EFFECT OF AUTOMATED PROJECT TASK SCHEDULING ON PERFORMANCE OF CONSTRUCTION PROJECTS IN RWANDA. A CASE OF BETTER DESIGN AND CONSTRUCTION LIMITED

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ABSTRACT

The construction industry is a vital sector in Rwanda's economic development, but it faces challenges related to project performance, including delays and cost overruns. This study explores the effects of automated project task scheduling on construction project performance, with a specific focus on Better Design and Construction Limited in Rwanda. The objective is to investigate how the implementation of automated scheduling software influences efficiency, accuracy, resource allocation, and overall project management in the Rwandan construction context. The study focused on: project task scheduling on performance of construction projects in Rwanda. In this study, the theoretical orientation covered Resource Based View Theory. The study adopted a descriptive survey design. The target population of the study were the 161 respondents dealing with the projects at Better Design and Construction Ltd. Census approach was adopted in this study. The study used both primary and secondary data, where questionnaires were used for data collection. Cronbach's alpha test was utilized in assessing reliability of research instrument. Data collected was analyzed through SPSS version 21. Data analysis involved statistical computations for averages, percentages, and correlation and regression analysis. Descriptive statistics and Correlation (using the Karl Pearson's coefficient of correlation) were used to analyze the data and establish the relationship between the dependent variables and the set of independent variables. Qualitative data was analyzed through thematic analysis and presented in narrative form and verbatim citations. The unstandardized coefficients: The unstandardized coefficients represent the direct impact of the independent variable on the dependent variable without taking into account the scale or units of measurement. In this case, the constant (B = 0.017) suggests a minimal effect on the "Performance of construction projects." The small standard error (Std. Error = 0.222) indicates that this effect is relatively uncertain or imprecise. In contrast, the independent variable "Automated Project task scheduling" has a substantial impact with a high unstandardized coefficient (B = 0.999), suggesting a strong relationship with the "Performance of construction projects." The small standard error (Std. Error = 0.049) means that this effect is estimated with greater precision. In conclusion, the study's robust statistical analysis demonstrates that the implementation of automated project task scheduling has a substantial and statistically significant positive impact on enhancing the performance of construction projects, underlining the importance of adopting

automation in the construction industry. Based on the strong and statistically significant positive relationship between automated project task scheduling and construction project performance, it is recommended that construction companies, including Better Design and Construction Limited, in Rwanda consider the adoption and implementation of automated scheduling solutions to enhance efficiency and overall project outcomes. Further studies could explore the long-term sustainability and lifecycle benefits of automated project task scheduling in construction, examining its impact on maintenance and post-construction phases.

***Keywords**: Automated project task scheduling, Construction project performance, Rwanda construction industry, Better Design and Construction Limited, Project scheduling software*

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BACKGROUND OF THE STUDY

Globally, project management automation, driven by advancements in technology, has become a crucial component in modern project management practices (Hastie & Wojewoda, 2015). The construction industry is commonly characterized by its comparatively low productivity and resistance to change, which are widely perceived as the primary factors contributing to the lagging adoption of technological innovations in the Architecture, Engineering, and Construction Industry when compared to other sectors (Munoz-La Rivera *et al.,* 2021). Moreover, it is well acknowledged that the construction sector exhibits a significant degree of segmentation, indicating a constant demand for labor, enhanced tools, and a substantial level of risk associated with each construction project (Chovichien & Nguyen, 2013). Although the inception of research in construction robotics and automation can be traced back to the 1980s, the construction industry remained relatively unexplored by the robotics and automation community until recently (Delgado *et al.,* 2019). Consequently, there is a growing trend towards enhancing automation throughout many stages of the project life cycle.

