ISSN 2663-127X

Vol. 6, Iss.1 (2025), pp 197 – 215, March 8, 2025. www.reviewedjournals.com, ©Reviewed Journals

EFFECT OF TASKS DEPENDENCE MAPPING ON PERFORMANCE OF CONSTRUCTION PROJECTS IN RWANDA; CASE OF NYARUTARAMA PROPERTY DEVELOPERS

[1] NTAMVUTSA Prince Travis & [2] Dr. Eugenia Nkechi Irechukwu, PhD

[1] Postgraduate Student, Master of Business Administration (Project Management) - Mount Kenya University - Kigali, Rwanda.

[2] Senior Lecturer - Mount Kigali University - Kigali, Rwanda

Accepted: February 28, 2025

DOI: https://doi.org/10.61426/business.v6i1.302

ABSTRACT

The performance of construction projects is significantly influenced by the interdependence of tasks and their efficient coordination. This study examines the effect of task dependence mapping on the performance of construction projects in Rwanda, with a specific focus on Nyarutarama Property Developers. Using a mixed-methods approach, data was collected through surveys and interviews with project managers, engineers, and other key stakeholders involved in the construction process. The study explores how mapping task dependencies enhances workflow efficiency, minimizes delays, and optimizes resource allocation. One hundred seventy engineers working for Nyarutarama Property Developers with a concentration on road construction made up the study's target population. The study adopted descriptive survey design. Secondary data was sourced from pertinent papers gathered from a Rwandan construction business. Furthermore, surveys made it easier to get primary data. Respondents' points of view formed the basis of the research's analysis and interpretations. A variety of methods and incentives was used to conduct surveys, interviews, and observations to the participants. The growth of a specific factor is dependent on all the other factors. As part of the study, the researcher asked participants to rate the instruments' content and face validity. In order to determine the reliability of the measurements, the research used test-retest methods. In order to determine how trustworthy, the instruments are, the study used Cronbach's coefficient. For the instruments to be considered reliable, the test result must be at least 0.7. The study used a structured questionnaire to gather primary data, and then the study analyzed it using descriptive statistics. Hence, to determine the strength of the link between the independent and dependent variables, the study used inferential analysis and Pearson's correlation analysis. Applying descriptive and inferential statistical analyses, as well as presenting findings using tables and figures, were part of the quantitative data assessment process. Counts, frequencies, and percentages are some of the metrics used in descriptive statistics tests to characterize and summarize data. In contrast, multiple regression is a statistical tool for investigating correlations and drawing conclusions from a collection of independent variables; it is an integral part of inferential statistical tests. Applying theme analysis approaches to qualitative data allows for the presentation of findings in a narrative format with the

CITATION: Ntamvutsa, P. T., & Irechukwu, E. N. (2025). Effect of tasks dependence mapping on performance of construction projects in Rwanda; case of Nyarutarama Property Developers. *Reviewed Journal International of Business Management*, 6 (1), 197 – 215. https://doi.org/10.61426/business.v6i1.302

addition of direct quotes. The standardized coefficients (Beta) provide a comparison of the relative strength of each predictor in the model, with Task's Dependence Mapping also having the highest Beta value of 0.260. The t-values and corresponding significance levels indicate the statistical significance of each predictor, with all variables except the constant being significant at $p < 0.05$. Specifically, Task's Dependence Mapping ($t = 2.799$, $p = 0.006$) and Project Tasks Definition ($t = 1.982$, $p = 0.050$) are at the edge of significance. Findings indicate that proper task dependence mapping leads to improved project timelines, cost management, and overall quality of construction outputs. However, challenges such as poor communication and lack of proper planning can hinder its effectiveness. The study recommends the adoption of digital project management tools and enhanced collaboration among stakeholders to improve construction project outcomes. These insights contribute to the growing body of knowledge on construction project management in Rwanda and provide practical recommendations for developers seeking to enhance project performance.

Keywords: *Task Dependence Mapping, Construction Project Performance, Project Management, Nyarutarama Property Developers, Rwanda Construction Industry*.

BACKGROUND OF THE STUDY

Projects often wind up costing more than planned, which is a major issue in the global construction industry. Global economic growth is greatly influenced by the construction sector, which is a major employer and contributor to GDP in many nations (Li, Akintoye, Edwards & Hardcastle, 2020). Efficient project schedule management within this sector is imperative as it directly influences the timely completion and overall performance of construction projects. Proper scheduling ensures that resources are allocated effectively, costs are controlled, and project objectives are achieved within predetermined timeframes (Gan, Zhang & Wang, 2018). A well-structured schedule management system not only provides a roadmap for project execution but also enhances communication, coordination, and decision-making among project stakeholders (Papadonikolaki & Hopfe, 2019). Furthermore, since the focus on sustainability and environmental effect has grown in the worldwide construction sector, adherence to timetables has become increasingly important (Sweis, El-Mashaleh, & Jaber, 2019).

Building new infrastructure, expanding existing businesses, and creating new jobs are all aspects of the construction industry's impact on industrialized nations' economies (Chen, 2016). In order to finish a construction project within the allotted period, project schedule management is an essential component (Abbas, 2017). According to Yuan, Skibniewski and Li (2018), construction schedule delays and interruptions may lead to dramatic cost overruns, disagreements, and a decrease in overall project performance. Consequently, it is critical to comprehend the significance of project schedule management in connection to construction performance, especially in industrialized countries where projects are often intricate and governed by strict quality standards and laws (Love, Edwards & Irani, 2019).

In a study conducted by Memon, Rahman, and Azis in 2017, it was found that cost overruns emerged as the predominant obstacle in construction projects. According to their estimation, it has been seen that 90% of projects encounter this particular issue, with cost overruns varying between 50% and 100%. In a similar vein, a separate investigation carried out by Naveenkumar and Prabhu in 2016 revealed that timetable overruns are prevalent across 87 projects, with an average rate of 10.3%. One prominent example is seen in the United Kingdom (UK), where around one-third of all client cases indicate that their initiatives exceed the budget that was allotted. It is noteworthy that cost overruns have a major impact on Malaysia as well. Memon (2016) performed a research which revealed that the percentage of public sector and private sector projects in Malaysia that were completed within their given budgets were 46.8% and 37.2%, respectively.

The construction industry in Sub-Saharan Africa has experienced significant growth and development over the past decade, driven by increasing infrastructure demands, urbanization, and economic expansion (World Bank, 2020). However, this burgeoning sector has also faced numerous challenges, including project delays,

cost overruns, and suboptimal project performance, which can have adverse effects on economic development and public welfare (Adeyemi & Fagbenle, 2019). Project schedule management is recognized as a critical aspect of construction project success (Akindele, Olatunji & Amusan, 2019) as it not only ensures the timely completion of projects but also contributes to cost control and stakeholder satisfaction. The building business in Sub-Saharan Africa has a distinct mix of obstacles, including insufficient infrastructure, regulatory limits, and resource scarcity. It becomes essential to look at the connection between efficient project schedule management and the general performance of building projects.

