Evaluating Robotic Process Automation (RPA) Technology for Human-Centric and Future-Oriented Automated Tracking and Adherence to Sustainable Regulations in Construction

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This research aims to investigate the use of Robotic Process Automation (RPA) in the construction sector to address the increasing need for efficient and sustainable practices. Specifically, it focuses on applying RPA for automated tracking and compliance with sustainable legislation. The research gap pertains to the comparatively limited exploration of the potential of RPA in this particular context. The research presented in this study is distinguished by its concentrated examination of the effects of many components, such as data management, auditing, cost management, and efficiency, on adopting RPA. This research aims to thoroughly evaluate these factors' impact on the effective incorporation of RPA, focusing on solving the urgent sustainability issues within the sector. Data from a pilot survey with 83 participants and a comprehensive questionnaire with 108 participants were analyzed using a mixed-methods approach that included Exploratory Factor Analysis (EFA) and Structural Equation Modelling (SEM). The findings highlight the favourable impact of these factors on the deployment of RPA, emphasizing their importance in enhancing compliance and data precision within the construction industry. This study expands upon the current body of knowledge, providing a significant addition to the subject of RPA.

Keywords: Robotic Process Automation (RPA); Sustainable Regulations; Construction Industry; Implementation Factors.

1. Introduction

Over the last several years, there have been notable changes in the worldwide construction sector, propelled mainly by a growing focus on sustainability and the implementation of environmental rules. The construction industry is of great significance in influencing the trajectory of urban development and addressing the challenges posed by population expansion and urbanization. Its role is crucial in assuring the building and operation of cities in an ecologically sustainable way [1,2]. The building industry significantly contributes to global energy use, resource depletion, and greenhouse gas emissions. The building sector is accountable for over 40% of worldwide carbon emissions from energy consumption [3,4]. This startling figure highlights the urgent need to mainstream ecologically friendly building practices.

The value of automated tracking systems and adherence to environmentally friendly rules in the construction sector cannot be emphasized. Greenhouse emissions, garbage, and resource depletion contribute to climate change, and the building industry is primarily to blame. The negative impact that building projects have on their environments may be significantly mitigated via the adoption of sustainable laws [5]. This is crucial in light of the reality of climate change and the immediate need to mitigate its impacts [6]. About 40% of global energy and raw material consumption goes towards the construction industry [7] [8]. Sustainable building practices aim to make efficient and ecologically friendly use of water, energy, and raw materials. With the world's population rising and the issue of resource scarcity worsening, protecting these supplies is of the highest significance [9,10]. In the globe as a whole, the construction sector consumes around 35% of all energy and raw resources [10,11].

Cost savings might accrue during the building's lifespan if eco-friendly techniques were used in its development [12]. Energy-efficient buildings, such as those that consume less energy overall, have lower operating expenses and, in theory, a greater market value. The energy consumption of green buildings may be reduced significantly; some estimates put the potential savings at 30 percent or more. Furthermore, these buildings may substantially decrease water usage by 50% to 70 % [12,13].

Despite the clear need for sustainability criterion support, studies have yet to be undertaken on using Robotic Process Automation (RPA) for automated monitoring and compliance in the building sector [14,15]. This novel method can address several issues plaguing the construction sector effectively. Manual documentation is widely used in the more conventional development methods, although this technique is notorious for its lengthy execution time, error-prone nature, and lack of efficiency [13,14]. The ability of RPA to automate tasks like data collecting and administration helps to eliminate human error and boost precision. Meeting sustainability requirements is a challenging endeavor that requires in-depth tracking and documentation of several factors. Materials choice and energy monitoring are two examples of such considerations. RPA can ensure the accurate and consistent collecting and reporting of compliance data. This capacity is one of its many benefits.

The study assesses how well RPA programmes work in automating construction firms' monitoring of and adherence to sustainable requirements. The ultimate purpose of this study is to improve sustainable practices in the building sector by assessing RPA's potential to increase efficiency in data collecting, reporting, and monitoring. The use of RPA in construction organizations has the potential to optimize efficiency and allocate resources more effectively. Enhancing efficiency may result in reductions in costs. RPA facilitates the continuous monitoring of regulatory modifications, assisting construction enterprises in effectively adjusting to the ever-changing sustainability mandates. Ensuring future proofing is paramount in a global context where environmental norms are constantly reinforced.