The adoption of automation in project management has shown promising impacts on project performance. According to a study by Oke *et al.,* (2017) organizations that integrated project management automation tools experienced shorter project cycles and reduced delays. Furthermore, automation facilitated better decision-making by providing accurate and up-to-date project data, leading to improved project outcomes (Chitkara, 2013). An autonomous construction system would be best suited for these kinds of demands since it could handle unpredictable conditions during the course of a project while operating without supervision or intervention (Melenbrink *et al.,* 2020). Automation in construction processes can decrease the demand for a workforce, which is extremely useful in countries with a workforce shortage or with high labour costs. Also, the construction phase could be less weather-dependent throughout the entire year despite the unfavourable climatic conditions. Another noteworthy aspect is the everlasting and crucial industry problem of construction site work safety, which could be increased by production automation (Bock, 2015). The goal is for workers to spend less time operating at great heights, great depths, extreme temperatures, radiations, and approaching inaccessible terrains

The successful execution of a construction project is influenced by a multitude of factors. Investors place a paramount emphasis on ensuring both the

projected timeline and costs of the project. This heightened concern stems from the recognition that obstacles impacting the project's timely completion can have extensive repercussions, directly impacting the vested interests of the owners. A study by AbuHussein, Alawneh and Al-Debei (2016) conducted in the UK construction industry found that the adoption of automation tools led to improved project scheduling accuracy and reduced delays. Similarly, Adams (2022) observed that automated communication platforms facilitated better information sharing among project teams, contributing to enhanced project coordination and timely decision-making. They also pinpoint specific knowledge management areas crucial for the optimal performance of project managers. These areas encompass project time management, which involves not only devising an effective project schedule for timely delivery but also ensuring the actual adherence to that schedule. O'Brien and Sullivan (2018) suggest that automation reduces the likelihood of human errors and accelerates project timelines, leading to improved project completion rates.

Research indicates that project management automation has the potential to significantly impact project performance. In a study by Kwame et al. (2018), it was found that the integration of automation tools in project planning and execution led to improved communication, reduced delays, and enhanced overall project efficiency in infrastructure projects across multiple African countries. However, the relationship between automation and project performance is not without challenges. According to Juma and Omondi (2019), while automation can enhance certain aspects of project management, its success is contingent on factors such as the organization's readiness for automation, the quality of data input, and the adaptability of project teams. The impact of project management automation on project performance may be distinct in the African context due to unique challenges faced by the region. Infrastructure deficits, regulatory complexities, and socio-economic factors can all influence the effectiveness of automation strategies (Makoni, 2021). Ahmed and Nwosu (2017) highlight that cultural differences and workforce skill gaps can also affect the implementation and outcomes of automation initiatives in Africa.

In a study conducted by Ssewankambo (2019) in Uganda, the implementation of project management automation led to a notable reduction in project delays and cost overruns. Moreover, the study found out that organizations that implemented project management automation experienced reduced project timelines by an average of 20%. Similarly, the implementation of automated project scheduling tools in a construction project led to a 15% reduction in project duration and a 10% decrease in cost overruns in Kenya (Kibuchi & Wangeci, 2021). Such successes highlight the potential for automation to address project management inefficiencies.

Rwanda has witnessed rapid economic growth and infrastructural development in recent years (Kagame *et al.,* 2020). As the country invests in various projects, there is a growing need for efficient project management practices. The adoption of automation technologies in project management aligns with Rwanda's vision for technological advancement and economic progress. A study by Nzabonimana and Uwizeyimana (2019) found that the implementation of project management software led to a significant reduction in project delays and cost overruns in Rwandan construction projects. Similarly, Karangwa *et al.* (2021) reported that automation improved collaboration among project teams and stakeholders, resulting in better project outcomes. While the benefits of project management automation are evident, challenges related to technological infrastructure, user training, and data security need to be addressed (Gasana & Mugisha, 2017). Additionally, cultural factors and resistance to change can impact the successful implementation of automation tools in Rwandan projects.

Better Design and Construction Ltd serves as an important context for understanding the implications of project management automation.

According to Rwagaju (2021), the Authority has recognized the potential of automation in improving project efficiency and resource allocation. However, empirical research assessing the actual impact of automation on project performance within this specific context remains limited. It is crucial to investigate how the adoption of project management automation tools can address these challenges and improve project outcomes.

Statement of the Problem

In the context of construction project management, Nzabonimana and Uwizeyimana (2019) emphasize the pivotal role of project management automation systems in enhancing project efficiency. These systems encompass various functionalities, including work scheduling, resource allocation, and progress tracking tools, all of which contribute to a smoother project execution. Automation reduces the need for manual data entry, minimizes the risk of errors, and optimizes resource allocation. For instance, technologies like Gantt charts and automated milestone tracking enable project managers to oversee progress effectively and allocate resources efficiently, as highlighted by Gatabazi *et al.*, (2021). The adoption of such automation can significantly improve the overall project management landscape, leading to better outcomes in terms of cost and time efficiency.