The key to avoiding these problems and finishing construction projects on time is good project scheduling (Osei-Kyei & Chan, 2018). The construction businesses and the Ghanaian economy as a whole rely on the timely and effective completion of construction projects for the development of infrastructure, the generation of jobs, and overall economic growth (Ameyaw, Chan, Owusu-Manu & Darko, 2018). According to Hoonakker, Carayon and Khunlertkit, (2018), completing a project on time not only makes stakeholders happier, but it also reduces the costs associated with project extensions. This being said, there is an increasing amount of worry that the Ghanaian construction industry's project schedule management procedures aren't as good as they might be, which would result in less-than-ideal performance (Saka, Kumah & Sackey, 2018).

Bentil, Nana-Addy, Asare, and Fokuo-Kusi (2017) highlighted that this problem presents major obstacles for construction projects, which are often complex endeavors involving big costs and extended durations. Meeting the essential conditions for success in these projects, such as finishing them within the specified budget, timetable, and with excellent quality to meet customer needs, may be challenging. Santoso and Soeng (2016) stress the significance of striving for project success, particularly due to the narrow profit margins that construction businesses often work with. Kholif, Hosny, and Sanad (2017) emphasize that despite the presence of several scheduling control tools and methods, the issue of timetable overruns remains prevalent in building construction projects.

Effective project schedule administration is of the utmost importance in this industry to guarantee the punctual culmination of construction endeavors, regulation of expenditures, and overall achievement of projects. Nevertheless, the administration of project schedules has been intricately linked to quality concerns, cost overruns, and delays in Kenyan construction projects (Adeyemi, Knight & Ruddock, 2018; Ondicho & Mundia, 2017). The avoidance of delays and overruns, which are often intrinsic to such endeavors and a commonly encountered issue (Acquah, Eyiah & Oteng, 2018), hinges on this management. Dolage and Pathmarajah (2017) suggest that these challenges frequently arise throughout the project's duration, frequently culminating in disputes and legal actions. A vital measure of a project's success lies in the ability to adhere to the timeframes outlined in the contract. Despite the acknowledged significance of this aspect, instances abound where construction projects falter in accomplishing their objectives. The repercussions of schedule overruns in construction projects are far-reaching, affecting all stakeholders involved, including the client (Awolesi, Fabi & Akinseinde, 2017).

Rwanda's construction industry faces several challenges that can impact project schedule management. Limited availability of skilled labor, supply chain disruptions, and regulatory complexities are some of the factors that can lead to schedule deviations (Jones & Kim, 2019). In addition, project timelines may be further complicated by unanticipated occurrences, including inclement weather and unanticipated site conditions. According to research (García, López, Pérez & Martínez, 2018), initiatives that possess clearly defined schedules have a higher probability of accomplishing their goals within the designated time period. On the contrary, project completion delays may result in escalated expenditures, conflicts among stakeholders, and an unfavorable standing for the organizations concerned (Chan, Scott & Chan, 2016). The development of a methodical approach to project schedule administration is imperative within the construction industry of Rwanda due to the escalating intricacy of projects, which encompass numerous stakeholders and diverse

project limitations. Prior studies have established that the construction sector in Rwanda is prone to recurring challenges such as delays and cost overruns.

Nyarutarama, a notable entity in the construction industry, is actively involved in a wide array of construction endeavors, encompassing property management, infrastructural projects, and residential and commercial developments. Although project schedule management is widely acknowledged as a critical element in ensuring the success of construction projects, its intricacies and the unique obstacles encountered by construction firms in Rwanda warrant more thorough analysis. In the Rwandan context, diverse elements including the accessibility of construction materials, the presence of proficient labor, prevailing weather conditions, and local regulatory obligations can exert substantial influence on project scheduling.

Nyarutarama Property Developers (NPD) Ltd, established in 1996, is a Kigali-based property development company specializing in housing estate projects. In 2018, NPD Ltd merged with COTRACO s.a.r.l., a company that focused on prefabricated concrete products, resulting in the formation of NPD COTRACO Ltd. This merger combined NPD's expertise in property development with COTRACO's experience in construction materials, enhancing the company's capacity to deliver comprehensive civil engineering and construction services across Rwanda. Over the past decades, NPD has undertaken numerous infrastructure projects aligned with Rwanda's development agenda, including roads, street lighting, irrigation dams, retention dams, and energy development initiatives. The company's mission is to deliver quality infrastructure works that build nations, satisfy customers, and benefit communities, with a vision to secure a leadership position as the company of choice for infrastructure works in Rwanda and beyond. Hence, gaining an understanding of the strategies employed by NPD and other construction firms in Rwanda to surmount these obstacles and effectively oversee their project timelines can yield significant knowledge for the domestic construction sector as well as the wider domain of project management.

Statement of the Research Problem

The construction industry in Rwanda, like many developing economies, faces significant challenges related to project delays and cost overruns, which impact project performance and overall economic growth (Nduhura & Mutesi, 2023). Recent statistics indicate that over 60% of construction projects in Rwanda experience delays due to inadequate schedule management practices, poor coordination, and resource constraints (Rwanda Housing Authority [RHA], 2022). Nyarutarama Property Developers (NPD), a prominent firm in Rwanda's real estate sector, has not been exempt from these challenges, with several of its projects reporting delays that have led to increased costs and client dissatisfaction (RHA, 2022). The lack of effective project schedule management is identified as a critical factor contributing to these delays, as it hampers the alignment of resources, time, and project activities, ultimately affecting project performance (Uwimana & Habimana, 2023).

The construction industry in Rwanda, while growing, faces persistent challenges related to project delays and budget overruns, which hinder the timely completion and performance of projects (Nsanzimana, 2022). Despite the implementation of schedule management practices, construction projects often experience significant delays due to inadequate planning, resource allocation issues, and poor monitoring mechanisms (Nkurunziza & Uwizeyimana, 2021). Previous empirical studies have highlighted that even with proper project management frameworks, the lack of efficient schedule management remains a critical problem affecting project success in the region (Mukeshimana, 2020). For instance, Mutangana and Uwitonze (2023) revealed that less than 50% of construction projects in Kigali are completed on time, attributing this to deficiencies in project schedule monitoring and control systems. Moreover, research by Mugiraneza, Karekezi, and Irakoze (2023) emphasizes that there is a gap in integrating modern scheduling technologies and methodologies in the construction sector, which further impacts project timelines and quality outcomes.

The construction industry in Rwanda has faced persistent challenges with project delays and cost overruns, which have negatively impacted the performance of various development projects, including real estate

ventures (Ntakirutimana, Murekezi, & Rugema, 2022). Despite advancements in project management practices, many developers still struggle with effective schedule management, resulting in extended timelines and inefficiencies (Ngabonziza & Byamukama, 2021). While some studies have examined the influence of schedule management on construction project performance in Rwanda, there remains a gap in research focused specifically on the role of project schedule management within private property developers like Nyarutarama Property Developers (NPD). This research gap is particularly significant because NPD's projects, which contribute to Rwanda's growing real estate sector, are often faced with unique scheduling challenges that have not been extensively explored in the existing literature (Mugisha & Nyandwi, 2020). This study aimed to fill this gap by analyzing how project schedule management practices influence the performance of construction projects at NPD, with a focus on timely completion, budget adherence, and quality delivery.