2. Literature Review

The building sector has a vital role in constructing physical infrastructure, which is also highly responsible for environmental degradation, energy consumption, and resource depletion. In the combat against the negative impacts, a number of sustainable regulation have been introduced around the world [16]. Extensive research into the application of RPA in the construction industry worldwide has identified a set of significant areas wherein automation can efficiently support compliance with sustainability-related legislation [17]. Previous studies have illustrated the potential significant contribution of RPA in data management, project monitoring, and assurance for regulatory compliance [18]. These studies have pointed out the possible advantages of RPA, which concern reducing human errors and enhancing real-time data processing, among others [19]. From results of previous research, enabling the possibility for RPA to comply with sustainable norms is likely to be evoked, especially in regard to the automation of data collection and reporting processes. This could be portrayed as potential by the findings of this study [20]. Various studies conducted in the Saudi Arabian construction industry have revealed that the country is committed to the goals of sustainable development, as identified in [21].

Saudi Arabia has developed various laws and implemented programs, including the Green Construction Index (GBI) and the Low Carbon Cities Framework (LCCF), to ensure building principles that are environmentally sustainable. The researchers mentioned that these moves would help in natural resource conservation, emissions reduction as well as energy efficiency [22]. However, what has been quite lacking so far are proper monitoring and compliance mechanisms for this set of norms to be followed globally. Greener construction techniques are increasingly being adopted in Saudi Arabia's construction industry. On the other hand, using RPA to automatize monitoring and compliance of green rules in such an environment is relatively scant in terms of academic research [23]. Extant research in Saudi Arabia has primarily focused on policy analysis and the evaluation of sustainable building practices. More emphasis needs to be directed towards understanding the role of automation in compliance issues.

The empirical evaluation of the direct influence of RPA on sustainable compliance within the construction sector in Saudi Arabia needs to be revised. Nevertheless, research conducted in different geographical areas may significantly contribute to our understanding [24,25]. Previous studies have thoroughly examined the use of RPA across many sectors, highlighting its capacity to optimize operational processes, decrease expenditures, and enhance the precision of data [26,27]. The aforementioned advantages align with the objectives of adhering to sustainability regulations in the construction industry, making RPA a compelling proposal within the Saudi Arabian setting.

Although the potential advantages of RPA are apparent, scholarly sources also recognize the existence of obstacles and impediments. Considerable challenges, including resistance to change and a need for more understanding among industry players, hinder the implementation of RPA. The conservative character of the Saudi Arabian construction industry is expected to contribute to the presence of these difficulties.

3. Methodology

The research used a mixed-methods approach, integrating both qualitative and quantitative methodologies. A thorough review of the literature found 28 success factors of RPA adoption. Further, ten interviews were conducted with experts having experience in RPA issues of Saudi Arabia's construction sector. Quantitative data were gathered through an online pilot survey, and for further analysis, exploratory factor analysis was used to investigate the obtained results. With the help of SEM, the success factors that were proven to be statistically significant by EFA were further added as the researchers continued with data analysis. This approach would give a comprehensive insight into the application of RPA within the construction industry in Saudi Arabia. Figure 1: Flowchart of the method of study. This study was conducted in accordance with the ethical standards of a university. The research protocol was reviewed and approved by the Institutional Ethics Committee, reference number IEC-MY2023-09. All participants were provided with detailed information about the study's aims and voluntarily gave their informed consent prior to participation. Data collection was carried out in designated regions, ensuring that the anonymity and confidentiality of all participants were strictly maintained. All data were securely stored and were accessible only to the research team. Any potential conflicts of interest were transparently disclosed and managed in accordance with the university's ethical guidelines.