Conversely, Kayitare and Mbabazi (2016) shed light on the challenges faced by the Ministry of Infrastructure in Rwanda in implementing construction projects. The authors identify issues related to contractor performance, insufficient documentation, decision-making procedures, and project schedule extensions, which frequently result in project stagnation or failure. Furthermore, the absence of a structured monitoring process and a centralized data repository for active initiatives exacerbates the situation. Notably, project cost overruns, such as the case of the Kigali Convention Centre, underscore the need for more effective project management practices. The integration of automation tools can be a potential solution to address these challenges, though adapting them to Rwanda's unique socio-economic and operational conditions will require a nuanced approach. A comprehensive understanding of how project management automation influences construction project performance in Rwanda is crucial, taking into account factors like workforce skills, financial investment, technology infrastructure, and organizational change management. Ultimately, embracing automation in construction project management can contribute to addressing the multifaceted challenges facing the construction industry in emerging economies like Rwanda (Ndayambaje *et al.,* 2018), ultimately leading to more successful project deliveries.

LITERATURE REVIEW

Automated Project Task Scheduling

Project managers invest a significant amount of their time resolving issues stemming from inadequate coordination, untimely information, and inaccurate or obsolete data (Hongling *et al.,* 2016). Many enterprises have directed their resources towards advanced Management Information Systems (MIS) and Enterprise Resource Planning (ERP) systems, aiming to support company and project managers in their operational tasks (Rizo-Maestre *et al.,* 2020). Nevertheless, the capabilities of such systems are inherently constrained by the availability of information. The process of acquiring data incurs costs, transformation into meaningful information demands further expenses, and rendering it in a machine-readable format amplifies the financial outlay. Striking a balance between the value of the information and the expenditure a company is prepared to undertake for data acquisition and information generation is a crucial consideration.

The principal objective of Automated Project Performance Control (APPC) is to render the procurement of machine-readable information economically viable. This, in turn, enhances the overall performance of systems and, consequently, the execution of construction projects. Effective project task scheduling is a critical aspect of construction project management that directly

influences project performance (Shtub *et al.,* 2017). The allocation of resources, sequencing of activities, and timely execution of tasks play a significant role in determining the success of construction projects. Moreover, Mahmoud and Mohamed (2015) highlighted that task scheduling involves organizing project activities in a logical sequence to ensure optimal resource utilization, minimize delays, and meet project objectives. The scheduling process often utilizes various techniques, such as Critical Path Method, Program Evaluation and Review Technique and Building Information Modeling to create efficient schedules that align with project timelines (Shen & Nguyen, 2019).

Scheduling is an integral part of construction project management, contributing significantly to project performance outcomes. Ahmad and Duffuaa (2020) highlight the importance of scheduling in managing project uncertainties and complexities, ultimately leading to improved project performance. Effective scheduling minimizes disruptions and resource conflicts, thereby enhancing productivity (Al-Tmeemy *et al.,* 200).

Wanderi, *et al.,* (2015) asserted that many projects that have been adequately planned have always succeeded in accomplishing their goals, but others that have been poorly planned have always failed in the early phases or failed to produce the desired effects. Denotes the successful accomplishment of a project while abiding by the predetermined budget, project tasks, and resource allocations during a specific timeframe outlined by the project calendar. Assessing performance involves evaluating cost planning, scrutinizing financial indicators related to tasks and resources, and delving into transactional data such as commitments, expenses, and events. This comprehensive approach facilitates overall risk management by examining the performance of individual tasks in the life of cost planning and scheduling (RDB, 2013).

Critical path analysis has emerged as a crucial technique for identifying the most critical tasks in a construction project schedule. Research by Smith and Johnson (2018) demonstrated that proactive management of tasks along the critical path can significantly reduce project duration and enhance project performance. Additionally, Kim *et al.* (2020) explored the benefits of schedule compression techniques in accelerating project completion while maintaining quality standards.