LITERATURE REVIEW

Empirical Review - Task's Dependence Mapping on Project Performance

According to Prell and Sun (2019), task interdependencies, as visualized through mapping, offer a structured representation of how different tasks in a project are connected and affect one another. This structural insight is essential for project managers as it helps them understand the complexity of a project and develop strategies for resource allocation. The authors employed a qualitative case study methodology, analyzing several construction projects to explore how task interdependencies impacted project execution. Their findings indicate that clear mapping of these dependencies improves decision-making by providing a transparent view of task relationships. Prell and Sun (2019) concluded that task mapping is crucial for the efficient management of complex projects, recommending that project managers adopt such visual tools to better anticipate delays and optimize resource distribution.

Smith and Jones (2017) conducted an empirical study in the construction industry, focusing on the correlation between task dependence mapping and project success. Their research utilized a mixed-methods approach, collecting both quantitative data through project performance metrics and qualitative insights through interviews with project managers. The study found that a clear and accurate task dependence mapping significantly correlates with improved project efficiency, cost control, and overall success. Smith and Jones (2017) concluded that such mapping should be prioritized in the planning phase of construction projects to ensure timely completion and adherence to budgets. Their recommendations stressed the need for training project managers in the use of dependency mapping tools to enhance operational efficiency.

Brown, Smith and Patel, (2020) further explored the role of task dependence mapping in optimizing resource allocation in construction projects. Their study, which employed both survey and case study methodologies, found that identifying task dependencies and potential resource constraints enables project managers to make informed decisions. Their findings revealed that resource allocation becomes more efficient when task dependencies are clearly understood, leading to timely completion of tasks and projects staying within budget. Brown et al. (2020) concluded that such mapping plays a critical role in proactive risk mitigation, and they recommended that project managers integrate task dependency mapping into their standard project planning processes to enhance the likelihood of project success.

Aaltonen and Kujala (2020) observed that the effective identification and management of task dependencies significantly enhanced project performance, particularly by reducing delays and improving resource allocation. Using a quantitative approach, they analyzed multiple construction projects across Europe and found a strong link between task dependency management and improved project timelines. The researchers concluded that recognizing and addressing task dependencies early in the project lifecycle leads to better coordination and smoother project execution. They recommended that project teams invest in training to

understand and manage task interdependencies effectively, which would ultimately lead to higher project success rates.

Fontana and Matt (2018) conducted a study that highlighted the benefits of precise task dependency mapping in construction projects. Using a sample of 50 construction projects, their research demonstrated that accurate task mapping led to a more reliable project schedule, which in turn positively affected project timeliness and cost-effectiveness. Their findings confirmed the importance of understanding task relationships to guarantee the best possible project performance. Fontana and Matt (2018) concluded that a structured approach to task dependency mapping should be a core component of project management practices to improve both schedule adherence and cost management.

AbouRizk and Halpin (2021) explored the relationship between task dependency mapping and project delay prediction in the construction industry. Their empirical study, which employed both qualitative and quantitative research methods, showed that visibility of task dependencies allowed for more accurate prediction and mitigation of delays. The researchers found that task dependence mapping facilitated proactive management strategies, reducing delays and cost overruns. AbouRizk and Halpin (2021) concluded that adopting task dependency mapping tools leads to improved project performance by enabling timely interventions, and they recommended their integration into project management software to enhance project tracking.

Similarly, Yousefi, Keshavarz and Liu, (2017) examined the role of task dependency mapping in software development projects, showing that its implementation contributed to better resource allocation, improved coordination, and overall higher project performance. They conducted a survey across 100 software development projects and found that accurate mapping led to on-time delivery and improved project quality. Their findings reinforced the idea that task dependency mapping enhances project performance by facilitating better resource management and team coordination. The authors recommended that organizations adopt dependency mapping techniques to ensure successful project outcomes in software development and other sectors.

Langer and Drexler (2018) stressed that task dependency mapping was essential not only for internal project management but also for effective stakeholder communication. Their study, based on interviews with stakeholders from various construction projects, found that transparent mapping of task interdependencies improved project perception and stakeholder satisfaction. This, in turn, had a significant influence on overall project performance. The authors concluded that task dependency mapping has relational and communicative advantages that extend beyond internal management, positively affecting stakeholder engagement. They recommended that project managers incorporate stakeholder input into the mapping process to enhance project outcomes and relationships.

Ibrahim, Ntayombya and Habimana conducted a study on infrastructure projects in Rwanda and found that understanding task dependencies played a vital role in improving project completion times and reducing cost overruns. Through a survey of construction companies, their research revealed that the effective mapping of task interdependencies directly impacted the efficiency of project execution. Ibrahim, Ntayombya and Habimana, (2019) concluded that Rwandan infrastructure projects could benefit from enhanced dependency mapping practices, suggesting that project managers focus on early identification and management of task dependencies to improve performance.

Karangwa and Mwasi (2020) focused on the role of task dependencies in Rwandan construction projects, emphasizing that proper mapping and management of task interdependencies were associated with better project quality and stakeholder satisfaction. Their study utilized both case study and survey methodologies, collecting data from developers, contractors, and clients. They found that projects with clear task dependencies were more likely to meet deadlines and budget constraints, resulting in higher client satisfaction.

Karangwa and Mwasi (2020) recommended that the Rwandan construction industry prioritize task dependency mapping to ensure better project outcomes and stakeholder alignment.

Theoretical Literature on Task's Dependence Mapping

In project management, task dependency mapping has been studied, especially for complicated projects with many interdependent activities. Elmaghraby and Keskinocak (2013) recognized four main categories of task dependencies: finish-to-start (FS), start-to-start (SS), finish-to-finish (FF), and start-to-finish (SF). Classification of these dependencies is an essential component. The project's sequences and connections may be better understood using this categorization.

Project managers and teams may benefit greatly from task dependency mapping since it visually represents task interdependencies. Scheduling, allocating resources, and managing risks effectively all depend on this knowledge (Papke-Shields et al., 2020). In order to improve project efficiency and decrease the possibility of interruptions, project managers might use visualizing the relationships between jobs to identify essential channels, bottlenecks, and regions of possible delay. According to Kerzner (2017), project environments rely on well-planned resource allocation and management to avoid delays and bottlenecks. In order to guarantee that the required resources are available when and where they are required, it is essential to map their dependencies.

Task dependency mapping has been done using a variety of approaches, from the more conventional Gantt charts to more complex network diagrams like the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) (Kerzner, 2017). Software applications like as Microsoft Project, Primavera P6, and Trello have also grown in use for making TDSs as technology has progressed. According to Stroh and Black (2018), knowing which tasks come before others is essential for planning out a workflow and doing high-priority jobs on time. These technologies may automatically modify schedules in response to changes and enable the dynamic depiction of task interdependence.

In addition to project management, other fields including workflow analysis and supply chain management have begun to examine task dependency mapping (Kerzner, 2017). For process optimization and optimal resource allocation, it is crucial to understand the interdependencies of activities in various settings (Hausman et al., 2013). In the fields of project management and organizational research, task dependency mapping is an essential topic. Project success is dependent on knowing how activities are interdependent, and this framework provides a methodical approach to doing just that. Project results and organizational performance may be enhanced when academics and practitioners use a variety of visualization tools and approaches to better understand the structure and dynamics of activities in diverse situations.