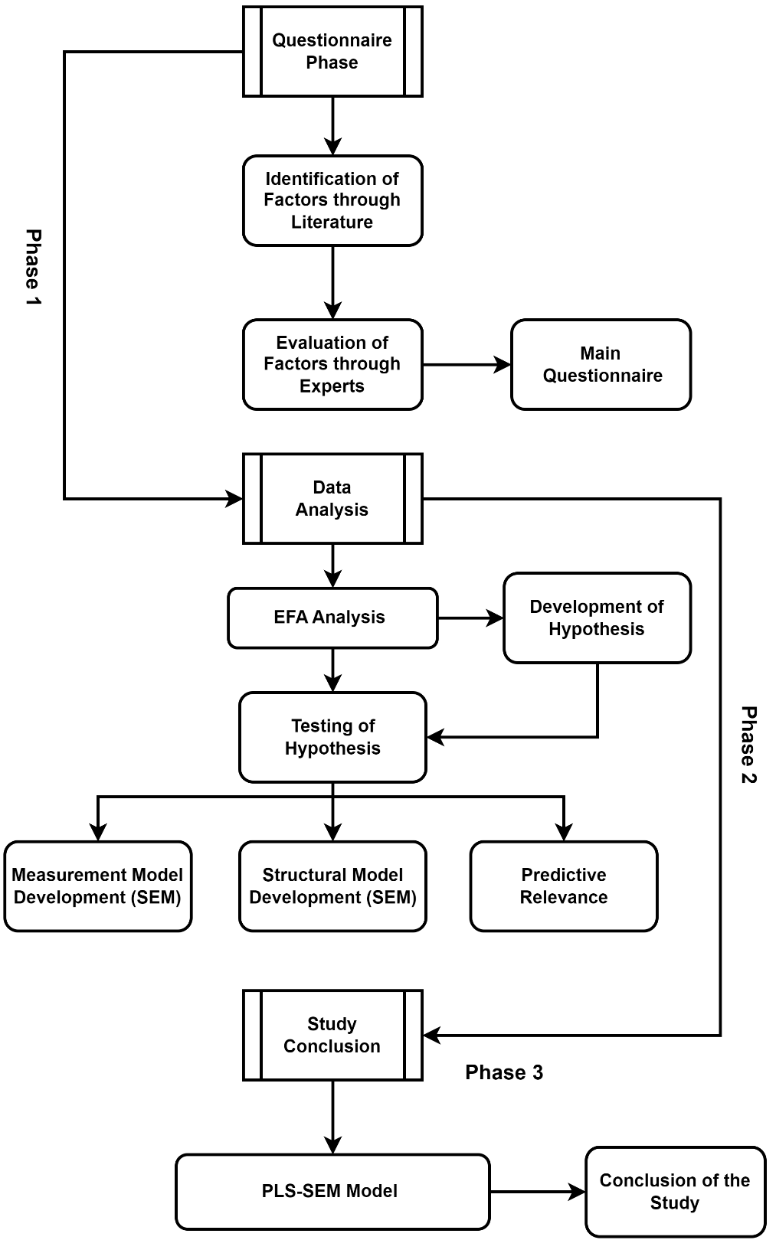

Figure 1 Flowchart of research method

1 Identification of Factors

In this respect, an inclusive method was applied to identify all 28 criteria that constituted critical success factors for RPA adoption. Such a method included the integration of findings from existing literature and expert views. The variables discussed above encapsulate many aspects of RPA implementation in the construction industry. This becomes particularly relevant with the industry's focus on efficient data handling and compliance with sustainable standards being of utmost importance. Additionally, RPA is going to help with compliance of laws through the enforcement of the rules, by making the monitoring constant and vigilant, and by allowing for the detailed creation of audit trails [28]. Audit trails that would be of essence in demonstrating compliance with sustainable standards. In RPA, the financial costs are drastically reduced by avoiding human labor, allocating intelligent resources, and making long-term investments accordingly [29]. All the above-mentioned aspects jointly highlight the multifaceted importance of RPA in automating monitoring and compliance with sustainable laws in the construction sector.

Table 1 Factors presenting RPA success factors

Code	Item	References
RPA1	A seamless integration of data.	[30,31]
RPA2	Avoidance of costly errors.	[32,33]
RPA3	Reliable management	Interview
RPA4	Evaluation of compliance without bias.	Interview
RPA5	Rapid automated evaluation.	[34,35]
RPA6	Comprehensive data analysis.	[36,37]
RPA7	Immediate alerts for noncompliance.	[38,39]
RPA8	To avoid regulatory penalties.	Interview
RPA9	Instantaneous report creation	Interview
RPA10	Automated data validation.	[38,40]
RPA11	A meaningful aggregation of data.	Interview
RPA12	Rapid collection of data.	Interview
RPA13	Strong data protection.	Interview
RPA14	Simple data tracing.	[24,26]
RPA15	Construction project management.	[25,27]
RPA16	Safety management.	[41,42]
RPA17	Risk management.	Interview
RPA18	Health management.	Interview
RPA19	Enhanced operational effectiveness.	Interview
RPA20	Quality and defects management.	Interview
RPA21	Facility management.	[43]
RPA22	Eradication of human mistakes.	[44]
RPA23	Rule compliance.	[15,45]
RPA24	Continuous and vigilant surveillance.	[12,13]
RPA25	Detailed creation of audit trails.	[7,9]
RPA26	Reduced expenditures of manual labour.	Interview
RPA27	Strategic allocation of resources.	Interview
RPA28	Long-term investment yield.	Interview

2 Data Collection

The major phases of data collection in this research study consist of a pilot survey and a substantial questionnaire survey. In the first survey, there were 83 respondents selected by using stratified sampling methods from the Saudi Arabian construction industry. This approach ensures that the participants chosen to represent different population groupings, hence reflecting variation in experience as well as professional background. In addition, the pilot survey respondents represented diversified experience in years of work and professions in the construction industry.

The main questionnaire survey, therefore, involved an increased sample size of 108 individuals from the same population. Mainly the same as the pilot test, the preliminary questionnaire adopted a stratified sampling approach to ensure that the population sample was well-proportioned. Responses to the main questionnaire survey had different demographic factors in the construction industry with regards to the years of service and occupations held. Because of this diversity, we got a good understanding of the opinions and experiences of people who are actively involved in this particular area, as indicated in Table 2.