El-Sayegh (2008) found that projects with well-defined schedules experience fewer delays and cost overruns. Moreover, proper scheduling allows for accurate forecasting of resource requirements, leading to cost savings. Advancements in technology have revolutionized scheduling practices in construction. Building Information Modeling and advanced scheduling software offer new opportunities for optimizing project performance. Zeng *et al.* (2016) emphasize how BIM-based scheduling enhances collaboration and communication among project stakeholders, leading to improved performance outcomes.

Several scheduling techniques and tools have been proposed to address the challenges faced in construction projects in Rwanda. Building Information Modeling (BIM) has gained traction as a technology that enables effective visualization and coordination of project tasks, leading to improved scheduling accuracy (Gatabazi *et al.,* 2021). Additionally, the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) have been adapted to suit Rwanda's unique project environment, as discussed by Rwigema (2017). Rwanda's construction industry is marked by various challenges that impact task scheduling and project performance. Limited availability of skilled labor, inadequate project management practices, and external factors such as weather conditions can lead to schedule disruptions (Mukundane & Nzabonimana, 2019). These challenges highlight the need for robust scheduling techniques tailored to the Rwandan context.

Resource Based View Theory

Barney introduced the concept of the Resource-Based Theory in 1991. The Resource-Based View (RBV) theory asserts that a company can be defined based on the resources it possesses (Almarri &

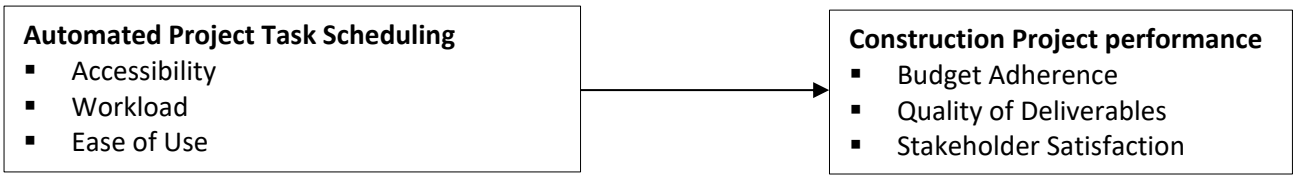
Gardiner, 2014). This theory emerged from research in strategic management that aimed to understand how companies generate value and, more specifically, how they can gain a competitive edge in the market. According to Barney, a company's competitive advantage stems from its distinct and valuable strategy, one that significantly sets it apart from its current and future competitors. Consequently, the firm's resources constitute the foundation of its lasting competitive advantage (Kabue & Kilika, 2016). In this perspective, a company's resources, both tangible and intangible, represent its primary wellspring of competitive advantage, potentially serving as strengths or weaknesses.

The Resource-Based View (RBV) theory presents a strategic management approach that underscores the significance of a company's internal resources and capabilities in attaining a sustainable competitive advantage (Salazar, 2017). Within the context of construction projects, the RBV theory suggests that the triumph of a project is influenced by the proficient allocation and utilization of various resources, encompassing human, financial, technological, and organizational elements. Effective task scheduling, a pivotal component of project management, assumes a critical role in optimizing these resources and elevating the overall performance of the project (Yang, Jia & Xu, 2019). Automated project task scheduling involves the use of technology and algorithms to allocate resources and tasks efficiently throughout the project lifecycle. This process aims to optimize resource utilization, minimize delays, and enhance overall project performance. RBT aligns well with automated project task scheduling, as it underscores the significance of leveraging unique resources and capabilities to create a competitive edge.

By incorporating RBT principles, organizations can identify resources that offer a competitive advantage, allocate them optimally, and achieve better project outcomes (Olanipekun & Xia, 2017). For instance, a construction company might have specialized equipment or highly skilled personnel that can be strategically scheduled using automated tools to maximize their impact on project efficiency and quality. The construction sector plays a pivotal role in Rwanda's economic progress, with various infrastructure projects contributing significantly to the nation's development. Effective project management, which encompasses proficient task scheduling, is imperative to guarantee timely project completion and successful outcomes. The Resource-Based View theory underscores the importance of resources, capabilities, and their strategic administration in securing a competitive edge and superior performance. In the context of construction projects in Rwanda, which often involve complex logistics and resource constraints, the Resource-Based Theory can be highly relevant. Automated project task scheduling can help construction firms leverage their resources more effectively, leading to improved project timelines, reduced costs, and ultimately better project outcomes. Given that project task scheduling is a pivotal facet of project management, the RBV theory finds applicability in the present study.