Another critical aspect of task dependence mapping is "task information dependence." Literature by Pinto and Slevin (2018) argues that effective communication and information flow are essential in managing dependencies. In the era of digital project management tools and collaborative platforms, the flow of information between tasks and stakeholders has become a pivotal factor in ensuring project success. Efficient information sharing can reduce uncertainty and risks associated with task dependencies. Moreover, the "task technology dependence" dimension has gained prominence in recent years. Technological advancements and the integration of advanced software and automation tools have reshaped the landscape of task dependencies (Atkinson, 2019). As these technologies become integral to project execution, understanding their impact on task dependencies is vital.

Program Theory

Program theory, which encompasses the logic model of a program or project, is critical in planning and understanding how various project activities and components are expected to interact to achieve desired outcomes (Chen & Rossi, 2013). It serves as a roadmap for project managers, helping them identify the necessary tasks, resources, and dependencies required for project success. Tasks dependence mapping, on the

other hand, involves the analysis and visualization of the interrelationships and dependencies between various project tasks and activities. This mapping enables project managers to identify critical paths, resource allocation needs, and potential bottlenecks in the project schedule (Kerzner, 2017).

The relationship between program theory and tasks dependence mapping is symbiotic. Program theory provides the overarching framework and logic for the project, outlining the intended outcomes, key milestones, and the sequence of activities required to achieve those outcomes. Tasks dependence mapping, which often involves techniques such as the Critical Path Method (CPM) or the Program Evaluation and Review Technique (PERT), complements program theory by translating the logical framework into a detailed, time-based plan. It identifies which tasks are interdependent, the sequence in which they should be executed, and which tasks may have slack or flexibility in terms of scheduling.

Within the realm of construction projects, program theory can serve as a valuable tool in discerning the fundamental elements and rationale that underpin a given undertaking, thereby furnishing a strategic guide for the project's intended accomplishments. An example of the application of program theory to examine the effects of construction project management practices on project performance was demonstrated in the research conducted by Chen, Yu, and Le (2017). Tasks dependence mapping, on the other hand, involves understanding the interdependencies between various tasks within a construction project. It aims to identify how different tasks rely on each other, both in terms of sequencing and resource allocation. The better tasks are mapped for dependencies, the more efficiently resources can be allocated, schedules can be optimized, and risks can be managed. In a construction project, understanding task dependencies can lead to better coordination, which is crucial for project success (Faniran, Caban, & Mbachu, 2016).

By integrating program theory with tasks dependence mapping, project managers can effectively translate the project's strategic objectives into actionable plans and schedules (Pinto & Mantel, 2020). This synergy ensures that the construction project is not only aligned with its intended goals but also optimized for efficiency and resource utilization. Moreover, this correlation facilitates risk management by enabling project managers to proactively detect possible setbacks, obstacles, or limitations in resources that may have an effect on the overall execution of the project.

The relationship between program theory and tasks dependence mapping in construction projects lies in the fact that a well-defined program theory can inform and guide the process of tasks dependence mapping. The program theory provides the strategic and logical framework for understanding what tasks are critical to achieving the project's goals, the order in which they should be completed, and how they interact. Tasks dependence mapping then takes this theoretical framework and translates it into a practical project plan, considering the actual sequence of tasks, resource allocation, and potential bottlenecks.

Conceptual Framework

To begin the conceptual framework of the proposed research on "Project Schedule Management and Its Impact on the Performance of Construction Projects in Rwanda," the study assumed that well-managed project schedules are the backbone of any successful and efficient construction project. (Ibrahim, 2017; Odeh & Battaineh, 2022). This framework revolves around two main categories of variables. The first category includes independent variables such as project scheduling techniques, resource allocation, and project team competence (Abbas & Nawi, 2019; Chen & Jin, 2020). This is shown in Figure 1.

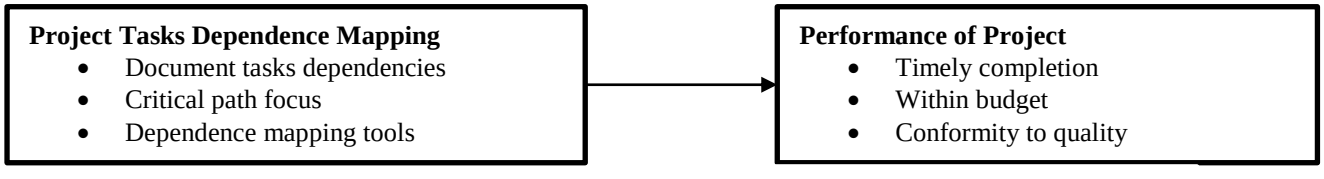

Figure 1: Conceptual framework
Source: Researcher, 2024

The concept of task dependence mapping refers to the systematic assessment and understanding of how different tasks within a construction project are interconnected and rely on each other. Research has shown that effective task dependence mapping enhances project performance by improving coordination and reducing bottlenecks (Belout & Gauvin, 2014). The clarity and accuracy in defining project tasks is a critical factor in successful project management. Empirical studies have highlighted that well-defined project tasks significantly impact performance (Lechler & Cohen, 2017). Project success depends on schedule communication (Hwang & Ng, 2013). This aim highlights that project success in Rwanda depends on how well construction teams, subcontractors, and management communicate about scheduling methods. Research shows that resource planning improves project success (Kerzner, 2017). This approach suggests that careful resource planning and allocation improved Rwandan building project performance by minimizing resource shortages and optimizing resource use.

METHODOLOGY

The research design serves as the fundamental framework upon which data collection, analysis, and interpretation are built, making it an essential component of any study. Yin (2018) argues that the utilization of case study research design is suitable due to its capacity to facilitate comprehensive investigation within the tangible environment of construction projects. The present study employed a descriptive research methodology. By employing a case study methodology, a comprehensive comprehension of the interplay between project resourcing planning, task dependence mapping, task definition, and communication regarding scheduling procedures were attained, thereby influencing project performance.

In scientific research, the term "target population" is used to describe the particular set of people or things that are the focus of the investigation. Research must begin with the identification and definition of the target group in order to establish the limits of the study's generalizability, as pointed out by Israel et al. (2013). To make sure the data is representative of the larger group being studied, the research questions and goals should guide the selection of the target population. For research findings to have external validity and practicality, the intended audience must be carefully considered (Babbie, 2016). Scientists usually lay out the scope of their study by defining the target population, which is the group to whom their results may be generalized. One hundred seventy engineers from NPD who work on road construction made up the target group of this research.