Table 2 Demographics of a primary questionnaire survey

Variable	Characteristics	Main Questionnaire Survey	
		No. of Respondents	%
Years of occupation	< 5 years	41	38.0
	6-10 years	38	35.2
	11-15 years	9	8.3
	16- 20 years	13	12.0
	> 20 years	7	6.5
Profession	Architect	19	17.6
	Quantity surveyor	21	19.4
	Builder	25	23.1
	Engineer	43	39.8

Both surveys used a five-point Likert scale to assess the participants' replies, from "Strongly Disagree" to "Strongly Agree." Therefore, random sampling was used to ensure data collected was representative and reliable. With the combination of both pilot and main questionnaires targeting the research questions using careful sampling methods, the study could undertake an in-depth study of the involvement of RPA for driving appropriate compliance for sustainability in Saudi Arabia's building sector.

3 Data Analysis

Exploratory Factor Analysis (EFA)

Successful application of RPA in the Saudi Arabian construction sector: data from the pilot survey was subjected to EFA, containing 28 variables. The component matrix obtained by the varimax rotation technique in EFA thus aided in the detection and formation of latent structures within the dataset. Emergent constructs from the analysis formed the basis for the formulation of hypotheses that allowed for a more systematic and hypothesis-driven approach in the subsequent phases of the study. Utilization of EFA had some important and valid views on the interrelationship that existed between most factors, hence enhancing this study in developing a framework of study that is more focused and well-informed.

Structure Equation Modelling (SEM)

This main questionnaire applied Structural Equation Modelling to test the relationships among various components identified in the pilot survey. The measurement model was adequately tested to establish the discriminant and convergent validity reliability of the measures. For this, AVE and reliability coefficients were computed by the researchers in order to test the strength and consistency of the measuring items [45]. Following this, a measurement model was constructed to assess the associations between hidden variables and observable indicators. In this study, a structural model was developed to examine the causal links among the identified constructs [46]s. The objective was to learn everything possible about the factors that influence the successful implementation of RPA in Saudi Arabia's building industry.

4. Results and Analysis

Exploratory Factor Analysis (EFA)

The factor loadings of several elements of the effective application of RPA in the Saudi Arabian construction sector are shown in Table 3, which presents the rotated component matrix. The details are allocated among five discrete components. Significantly, Component 1 encompasses elements of the smooth integration of data, the prevention of mistakes, and the dependable management thereof, suggesting a robust link between them. Component 2 comprises automated data validation, expedited data collecting, and significant data aggregation. Components 3 and 4 pertain to several facets of management, including safety, risk, and health management. Component 5 is linked to eliminating human errors, adherence to regulations, and ongoing monitoring.

Table 3 Rotated component matrix

Items	Component				
	1	2	3	4	5
RPA1	.855				
RPA2	.852				
RPA3	.848				
RPA4	.843				
RPA5	.841				
RPA6	.803				
RPA7	.765				
RPA8	.763				
RPA9	.735				
RPA10		.858			
RPA11		.775			
RPA12		.746			
RPA13		.721			
RPA14		.701			
RPA15		.672			
RPA16			.741		
RPA17			.732		
RPA18			.710		
RPA19			.668		
RPA20			.613		
RPA21			.598		
RPA26				.662	
RPA27				.660	
RPA28				.608	
RPA22					.768
RPA23					.706
RPA24					.528
RPA25					.524

Table 4 comprehensively classifies the difficulties linked to the specified constructions, organizing them according to their corresponding factor components. Understanding the constraints and potential in the practical application of RPA within the Saudi Arabian construction sector necessitates consideration of many elements. Accuracy and consistency involve addressing the difficulties associated with maintaining the precision and uniformity of data. Data management consolidates practices and techniques to achieve effective data administration within a given component. The efficiency and management construct pertains to several variables linked to improving operational efficiency and leadership within the construction sector [3]. The factor component of auditing and reporting encompasses the activities of auditing and reporting. Cost management includes the practises and strategies to effectively manage and allocate resources to control costs.