Conceptual Framework

According to the work of Kombo and Tromp (2017), a conceptual framework is a set of guiding principles drawn from the relevant fields of enquiry and used to structure a subsequent presentation. A conceptual framework is a methodological device developed to better comprehend and explain the phenomenon under study. The research suggests the following factors determine building project success: project task scheduling and construction project performance. The relationship between the variables and the measurement are presented in the conceptual framework Figure 1.



Independent Variable **Dependent Variable**

Figure 1: Conceptual framework

Source: Researcher, 2023

METHODOLOGY

A research design is a blueprint that guides the process of research from the formulation of the research questions and hypotheses to reporting the research findings (Yin, 2017). This study employed descriptive and correlative research design. This is because descriptive research does not involve modifying the situation under study or determining the cause-effect relationship. It also enables the researcher to obtain the opinions of project managers involved in construction projects in their natural setting. It is also correlative because it established a relationship between independent variables project task scheduling, and the dependent variable (performance of construction projects in Rwanda).

The focus of this study was on practitioners within the building business who are affiliated with the Better Design and Construction Ltd. The professionals encompassed by this group are Architects, Quantity Surveyors, Civil Engineers, Structural Engineers, Mechanical Engineers, Electrical Engineers, Construction Project Managers, and Land Surveyors. The target population comprised of 161 respondents working with Better Design and Construction Ltd.

The sample size is determined by; the objective of the study, importance of the inquiry, available data, usefulness of the study, what is credible and time and resources available for the study (Yin, 2017). A sample of 115 respondents were determined from a target population of 161 using Slovin's formula (1967) also cited by Sekaran and Bougie (2013).

$$n = \frac{N}{1 + N\,(e)^2}$$

Where n = the sample size.

e = probability of error, i.e., the desired precision, 0.05 for 95% confidence

$$n = \frac{161}{1 + 161(0.05)^2} = 115$$

Table 1: Sampling Frame

Category	Population	Sample
Architects	18	13
Quantity Surveyors	22	16
Civil Engineers	20	14
Structural Engineers	25	18
Mechanical Engineers	17	12
Electrical Engineers	27	19
Construction Project Managers	13	9
Land Surveyors	19	14
Total	**161**	**115**

Source: **Better Design and Construction Ltd**, 2023

The research utilized the stratified random sampling method to determine the sample across various distinct categories. According to Creswell and Clark (2017), the methodology of stratified random

sampling entails the systematic division of a population into distinct and well-defined groups known as strata. The expected sample size for each category within each stratum is shown in the corresponding table. In order to get the intended sample size, the researcher employed a random selection method using a roster provided by the Better Design and Construction Ltd

Because it took less time to complete, the questionnaire was closed-ended. Parametric analysis, which were used to assess the underlying premise of the study benefit from the inclusion of closed-ended questions. Analysis of project management automation papers provided further confirmation that self-administered questionnaires are a legitimate method for gathering quantitative research data (Creswell & Creswell, 2017).

The first section provided background information about the study, and the second section consist of a series of Likert-type scale questions (SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree, VE = Very Extremely, LO = Large, MED = Moderate, SM = Small, VS = Very Small). Data on construction project outcomes were collected inquiring on automation in project management. The research also makes use of records (reports) from the Better Design and Construction Ltd, in addition to questionnaires. Nominal scale was used to measure the variables.

The researcher made the decision to make use of the questionnaire for a variety of reasons. Kombo and Tromp (2017) highlight a few positive aspects of employing questionnaires as instruments for the data collection process. They are as follows: When there is a need to collect a substantial amount of data in a short length of time at a low cost, questionnaires are an excellent tool to use. Questionnaires, which are one of the most prevalent forms of data gathering instruments, are also able to be simply evaluated in terms of their dependability. According to Mugenda and Mugenda (2013), reliability is defined as the capability of a questionnaire to give the same findings in multiple implementations. This ability leads to consistency and dependability in the results. According to Kothari (2014), the other advantages of using surveys include its accuracy, generalizability, and simplicity. To conduct my research, I decided to make use of questionnaires because of all of the benefits described above. Nevertheless, in spite of these qualities, surveys typically have limitations when it comes to analyzing detailed patterns of interaction or complicated social interactions. Personal interaction was required in order to complete the questionnaires. It assisted save time and resources, as well as extract more information from queries. Leaving the questionnaire up to the respondents could result in the collection of skewed data and could result in additional expenditures associated with going back to pick it up.