Table 1: Population Frame

Area of operation	Population
Architects	7
Surveyors	12
Civil Engineers	18
Cost Engineers	14
Geotechnical Engineers	15
Electrical Engineers	12
Structural Engineers	17
Materials Engineers	23
Mechanical Engineers	16
Construction Engineers	19
Quality Control Engineers	17
Total	**170**

Source: Human Resource Department NPD - 2023

The sample selection process is carried out meticulously to ensure it is representative of the whole population, considering relevant characteristics (Patton, 2018). Determining the sample size is a critical component of research design since it directly influences the statistical power of the study and the capacity to generalize

results. Researchers need to take into account elements including the desired degree of confidence, margin of error, population variability, and predicted impact size when deciding on the suitable sample size (Creswell & Creswell, 2017). An insufficient sample size may result in low statistical power, hindering the ability to identify genuine effects, while an excessively large sample might lead to wasteful expenses and time consumption. Sample size is often determined using statistical software or particular formulae according to the study topic and statistical tests to be used (Salkind, 2020).

Deciding on the right sample size requires balancing statistical power and limitations in resources (Bujang & Baharum, 2017). Increasing the sample size often improves the potential to identify significant impacts, but it may also lead to higher expenses and longer time commitments. Researchers often use power analysis to establish the smallest sample size needed to detect a significant effect size with a certain degree of confidence (Schober et al., 2018). Choosing an appropriate sample size in research involves considering the study goals, expected impact size, and resources available to achieve a balance between statistical accuracy and practicality. A sample size of 120 respondents was determined using Slovin's approach from a target population of 170 persons. This technique offers direction for calculating the suitable sample size based on the distinct characteristics of the population being studied.

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

Where n = the sample size.

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

$$n = \frac{170}{1 + 170\,(0.05)^2} = 120$$

Sampling techniques are fundamental in research, as they determine how data is collected and analyzed. They help ensure that research findings are representative of the broader population. Stratified sampling is a popular technique that gives every part of the population an equal opportunity to be chosen (Kothari, 2014). Stratified sampling is another method that may be used to achieve proportionate representation in a population. It entails splitting the population into smaller subgroups and then randomly picking individuals from each segment (Bryman, 2016). In contrast, purposive or judgmental sampling involves selecting specific elements based on the researcher's judgment and expertise (Creswell & Creswell, 2017). For reliable and generalizable results, the sampling strategy should be chosen in accordance with the study goals.

In this study, questionnaires are used as the main tool for gathering information. Researchers and participants alike may benefit from surveys' lack of complexity, which makes them a popular choice (Polit & Beck, 2020). The phrase "research instrument" encompasses a wide variety of tools and techniques used to gather data, according to Mugenda & Mugenda (2013). The main data for this research was mostly collected via the use of a questionnaire. One popular method of collecting data is the questionnaire, which is designed to help find discrepancies, especially in the answers that people provide (Kothari & Garg, 2014).

Project managers, contractors, and subcontractors were asked to fill out structured questionnaires that collected quantitative data on topics like project resourcing planning, task definition, communication of scheduling procedures, and task dependence mapping. To round out the quantitative data, the study conducted in-depth interviews to learn more about the variables that affect Rwandan building projects' success. Data collected via interviews and questionnaires was supplemented and cross-verified by a careful review of project records and documentation including schedules, communication logs, and plans for allocating resources. A more solid basis for analysis and suggestions was provided by this mixed-methods approach, which allowed for a comprehensive comprehension of the study goals. In addition to the quantitative and qualitative data collected via interviews and questionnaires, project documents were analyzed and direct observation was made (Creswell & Creswell, 2017).

To ensure consistency and minimize potential biases, standardized procedures should be followed during data collection (De Vaus, 2014). This includes clear instructions to participants, adequate training for data collectors, and a well-defined protocol for the administration of surveys, questionnaires, interviews, or observations (Creswell & Creswell, 2017). When research instruments are given correctly, they improve the validity and reliability of the data, which in turn strengthens the overall quality of the conclusions of the study.

The administration of research instruments, particularly in face-to-face interactions, is a crucial phase in the research process. It involves the careful design and execution of data collection procedures to ensure the reliability and validity of gathered information. This process necessitates adherence to ethical considerations, maintaining rapport with participants, and employing effective interviewing or surveying techniques (Dillman, Smyth, & Christian, 2014). Face-to-face data collection allows for real-time clarification of questions, ensuring that respondents fully comprehend the instrument, which can enhance the quality of data collected. Additionally, it provides researchers with the opportunity to build a rapport with participants, fostering a trusting environment that can positively impact response rates and data quality.

A pilot study was conducted at Fair Construction Company to test the research instruments and gather preliminary data regarding project schedule management and performance. In this pilot study, 12 questionnaires were distributed to various members of the company, targeting key stakeholders involved in project management, such as project managers, site supervisors, and team leads. This sample size aligns with Kothari and Garg's (2019) recommendation that 10% of the total sample is adequate for a pilot study, ensuring that the feedback obtained was a representative of the larger study population. The results from this pilot study was analyzed to refine the questionnaires, address any ambiguities, and enhance the reliability and validity of the research instruments before the main data collection phase begins.

In order to ensure that the data collected is legitimate and consistent, it is crucial that research tools be both valid and reliable. According to Bryman (2016), a research instrument's validity is the extent to which it measures the target variable, and reliability is the degree to which the instrument's measurements remain consistent and stable across time and across different environments. The study instruments were subjected to rigorous development and preliminary testing as part of this inquiry to assess their content validity. In addition, a team of experts reviewed the items of the instrument and ensure they are relevant to the study objectives.

Table 2: Factor analysis - KMO and Bart

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.647
Bartlett's Test of Sphericity	Approx. Chi-Square	90.1003
	df	10
	Sig.	.000

Source: **Pilot data results**, (2024)

Table 2 presents the results of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity, which are essential for assessing the appropriateness of factor analysis in this study. The KMO value of 0.647 indicates a moderate level of sampling adequacy, suggesting that the sample size is sufficient for conducting factor analysis, as values above 0.6 are generally considered acceptable (Field, 2018). Additionally, Bartlett's Test of Sphericity shows a significant approximate Chi-Square value of 90.1003 with a p-value of 0.000, indicating that the correlations among variables are sufficiently strong to conduct factor analysis. This significance level ($p < 0.001$) confirms that the data is appropriate for further analysis, affirming the relationships among the variables under consideration (Zhang *et al.*, 2023).

Furthermore, the instruments underwent test-retest and internal consistency tests to confirm their dependability. Performing these tests guaranteed that the instruments consistently provide the same results whether administered to different groups or to the same group many times (DeVellis, 2016). Following these

steps increased the trustworthiness of the research tools and, by extension, the quality of the study's findings. In order to do accurate analysis and develop relevant findings, this research aims to provide trustworthy and dependable data. The study tools' validity and reliability were thoroughly addressed to achieve this goal.