Table 4 Factors with named constructs

Factor Components	Code
Accuracy & Consistency	RPA-AC1
	RPA-AC2
	RPA-AC3
	RPA-AC4
	RPA-AC5
	RPA-AC6
	RPA-AC7
	RPA-AC8
	RPA-AC9
Data Management	RPA-DM1
	RPA-DM2
	RPA-DM3
	RPA-DM4
	RPA-DM5
	RPA-DM6
Efficiency & Management	RPA-EM1
	RPA-EM2
	RPA-EM3
	RPA-EM4
	RPA-EM5
	RPA-EM6
Auditing & Reporting	RPA-AR1
	RPA-AR2
	RPA-AR3
	RPA-AR4
Cost Management	RPA-CM1
	RPA-CM2
	RPA-CM3

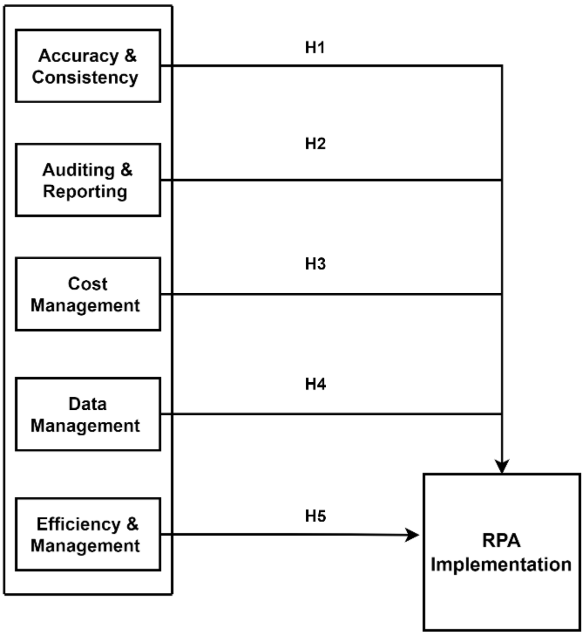

Figure 2 Hypothesized framework

Based on the results of the EFA, the following five study hypotheses were developed and fit within the hypothesized framework shown in Figure 2.

- H1: Accuracy and consistency positively impact RPA implementation for Automated Tracking and Adherence to Sustainable Regulations in Construction.
- H2: Auditing and reporting positively impact RPA implementation for Automated Tracking and Adherence to Sustainable Regulations in Construction.
- H3: Cost management positively impacts RPA implementation for Automated Tracking and Adherence to Sustainable Regulations in Construction.
- H3: Data management positively impacts RPA implementation for Automated Tracking and Adherence to Sustainable Regulations in Construction.
- H5: Efficiency and management positively impact RPA implementation for Automated Tracking and Adherence to Sustainable Regulations in Construction.

Structure Equation Modelling (SEM)

Measurement Model

Table 5 presents essential findings on the reliability and validity measures for the several factor components linked to the effective adoption of RPA in the Saudi Arabian construction sector. Factor loadings assess the magnitude of associations between latent variables and the observable indicators that represent them [6]. Reliability values, as shown by the construct reliability (CR), illustrate the internal consistency of the constructs under examination. On the other hand, the assessment of convergent validity is accomplished by utilizing the AVE.

The table presents an analysis of the strength and reliability of several factor components, namely "Accuracy & Consistency," "Data Management," "Efficiency & Management," "Auditing and reporting," and "Cost Management." The above factors demonstrate significant factor loadings, acceptable CR values, and large AVE scores, confirming their reliability and convergent validity [9]. Nevertheless, several elements were excluded from the model due to their lower factor loadings.

Table 5 Model reliability and validity statistics

Factor Components	Code	Factor Loading	CA	CR	AVE
Accuracy & Consistency	RPA-AC1	0.798	0.916	0.919	0.727
	RPA-AC2	0.823	-	-	-
	RPA-AC3	0.901	-	-	-
	RPA-AC4	0.863	-	-	-
	RPA-AC5	0.864	-	-	-
	RPA-AC6	0.865	-	-	-
	RPA-AC7	0.912	-	-	-
	RPA-AC8	0.784	-	-	-
	RPA-AC9	Deleted	-	-	-
Data Management	RPA-DM1	0.853	0.909	0.918	0.688
	RPA-DM2	0.808	-	-	-
	RPA-DM3	0.813	-	-	-
	RPA-DM4	0.874	-	-	-
	RPA-DM5	0.775	-	-	-
	RPA-DM6	0.851	-	-	-
Efficiency & Management	RPA-EM1	0.806	0.892	0.897	0.648
	RPA-EM2	0.847	-	-	-
	RPA-EM3	0.817	-	-	-
	RPA-EM4	0.805	-	-	-
	RPA-EM5	0.806	-	-	-
	RPA-EM6	0.747	-	-	-
Auditing & Reporting	RPA-AR1	0.842	0.851	0.853	0.691
	RPA-AR2	0.796	-	-	-
	RPA-AR3	0.850	-	-	-
	RPA-AR4	0.837	-	-	-
Cost Management	RPA-CM1	0.867	0.798	0.806	0.712
	RPA-CM2	0.814	-	-	-
	RPA-CM3	0.849	-	-	-

Table 6 displays the results of applying the Fornell-Larcker criterion to the context of RPA use in the Saudi Arabian construction industry. The diagonal components of the matrix represent the square root of the AVE for each construct. On the other hand, the off-diagonal values indicate the correlations between different constructs. It is worth noting that the diagonal members in the matrix are consistently more significant than the equivalent off-diagonal elements, which provides evidence for the discriminant validity of the constructs [11]. This finding illustrates that each construct assesses a separate and distinct aspect, guaranteeing no overlap between them and confirming their appropriateness for further structural modelling in the research.

