way information is managed.⁽¹⁴⁾ The use of BIM optimizes the planning, execution, and monitoring of works, resulting in a moderate improvement in information management. In other words,

information is organized, stored, and distributed more efficiently; however, the magnitude of the impact depends on various factors, such as the degree of implementation and the team's familiarity with the tool.⁽¹⁵⁾

The result presented is in line with the research by Oyewole et al.⁽¹¹⁾ the authors also identified the crucial role of advanced technologies (such as IoT, RFID, and sensors) in improving monitoring and quality management in construction. These technologies work in a complementary manner with BIM, and both promote automation and efficiency. Furthermore, the study presented by Hernández⁽¹⁶⁾ which uses BIM in combination with IoT and thermal imaging cameras, contributes to the real-time optimization of processes and supervision in construction projects. Both studies, together with the one developed, conclude that BIM automation provides improvements in information management and process control.

Consequently, BIM automation significantly enhances information management by centralizing data, providing real-time access, and minimizing human error. This finding is consistent with previous studies that highlight how BIM automates repetitive tasks and enables the accurate tracking of project progress. The context and scope of BIM implementation are factors that explain the differences observed in studies, such as that by Chumbiray⁽¹³⁾ which incorporates additional methodologies, including Lean2Cradle.

CONCLUSIONS

The study showed a moderate and significant correlation between BIM automation and information management, as well as a positive, albeit low-intensity, relationship between digital tools and information management. A moderate and significant correlation was found between BIM automation processes and information management, indicating that BIM automation processes have a substantial impact on improving information management, thereby promoting efficiency in project execution.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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