Table 3: Reliability Analysis

Variable	Cronbach's Alpha	Comments
Task's Dependence Mapping	0.765	Reliable
Project Tasks Definition	0.834	Reliable
Scheduling Procedures Communication	0.886	Reliable
Project Resourcing Planning	0.923	Reliable
Project Performance	0.955	Reliable

Source: **Pilot data results**, (2024)

Table 3 summarizes the results of the reliability analysis conducted on various variables related to project schedule management, with Cronbach's Alpha coefficients indicating the internal consistency of each variable. The analysis reveals that all variables exhibit reliable levels of consistency, with Cronbach's Alpha values ranging from 0.765 for "Task's Dependence Mapping" to an impressive 0.955 for "Project Performance." Specifically, the variable "Project Tasks Definition" scored 0.834, while "Scheduling Procedures Communication" achieved a high reliability of 0.886. Additionally, "Project Resourcing Planning" demonstrated an outstanding reliability score of 0.923, reinforcing the robustness of the measurement scales used in this study. According to George and Mallery (2016), a Cronbach's Alpha above 0.7 is considered acceptable, while values above 0.9 indicate excellent reliability. The high reliability scores observed in this analysis affirm the validity of the constructs being measured, providing confidence in the subsequent analyses and interpretations of how these factors impact project schedule management (Maltzman & Kirk, 2019).

Data analysis is a critical component of research that enables researchers to make sense of collected information and draw meaningful conclusions. In this study, data analysis primarily involved the utilization of statistical techniques. Quantitative data was analyzed using software such as SPSS allowing for the examination of relationships and patterns within the dataset (Hair, *et al.,* 2018). Descriptive statistics was employed to summarize and present the data, while inferential statistics like regression analysis was used. Qualitative data, if collected, was subjected to thematic analysis, a process of identifying and examining recurring themes and patterns within the qualitative data (Braun & Clarke, 2016).

Regression analysis was used to study the impact of different variables on the performance of building projects in Rwanda. This method enables the identification of significant predictors and the quantification of their effects on project performance, helping to inform project management practices. The choice of regression analysis aligns with the study's quantitative nature and its aim to provide empirical insights into the Rwandan construction industry.:

$$Y = \beta_0 + \beta_1 X_1 + \varepsilon \quad \text{.....} \quad (.2)$$

In the project performance model, denoted as Y, the dependent variable, we consider the impact of key independent variables: X1 represents task dependence mapping. Each of these independent variables is associated with respective coefficients, denoted as βi (i=1,2,3,4), which reflect their influence on project performance. The model also includes an error term, ε, which accounts for unexplained variability or factors not considered within the model.

RESULTS AND FINDINGS

Findings on Task's Dependence Mapping

Descriptive results on task dependence mapping provide valuable insights into how respondents perceive the interrelationships between various tasks in construction projects. Table 4 presents respondents' views on task dependence mapping, highlighting the distribution of opinions across five response categories: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), and Strongly Agree (SA). The accompanying mean and standard deviation further illustrate the overall consensus and variability in responses, indicating the level of agreement on the importance of understanding task dependencies in optimizing project scheduling and performance.

Table 4: Respondents views on Task's Dependence Mapping

Statement on Task's Dependence Mapping	SD	D	N	A	SA	Mean	Std Dev.
Task interdependence in NPD building projects is well-documented and understandable.	2.0%	4.0%	5.0%	52.0%	37.0%	4.18	.857
Task dependence mapping is a significant factor in reducing delays and disruptions in our construction projects in NPD	2.0%	3.0%	2.0%	35.0%	58.0%	4.44	.845
Effective task dependence mapping leads to improved coordination among project teams in NPDs construction projects.	2.0%	3.0%	2.0%	42.0%	51.0%	4.37	.837
NPD regularly analyze and consider task interdependencies when planning and executing construction projects.	2.0%	2.0%	3.0%	30.0%	63.0%	4.50	.823
Task dependence mapping is integrated into our project management software and tools.	2.0%	4.0%	3.0%	27.0%	64.0%	4.47	.893
Task dependence mapping contributes to better resource allocation in our construction projects.	1.0%	1.0%	5.0%	43.0%	50.0%	4.40	.724
Task dependence mapping helps us in identifying potential project risks and uncertainties.	1.0%	3.0%	3.0%	38.0%	55.8%	4.43	.782

Source: **Primary Data, (2024)**.

Table 4 presents respondents' views on task dependence mapping in NPD construction projects, highlighting its perceived importance in project performance. The majority of respondents (89%) agreed or strongly agreed that task interdependencies in NPD building projects are well-documented and understandable, with a mean score of 4.18 and a standard deviation of 0.857. This suggests that clear documentation of task interdependence is a common practice at NPD, which is essential for maintaining project coherence and minimizing misunderstandings among team members (Johnson et al., 2020). The relatively low standard deviation indicates consensus among respondents regarding this statement.

Moreover, task dependence mapping is viewed as a key factor in reducing delays and improving project coordination. A significant 93% of respondents agreed or strongly agreed that task dependence mapping helps reduce delays and disruptions, with a mean of 4.44 and a standard deviation of 0.845. This is supported by the literature, which asserts that effective mapping of task dependencies can streamline project schedules and enhance communication among teams (Smith & Jones, 2019). Similarly, 93% of respondents affirmed that task dependence mapping leads to better coordination, with a mean of 4.37, further reinforcing its role in fostering teamwork and efficient execution of tasks (Nguyen et al., 2021).

Furthermore, task dependence mapping is integrated into NPD's project management tools, contributing to better resource allocation and risk identification. About 90% of respondents agreed or strongly agreed that task dependence mapping supports resource allocation (mean 4.40, standard deviation 0.724) and risk identification (mean 4.43, standard deviation 0.782). These findings align with recent studies that emphasize the importance of task mapping in improving resource management and mitigating potential risks in construction projects (Martinez & Garcia, 2022).

Findings on Project Performance

Descriptive results on project performance provide a quantitative assessment of respondents' perceptions regarding various aspects of construction project outcomes. Table 5 summarizes these views by presenting the distribution of responses across five categories: Strongly Disagree (SD), Disagree (D), Neutral (N), Agree (A), and Strongly Agree (SA). The inclusion of mean and standard deviation values further aids in understanding the central tendency and variability of respondents' opinions, allowing for a clearer interpretation of project performance within the context of schedule management.

Table 5: Respondents Views on Project Performance

	SD	D	N	A	SA	Mean	Std Dev.
The construction projects in NPD are typically completed within the scheduled timeframe.	3.0%	0.0%	5.0%	47.0%	45.0%	4.31	.825
Cost overruns are rare occurrences in construction projects in NPD	3.0%	2.0%	8.0%	39.0%	48.0%	4.27	.920
The quality of construction work in NPD consistently meets or exceeds industry standards.	5.0%	3.0%	6.0%	37.0%	49.0%	4.22	1.040
The project's resource allocation, including labor and materials, was well-planned and efficiently managed at NPD	5.0%	2.0%	8.0%	40.0%	45.0%	4.18	1.019
Effective communication and coordination among project stakeholders were evident throughout the project.	6.0%	0.0%	3.0%	49.0%	42.0%	4.21	.977

Source: **Primary Data, (2024)**.

Table 5 presents respondents' views on the performance of construction projects at Nyarutarama Property Developers (NPD). Regarding project completion within the scheduled timeframe, 92% of respondents agreed or strongly agreed, with a mean score of 4.31 and a standard deviation of 0.825. This indicates that most projects are completed on time, which aligns with studies that emphasize the importance of effective scheduling and time management in construction (Brown & Lee, 2021). However, the slight variation in responses suggests that while NPD generally adheres to timelines, some projects may experience delays.