Table 6 Fornell Larker criteria results

Constructs	Accuracy & Consistency	Auditing & Reporting	Cost Management	Data Management	Efficiency & Management
Accuracy & Consistency=AC	0.853				
Auditing & Reporting=AR	0.536	0.831			
Cost Management=CM	0.646	0.705	0.844		
Data Management=DM	0.55	0.653	0.645	0.829	
Efficiency & Management=EM	0.436	0.561	0.698	0.58	0.805

Discriminant validity across constructs in the sphere of RPA deployment in the Saudi Arabian construction industry is explored using the HTMT data shown in Table 7. The HTMT values indicate the degree of correlation between various constructs, all falling below the threshold of 0.85. These findings provide robust support for the discriminant validity of the components, as seen by the much lower HTMT values compared to the recommended point. The conclusions confirmed that each construct within the study model is distinguishable and captures a separate element [12,13]. This finding supports the appropriateness of these constructs for further structural modelling and analysis.

Table 7 HTMT statistics

Constructs	Accuracy & Consistency	Auditing & Reporting	Cost Management	Data Management	Efficiency & Management
Accuracy & Consistency=AC					
Auditing & Reporting=AR	0.586				
Cost Management=CM	0.73	0.858			
Data Management=DM	0.572	0.736	0.747		
Efficiency & Management=EM	0.402	0.627	0.803	0.612	

Table 8 displays the cross-loadings of diverse items on distinct constructs, offering valuable insights into the associations between individual items and the underlying constructs within the specific context of RPA deployment in the Saudi Arabian construction sector. This table shows the numbers regarding the correlation values of each item with its concept. Regarding the present study, items' cross-loadings on their respective constructs would be better, stronger in comparison with the other constructs. In fact, the cross-loadings included in this study provide evidence by which the validity of the measurement model is established, and it is ascertained that the items correspond appropriately to their respective constructs, allowing the overall strengthening of the research model and enhancement of its reliability.

Table 8 Cross ladings

	Accuracy & Consistency	Auditing & Reporting	Cost Management	Data Management	Efficiency & Management
RPA-AC1	0.798	0.543	0.429	0.573	0.247
RPA-AC2	0.823	0.389	0.461	0.41	0.317
RPA-AC3	0.901	0.541	0.518	0.425	0.318
RPA-AC4	0.863	0.476	0.502	0.386	0.498
RPA-AC5	0.864	0.456	0.494	0.504	0.339
RPA-AC6	0.865	0.431	0.55	0.504	0.428
RPA-AC7	0.912	0.51	0.672	0.549	0.235
RPA-AC8	0.784	0.273	0.443	0.384	0.106
RPA-AR1	0.524	0.842	0.633	0.597	0.627
RPA-AR2	0.478	0.796	0.52	0.432	0.508
RPA-AR3	0.418	0.85	0.566	0.548	0.443
RPA-AR4	0.346	0.837	0.624	0.592	0.374
RPA-CM1	0.651	0.574	0.867	0.485	0.611
RPA-CM2	0.447	0.613	0.814	0.568	0.457
RPA-CM3	0.519	0.604	0.849	0.591	0.578
RPA-DM1	0.602	0.577	0.59	0.853	0.611
RPA-DM2	0.44	0.583	0.553	0.808	0.468
RPA-DM3	0.502	0.499	0.467	0.813	0.527
RPA-DM4	0.418	0.568	0.581	0.874	0.442
RPA-DM5	0.232	0.433	0.335	0.775	0.261
RPA-DM6	0.461	0.559	0.625	0.851	0.495
RPA-EM1	0.626	0.652	0.645	0.613	0.806
RPA-EM2	0.598	0.543	0.529	0.573	0.847
RPA-EM3	0.523	0.389	0.461	0.41	0.817
RPA-EM4	0.453	0.404	0.608	0.475	0.805
RPA-EM5	0.684	0.273	0.443	0.384	0.806
RPA-EM6	0.63	0.4	0.43	0.286	0.747

Structure Path Analysis

On the other hand, the results of the path analysis are summarized in Table 9, providing an indication of those factors that could influence whether the construction industry would adopt RPA to automate monitoring and compliance with sustainable norms. The present study evaluates five significant hypotheses-which test for the impact of individual structures on RPA adoption. Results of the study identify the factors of Accuracy and Consistency, Auditing and Reporting, Cost Management, Data Management, Efficiency, and Management as driving significant and positive impact on RPA deployment. The T-statistics and p-values of these tests identify the rejection of the null hypotheses. This underlines the importance of such structures in being able to supply not only an impact on construction sector automation but also reassurance over sustainability in legislative compliance [47]. Model path coefficients and significance are presented in Figure 3 whereas model path coefficients and t-stat values in Figure 4.