The pilot survey's initial 12 questions were given out by the researcher themselves. According to Drost (2016), a pilot study only needs ten percent of the total sample size. Those in the architectural, engineering, surveying, and construction management fields were eligible, as well as two engineers in each of those specialties. Kicukiro District is where we'll be doing our research. After receiving responses, they were evaluated to see if they contained the correct data.

Whether or not a test is valid depends on how well a representative sample of the items being tested actually reflect the target material (Kothari, 2014). According to Creswell & Creswell (2017), validity refers to the ability to draw actionable inferences from test results. The study's focus is on the contents' validity, which is defined as the extent to which the instrument provides sufficient coverage of the topic at hand. The supervisors of the research were consulted for updates to the materials to ensure they accurately reflect the intended usage and are free of any potentially misleading ambiguity. It ensured that everyone who fills out the survey has a firm grasp on its essentials.

Table 2: Factor analysis

	Extraction
Performance of construction projects	.923
Project task scheduling	.952

Extraction Method: Principal Component Analysis.

The table provides the results of a Principal Component Analysis (PCA) related to the performance of construction projects. It includes five different factors related to construction project management and their corresponding extraction scores. The extraction scores are as follows: construction project performance (.923), project task scheduling (.952). The issue of reliability asks whether or not the results of a study can be reproduced by other researchers (Bhatnagar, Kim, & Many, 2014). When the same people take the same measurements over and over again and get the same findings, you may be confident in your results. A research tool is said to be dependable if it exhibits consistency and stability, making it both predictable and accurate. The dependability of the study instrument was examined using an inter-item reliability test. The questionnaire contained multiple items that all aim to measure the same underlying notion. This involved a group of interconnected questions meant to assess how closely people understand a certain idea. This was accomplished by using Cronbach's Alpha coefficient analysis to determine the study's scale's internal consistency; a value of 0.7 was chosen as the bare minimum for determining the study's scale's reliability (Almanasreh *et al.,* 2019).

Table 3: Reliability Statistics

Variable	Alpha (α)	No of items	Comments
Project task scheduling	0.752	5	Reliable
Performance of construction projects	0.785	4	Reliable

Source: Pilot results, 2023.

Each construct's reliability coefficient is well above the recommended threshold of 0.7, indicating that the measurement instruments used to assess these constructs exhibit strong internal consistency (Nunnally, 2018). This suggests that the items within each construct are measuring the same underlying concept consistently. Specifically, project task scheduling (α = 0.752), and performance of construction projects (α = 0.785).

Multiple steps were performed to clean and organize the raw field data before it is analyzed. Finding and dealing with impossible values and handling missing data was among these procedures. A value is considered impossible if it lies outside the range of that scale (Creswell, 2013). To fix this, we'll do a descriptive analysis using frequencies using SPSS version 23, then track down the correct values in the surveys and enter them into SPSS to replace the implausible ones. The results of the descriptive statistics ensure that the final dataset does not contain any impossible values. When dealing with missing data, pairwise deletion was used, and values were well-coded and uniquely identifiable in the SPSS datasets as missing values. Since all data cases (including those with missing data) are used in analysis with pairwise deletion, the researcher is able to make better use of the available data. As a result of the change in sample size (N), the resulting statistics were also different. By maximizing all data available per analysis basis, pairwise deletion increases statistical analysis power (Newman, 2014). Both inferential and descriptive statistics were used to examine the quantitative data. Pearson correlation coefficients and multiple regression models are examples of inferential statistics that were employed.

The regression equation is: $Y = \beta o + \beta 1X1 + \varepsilon$

Where: Y = Performance of construction projects in Rwanda; X_1 = Project Task scheduling; ε =Error term

All volunteers received a thorough explanation of the study's goals and were assured that their participation is entirely optional. All respondents were assured of their anonymity and confidentiality, and they were warned that some of the questions they were asked are particularly delicate. Volunteers were required to sign a waiver stating that they understand the risks associated with taking part in the study. After receiving a letter of introduction from Mount Kenya University, a research permit can be obtained from the Better Design and Construction Ltd.