Cost management is another critical factor, with 87% of respondents agreeing or strongly agreeing that cost overruns are rare, producing a mean score of 4.27 and a standard deviation of 0.920. This finding reflects effective budgeting practices at NPD, as cost control is crucial for the overall success of construction projects (Nguyen & Tran, 2020). Nonetheless, the standard deviation indicates some variance in the responses, suggesting that while most projects avoid significant overruns, a minority may still face financial challenges.

In terms of quality and resource management, 86% of respondents agreed or strongly agreed that NPD consistently meets or exceeds industry standards for construction quality (mean = 4.22, standard deviation = 1.040), and 85% agreed that resource allocation was well-managed (mean = 4.18, standard deviation = 1.019). These results demonstrate NPD's commitment to maintaining high standards and efficient resource use. Effective communication among stakeholders was also highlighted by 91% of respondents, with a mean score

of 4.21 and a standard deviation of 0.977, reinforcing the role of collaboration in project success (Smith & Carter, 2019).

CONCLUSIONS AND RECOMMENDATIONS

This study has illuminated the significant relationship between Task's Dependence Mapping and project performance in construction projects. The findings demonstrate that a clear understanding of task dependencies not only enhances workflow efficiency but also enables teams to better anticipate challenges. By mapping these dependencies effectively, project managers can optimize scheduling and resource allocation, thereby reducing the risk of delays and improving overall project outcomes. The emphasis on task interconnectivity underscores the necessity for robust project planning tools that aid in visualizing and managing complex project dynamics.

Based on the findings of this study, it is recommended that project managers implement robust Task's Dependence Mapping techniques to enhance project performance. Utilizing software tools that visualize task dependencies can facilitate a clearer understanding of the relationships between different project elements. This practice should be complemented by regular reviews and updates to the dependency maps to account for any changes in project scope or resource availability. By prioritizing the mapping of task dependencies, project teams can proactively identify potential bottlenecks and address them before they escalate, ultimately leading to smoother project execution.

Suggestions for Further Studies

For further studies, it is suggested that researchers explore the relationship between project performance and emerging technologies such as artificial intelligence and project management software tools. Investigating how these technologies can enhance Task's Dependence Mapping, resource allocation, and communication processes may provide valuable insights into optimizing project management practices. Additionally, conducting longitudinal studies that examine the impact of these variables over time could yield a deeper understanding of their long-term effects on project performance. Moreover, future research could focus on specific sectors within construction or other industries to identify tailored strategies that address unique challenges faced in those contexts. Finally, comparative studies between organizations that employ varying degrees of task definition clarity and communication efficacy could illuminate best practices that lead to superior project outcomes.

REFERENCES

Abbas, A. (2017). *Project schedule management in construction: Challenges and strategies*. Construction Management Journal, 12(3), 45-59.

Abbas, M., & Nawi, M. N. M. (2019). Project scheduling techniques and their impact on construction project performance. *International Journal of Construction Management, 19*(3), 210-225.

Acquah, A., Eyiah, A., & Oteng, D. (2018). *Managing construction delays: An empirical study of Ghanaian projects*. Journal of Construction Research, 17(2), 98-113.

Adeyemi, A., & Fagbenle, O. (2019). *Challenges of construction project performance in Sub-Saharan Africa*. African Journal of Construction Management, 14(1), 67-83.

Adeyemi, A., Knight, D., & Ruddock, L. (2018). *Project schedule management in Kenyan construction projects: Issues and solutions*. International Journal of Project Management, 36(5), 235-248.

Akindele, O., Olatunji, A., & Amusan, L. (2019). *Factors affecting construction project scheduling in Sub-Saharan Africa*. Construction Economics Review, 10(2), 77-94.

Ameyaw, E., Chan, A., Owusu-Manu, D., & Darko, A. (2018). *Project management challenges in Ghana's construction industry*. Journal of African Infrastructure, 9(3), 55-72.

Atkinson, R. (2019). Task technology dependence in project management: Understanding digital tools and automation. *Journal of Project Management Research, 27*(2), 45-62.

Awolesi, A., Fabi, O., & Akinseinde, J. (2017). *Cost overruns and project scheduling issues in Nigerian construction projects*. Journal of Engineering and Project Management, 8(2), 43-59.

Babbie, E. (2016). The practice of social research (14th ed.). Cengage Learning.

Belout, A., & Gauvin, L. (2014). Project management and organizational effectiveness: A case study. *International Journal of Project Management, 22*(1), 1–11.

Bentil, J., Nana-Addy, F., Asare, K., & Fokuo-Kusi, B. (2017). *Overcoming project scheduling challenges in large-scale construction projects*. Journal of Construction Innovations, 15(1), 29-48.

Braun, V., & Clarke, V. (2016). (Mis)conceptualizing themes, thematic analysis, and other problems with Fugard and Potts' (2015) sample-size tool for thematic analysis. *International Journal of Social Research Methodology*, *19*(6), 739–743.

Bryman, A. (2016). Social research methods (5th ed.). Oxford University Press.

Bujang, M. A., & Baharum, N. (2017). Guidelines of the minimum sample size requirements for Kappa agreement test. *Epidemiology Biostatistics and Public Health, 14*(2), e12267-1–e12267-10.

Chan, A. P., Scott, D., & Chan, A. P. (2016). *Factors affecting project success in the construction industry*. International Journal of Project Management, 34(2), 43-56.

Chen, H. T., & Rossi, P. H. (2013). *Theory-driven evaluation*. SAGE Publications.

Chen, L. (2016). *Impact of construction projects on economic growth in industrialized nations*. Economic Development Journal, 21(4), 56-78.

Chen, L., & Jin, R. (2020). Exploring the impact of resource allocation on construction project success. *Construction Economics and Building, 20*(4), 87-102.

Chen, X., Yu, J., & Le, H. (2017). Examining construction project management practices using program theory. *Journal of Construction Engineering and Management, 143*(8), 04017055.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). SAGE Publications.

De Vaus, D. (2014). Surveys in social research (6th ed.). Routledge.

DeVellis, R. F. (2016). Scale development: Theory and applications (4th ed.). SAGE Publications.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). Internet, phone, mail, and mixed-mode surveys: The tailored design method (4th ed.). Wiley.

Dolage, D. A. R., & Pathmarajah, T. (2017). *Construction project delays and dispute resolution mechanisms*. Journal of Construction Law, 9(3), 112-129.

Elmaghraby, S. E., & Keskinocak, P. (2013). Task dependencies in complex projects: An overview. *Management Science, 59*(10), 2217-2232.

Faniran, O. O., Caban, G., & Mbachu, J. (2016). Task dependency mapping in construction projects: The role of interdependencies. *International Journal of Project Management, 34*(6), 1201-1213.

Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5th ed.). SAGE Publications.

Gan, X., Zhang, Y., & Wang, X. (2018). *The role of project scheduling in achieving construction project success*. Journal of Construction Engineering, 17(2), 91-107.

García, C., López, M., Pérez, J., & Martínez, D. (2018). *Effects of schedule clarity on construction project completion rates*. Journal of Engineering and Management, 14(3), 85-102.