Table 9 Model path analysis and hypothesis validation

Hypothesis	Constructs	(O)	(M)	SD	T stats	P values	Status
H1	Accuracy & Consistency -> RPA Implementation	0.464	0.458	0.046	10.098	0	Accepted
H2	Auditing & Reporting -> RPA Implementation	0.168	0.166	0.024	7.058	0	Accepted
H3	Cost Management -> RPA Implementation	0.132	0.134	0.019	6.812	0	Accepted
H4	Data Management -> RPA Implementation	0.213	0.21	0.022	9.496	0	Accepted

H5	Efficiency & Management -> RPA Implementation	0.179	0.184	0.049	3.672	0	Accepted
(O)= Original sample; (M)= Sample mean; SD= Standard deviation.							

Figure 3 Structure model significant and path coefficient

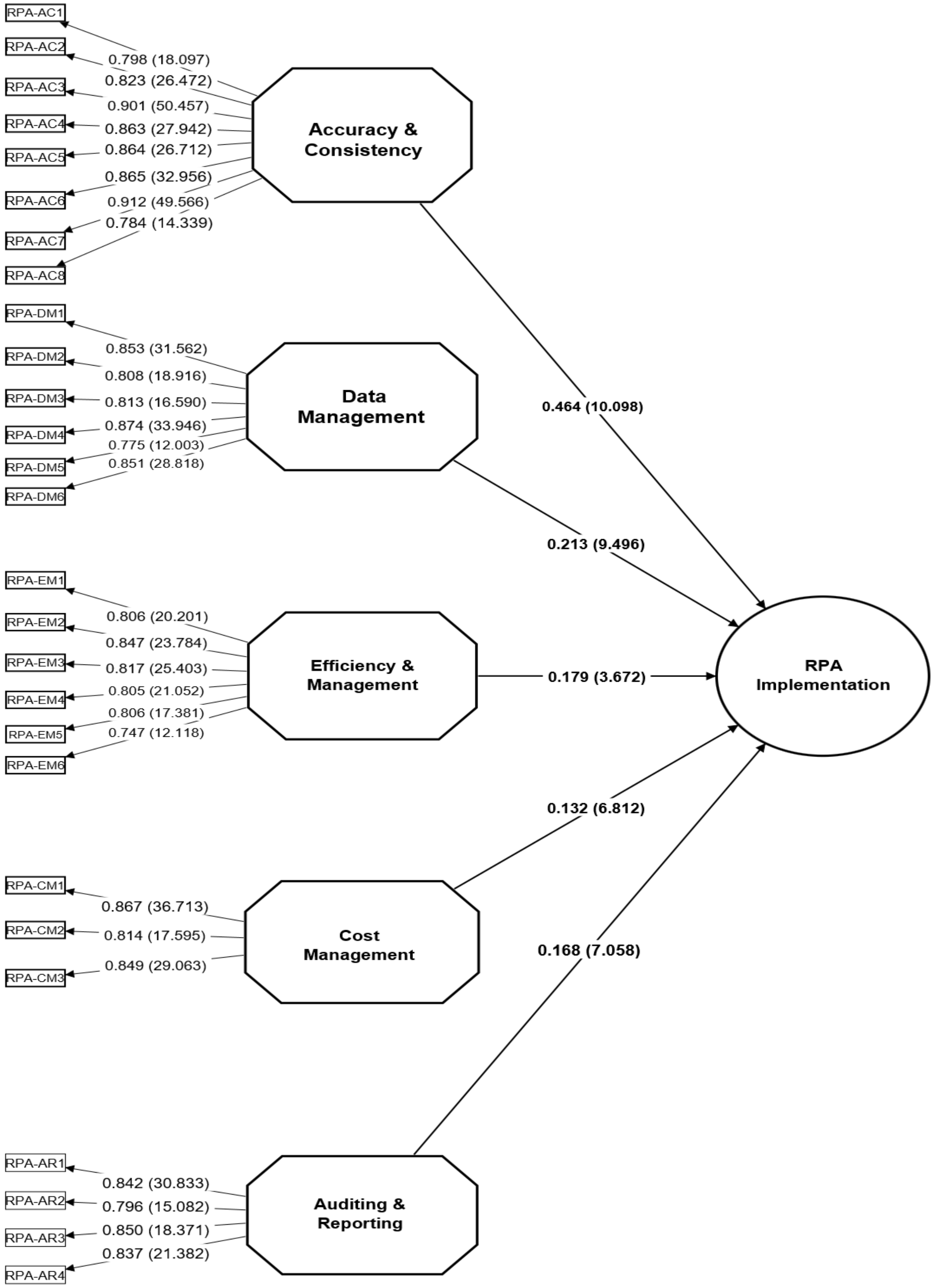

Figure 4 Structure model with t-stat and path coefficient

Table 10 examines the model's predictive ability by comparing the Sum of Squares Explained (SSO) and the Sum of Squares Error (SSE) for the construct known as "RPA Implementation." The model's predictive capacity may be measured by examining the Q2 value, computed by subtracting the SSE from the SSO and serving as an indicator. In this case, the Q2 value is estimated to be 0.498, indicating that the model can explain around 49.8% of the variability in the "RPA Implementation" construct. This particular instance was taken into consideration [13]. This showcases the model's capacity to accurately forecast and elucidate discrepancies in using RPA for automated monitoring and compliance with sustainable rules within the construction sector.

Table 10 Model predictive relevance

Constructs	SSO	SSE	Q^2 (=1-SSE/SSO)
RPA Implementation	2324.000	1166.742	0.498

5. Discussion

The research findings provide valuable insight into RPA's role in the automation of monitoring and compliance with sustainability regulations within Saudi Arabia's construction sector. The current study offered an in-depth, multi-faceted look given to the several elements and structures such as data management, auditing, cost management, efficiency, and accuracy. This illumination was a representation of the multifaceted nature involved in the implementation of RPA. These results ensure the importance of such frameworks in making RPA deployment possible. However, the unique contribution of this research investigates the particular circumstances within the construction sector of Saudi Arabia.

This sets up a very good opportunity to improve compliance and data management procedures with the use of RPA, with increasing emphasis on sustainable laws within the Saudi Arabian setting. Confirmation of all the hypotheses, which indicates a positive relationship between these constructs and the adoption of RPA, underlines the ability of RPA to achieve sustainability in the building sector [10]. The results underscore the distinctive obstacles and prospects inherent in the building sector of Saudi Arabia, particularly in the integration of data, precision, and efficient administration.