RESULTS AND FINDINGS

Descriptive Results Automated project task scheduling

The table presents findings related to task scheduling and project management in the context of building projects. It provides insights into various aspects of project scheduling and their impact on project performance, with responses recorded as percentages, means, and standard deviations. The statements are evaluated on a scale from 1 to 5, with 1 indicating strong disagreement and 5 indicating strong agreement.

Table 4: Respondents views on Automated project task scheduling

Statements	1	2	3	4	5	Mean	Std Dev.
Properly sequenced task scheduling reduces project delays and helps meet deadlines.	0.0%	0.0%	0.0%	52.3%	47.7%	4.48	.502
Inadequate task scheduling leads to resource conflicts and inefficient resource utilization.	0.0%	0.0%	0.0%	44.9%	55.1%	4.55	.500
Tasks assigned to the building project team are specific and well-defined.	0.0%	0.0%	0.0%	39.3%	60.7%	4.61	.491
The project team utilizes Gantt Chart to display the interdependencies between tasks.	0.0%	0.0%	5.6%	41.1%	53.3%	4.48	.604
Scheduling tasks is essential for making the most efficient use of available materials and labor on building projects.	0.0%	0.0%	0.0%	44.9%	55.1%	4.55	.500
There is a concentration of effort and materials along the project's crucial path.	0.0%	0.0%	0.0%	39.3%	60.7%	4.61	.491
Advanced scheduling techniques, such as Critical Path Method (CPM), enhance project predictability.	0.0%	0.0%	0.0%	44.9%	55.1%	4.55	.500

Source: **Primary data**, (2023).

Table 4 indicated that properly sequenced task scheduling significantly reduces project delays and helps meet deadlines. This aligns with the literature review that emphasizes the importance of effective scheduling in project management. The mean score of 4.48 suggests that a majority of respondents (47.7%) agree with this statement, while only 52.3% do not. The relatively low standard deviation of 0.502 indicates a fair level of consensus among respondents.

Second, the data supports the idea that inadequate task scheduling leads to resource conflicts and inefficient resource utilization. The mean score of 4.55, along with a low standard deviation of 0.500, suggests a strong consensus among respondents that improper scheduling can indeed lead to these issues. This finding is consistent with the literature, highlighting the negative consequences of poor scheduling practices.

Third, the findings show that tasks assigned to the building project team are specific and well-defined.

The mean score of 4.61 and a low standard deviation of 0.491 indicate that a significant majority (60.7%) of respondents agree with this statement. This is in line with the literature, emphasizing the importance of clear and well-defined tasks for successful project execution.

The fourth statement discusses the use of Gantt Charts to display task interdependencies. The data reveals a mean score of 4.48, indicating agreement among respondents, and a standard deviation of 0.604, suggesting some variability in responses. This finding aligns with the literature, which often recommends the use of Gantt Charts as a visual tool for managing project tasks.

The fifth statement emphasizes that scheduling tasks is essential for making efficient use of available resources. The mean score of 4.55 and a low standard deviation of 0.500 reflect a consensus among respondents. This is consistent with the literature, which stresses the role of scheduling in optimizing resource allocation.

The sixth statement discusses the concentration of effort and materials along the project's crucial path. The mean score of 4.61 suggests a strong agreement among respondents (60.7%). This is in line with the literature, which emphasizes the importance of focusing resources on critical tasks to prevent project delays.

Finally, the findings indicate that advanced scheduling techniques, such as the Critical Path Method (CPM), enhance project predictability. The mean score of 4.55, along with a low standard deviation of 0.500, reflects a consensus among respondents. This is also supported by the literature, which highlights the effectiveness of advanced techniques like CPM in project planning and control. The findings suggest that proper task sequencing, well-defined tasks, efficient resource utilization, and focusing on crucial project paths are considered important for successful project management. It also highlights the significance of using advanced scheduling techniques. On the other hand, inadequate scheduling practices can lead to resource conflicts and inefficiency. The low standard deviations in most cases indicate a relatively consistent agreement among respondents on these aspects of project management.