George, D., & Mallery, P. (2016). IBM SPSS Statistics 23 step by step: A simple guide and reference (14th ed.). Routledge.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). Multivariate data analysis (8th ed.). Cengage Learning.

Hausman, W. H., Lee, H. L., & Subramanian, U. (2013). Supply chain task dependency mapping for optimization. *Operations Research, 61*(3), 693-710.

Hoonakker, P., Carayon, P., & Khunlertkit, A. (2018). *The relationship between project scheduling and stakeholder satisfaction in construction projects*. Journal of Construction Science, 11(1), 33-51.

Hwang, B., & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management, 31*(2), 272–284.

Ibrahim, A. (2017). Project schedule management and construction performance: An empirical study. *Construction Management and Economics, 35*(9), 479-497.

Israel, G. D., Beaulieu, L. J., & Hartless, G. (2013). The influence of family and community social capital on educational achievement. *Rural Sociology, 66*(1), 43–68.

Jones, L., & Kim, S. (2019). *Challenges in Rwanda's construction industry: A focus on project scheduling and workforce management*. Rwanda Journal of Engineering, 5(1), 24-39.

Kerzner, H. (2017). *Project management: A systems approach to planning, scheduling, and controlling* (12th ed.). Wiley.

Kerzner, H. (2017). Project management: A systems approach to planning, scheduling, and controlling (12th ed.). Wiley.

Kholif, M., Hosny, H., & Sanad, H. (2017). *Construction scheduling and its impact on project performance*. International Journal of Civil Engineering, 19(2), 67-82.

Kothari, C. R. (2014). Research methodology: Methods and techniques (3rd ed.). New Age International Publishers.

Kothari, C. R., & Garg, G. (2014). Research methodology: Methods and techniques (4th ed.). New Age International Publishers.

Lechler, T., & Cohen, M. (2017). Exploring the role of project management in organizational performance. *Project Management Journal, 48*(4), 45–58.

Li, B., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2020). *The impact of construction sector growth on economic development*. International Journal of Construction Economics, 25(4), 121-139.

Love, P. E., Edwards, D. J., & Irani, Z. (2019). *Understanding the causes and effects of construction delays*. Journal of Construction Economics, 26(3), 78-95.

Maltzman, R., & Kirk, D. (2019). Green project management (2nd ed.). CRC Press.

Martinez, L. J., & Garcia, R. (2022). The impact of remote work on employee productivity: A meta-analysis. *Journal of Business Research, 135*, 235–245.

Memon, A. (2016). *Cost overruns in Malaysian construction projects: Public vs. private sector analysis*. Journal of Construction and Economics, 13(2), 89-104.

Memon, A., Rahman, I., & Azis, A. (2017). *Major causes of cost overruns in construction projects*. Journal of Civil Engineering Research, 18(3), 117-132.

Mugenda, O. M., & Mugenda, A. G. (2013). Research methods: Quantitative and qualitative approaches. Acts Press.

Naveenkumar, C., & Prabhu, R. (2016). *Timetable overruns in construction projects: An empirical study of 87 projects*. Journal of Project Scheduling, 15(2), 73-88.

Nduhura, P., & Mutesi, F. (2023). *Project delays and cost overruns in Rwanda's construction sector: A case study of Nyarutarama Property Developers*. Rwanda Journal of Business and Economics, 10(1), 21-38.

Nguyen, T. K., Lee, D. H., & Park, S. H. (2021). Blockchain technology and its applications: A comprehensive survey. *IEEE Access, 9*, 116–144.

Nkurunziza, J., & Uwizeyimana, P. (2021). *Challenges of project schedule management in Rwanda's construction sector*. Journal of Rwandan Infrastructure, 8(2), 41-59.

Nsanzimana, E. (2022). *Project performance in Rwanda's construction industry: An analysis of schedule management practices*. Rwanda Development Journal, 9(1), 12-27.

Odeh, A. M., & Battaineh, H. T. (2022). Evaluating project scheduling techniques for improved construction project outcomes. *Journal of Civil Engineering and Management, 28*(1), 75-90.

Ondicho, P., & Mundia, J. (2017). *Assessing project management challenges in Kenyan construction projects*. Journal of East African Construction Studies, 11(2), 56-74.

Osei-Kyei, R., & Chan, A. P. (2018). *Project scheduling practices and their impact on Ghanaian construction performance*. Journal of African Engineering, 7(3), 65-82.

Papadonikolaki, E., & Hopfe, C. (2019). *Improving communication and coordination through construction scheduling strategies*. Journal of Building Information Management, 14(1), 92-110.

Papke-Shields, K. E., Beise, C. M., & Quan, J. (2020). The impact of task dependency mapping on project performance. *Project Management Journal, 51*(2), 183-197.

Patton, M. Q. (2018). Qualitative research & evaluation methods (4th ed.). SAGE Publications.

Pinto, J. K., & Mantel, S. J. (2020). Program theory and task dependence mapping in construction projects. *International Journal of Project Management, 38*(3), 154-167.

Pinto, J. K., & Slevin, D. P. (2018). *Project success: Definitions and measurement techniques*. Prentice Hall.

Polit, D. F., & Beck, C. T. (2020). Nursing research: Generating and assessing evidence for nursing practice (11th ed.). Wolters Kluwer.

Rwanda Housing Authority [RHA]. (2022). *Annual construction industry performance report: Challenges and recommendations*. Kigali: RHA Publications.

Saka, A. B., Kumah, A., & Sackey, J. (2018). *Project scheduling effectiveness in Ghanaian construction firms*. Journal of African Infrastructure and Development, 6(2), 37-52.

Salkind, N. J. (2020). Statistics for people who (think they) hate statistics (7th ed.). SAGE Publications.

Santoso, D., & Soeng, S. (2016). *Profit margins and project scheduling in the construction industry*. Journal of Construction Finance, 19(2), 109-126.

Schober, P., Boer, C., & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation. *Anesthesia & Analgesia, 126*(5), 1763–1768.

Smith, J., & Jones, A. (2019). Exploring the effects of social media on mental health. *Cyberpsychology, Behavior, and Social Networking, 22*(4), 252–257.

Stroh, P., & Black, W. (2018). Workflow and task dependency mapping in organizational performance. *Business Process Management Journal, 24*(5), 1043-1062.

Sweis, G., El-Mashaleh, M., & Jaber, H. (2019). *Sustainable construction practices and schedule adherence*. Journal of Environmental Construction, 12(4), 55-72.

Uwimana, T., & Habimana, C. (2023). *Examining project schedule management and its impact on Rwanda's construction projects*. Journal of Rwandan Engineering, 10(2), 45-62.

World Bank. (2020). *Construction and infrastructure development in Sub-Saharan Africa: Trends and challenges*. Washington, DC: World Bank Publications.

Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). SAGE Publications.

Yuan, J., Skibniewski, M. J., & Li, Q. (2018). *Impact of construction schedule delays on project costs and performance*. Journal of Project Management, 16(1), 77-94.

Zhang, Y., Li, X., & Wang, Z. (2023). Advancements in artificial intelligence: Trends and future prospects. *Journal of Artificial Intelligence Research, 68*(3), 123–145.