The distinctiveness of this study becomes evident upon comparing the obtained findings with the current body of research in the broader domain of RPA. Previous studies have examined RPA's use in several fields [12,13,48]. However, this research zeroes exclusively on the building sector, yielding essential lessons directly relevant to the context of Saudi Arabia [45,49]. This research fills a critical need for the existing body of literature by presenting actual findings that support the efficacy of RPA in effectively tackling the unique obstacles presented by sustainable rules in this particular sector.

This paper provides substantial empirical and theoretical contributions. The study provides empirical evidence on the Saudi Arabian construction sector [14,45]. It highlights the beneficial effects of many factors, such as data management, auditing, cost management, and efficiency, on applying RPA to ensure sustainable compliance [9,15]. The research, in a theoretical sense, contributes to the advancement of knowledge on the role of RPA in effectively resolving industry-specific difficulties associated with implementing sustainable laws.

Thirdly, by applying RPA successfully, attention must be shifted to organizational-level data management enhancement, implementation of appropriate and strict auditing, establishment of reporting systems, optimization of cost management practices, and enhancement of operational efficiency. The construction organization, as a result of making such changes, may record huge cost saving, high data integrity, and quick compliance with sustainable requirements. Managers in effective RPA integration can allocate resources toward employee training and IT infrastructure development.

While this research thus contributes to the development of the discipline, it is nonetheless not free from certain limitations. The study only focuses on the Saudi Arabian construction industry, and the results may not generalize easily to other geographical locations or industries. Further research would be needed to establish the level at which RPA is scalable across different contexts.

6. Conclusion

In this respect, this study analyzed the application of RPA in the Saudi Arabian construction sector, focusing on the likely issues of monitoring and compliance with legislation to enhance sustainability. The primary objective of this research was the analysis of various factors that influence RPA uptake in such a setting, which relate to information management, auditing, cost management, and efficiency. Thus, the contributions of this study not only validate those components' importance in influencing effective RPA execution but also bring fresh insight into the domain of RPA research. This study has contributed significantly by explicitly addressing the Saudi Arabian construction sector. It has addressed a specific lacuna in the existing research literature and provided empirical information relevant to the context of sustainable compliance. The findings from this study add to the growing literature on RPA and provide valuable lessons for business leadership and regulators in Saudi Arabia's construction industry, struggling to implement greener practices.

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