Regression Results for Automated project task scheduling

In this analysis, the R Square value is 0.800, which means that 80% of the variance in the dependent variable can be explained by "Automated Project task scheduling." This is a relatively high R Square value, indicating that the predictor variable is a good fit for explaining the variability in the dependent variable.

Table 5: Model summary for Automated project task scheduling

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.895[a]	.800	.798	.10875

a. Predictors: (Constant), Automated Project task scheduling

Source: **Primary data**, (2023).

The regression analysis shows that the model as a whole is statistically significant ($F(1, 105) = 420.902$, $p < .001$). This means that the model's predictors, which include automated project task scheduling, collectively explain a significant amount of the variance in the performance of construction projects.

Table 6: ANOVA results for Automated project task scheduling

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.977	1	4.977	420.902	.000[b]
	Residual	1.242	105	.012		
	Total	6.219	106			

a. Dependent Variable: Performance of construction projects

b. Predictors: (Constant), Automated Project task scheduling

Source: **Primary data**, (2023).

The main predictor variable, "Automated Project Task Scheduling," has a substantial positive effect on the performance of construction projects. The unstandardized coefficient for this variable is 0.999, with a low standard error of 0.049. The standardized coefficient (Beta) for this predictor is 0.895, indicating a strong positive relationship. The t-value is 20.516, and the associated p-value is highly significant at $p < 0.001$. This finding suggests that automated project task scheduling has a significant and positive impact on the performance of construction projects. The Beta value of 0.895 indicates that for every one-unit increase in "Automated Project Task Scheduling," there is an expected increase of 0.895 standard deviations in the performance of construction projects.

Table 7: Coefficient results for Automated project task scheduling

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.017	.222		.076	.940
	Automated Project task scheduling	.999	.049	.895	20.516	.000
a. Dependent Variable: Performance of construction projects						

Source: **Primary data**, (2023).

CONCLUSIONS AND RECOMMENDATIONS

The study's findings demonstrate the positive impact of automated project task scheduling on the performance of construction projects in Rwanda. Through the implementation of automated scheduling tools and techniques, project delays and resource conflicts were significantly reduced, resulting in improved project predictability and an increased likelihood of meeting project deadlines. The use of advanced scheduling techniques like the Critical Path Method (CPM) also played a pivotal role in enhancing project management, aligning with global best practices. Additionally, the emphasis on well-defined tasks and the concentration of effort and resources on critical project paths underline the importance of clear project planning and execution. Overall, the study underscores the potential for automation in project task scheduling to substantially enhance the performance of construction projects in Rwanda, contributing to more efficient resource utilization and successful project outcomes.

Based on the findings of this study, it is strongly recommended that Better Design and Construction Limited and other construction companies in Rwanda consider the adoption of automated project task scheduling as a strategic initiative to enhance project performance. The benefits of automation, including improved efficiency, resource optimization, and real-time monitoring, are evident in the case of Better Design and Construction Limited. However, successful implementation and adaptation to automation require careful planning, training, and addressing potential resistance among project personnel. It is also essential for construction companies in Rwanda to tailor their strategies to the local context, considering factors such as local regulations, labor availability, and project-specific challenges. Embracing technology and data-driven project management practices can significantly contribute to the achievement of more efficient and successful construction projects in Rwanda, aligning with the country's development objectives and contributing to the overall growth of the construction industry.

Suggestions for Further Studies

This study sheds light on the impact of automated project task scheduling on construction project performance in the Rwandan context, focusing on Better Design and Construction Limited. Further research could expand on this topic by investigating the scalability and transferability of automation solutions to other construction companies in Rwanda, considering variations in project types and sizes. Additionally, examining the long-term effects of automated scheduling on project outcomes,

including maintenance and post-construction phases, would provide a comprehensive understanding of its sustainability and lifecycle benefits. Furthermore, a comparative study could explore the differences in the effects of automation in construction project management between Rwanda and other countries with varying economic and regulatory environments. Lastly, in the age of digital transformation, research on the integration of emerging technologies such as artificial intelligence, Internet of Things (IoT), and blockchain in construction project management could open new avenues for enhancing efficiency, transparency, and performance in the Rwandan construction industry.

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