

## **MATERIAL REQUIREMENT PLANNING AND PROJECT DELIVERY EFFECTIVENESS OF CIVIL CONSTRUCTION COMPANIES IN RIVERS STATE**

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### **Abstract**

This study examined the relationship between material requirement planning (MRP) and project delivery effectiveness of civil construction companies in Rivers State. MRP was the predictor variable while project delivery effectiveness, measured as project cost reduction, project time reduction, and project quality was the criterion variable. The study adopted correlational research design. Primary data was generated through structured questionnaire. The population of the study comprised 18 civil construction companies in Rivers State. Sample size of the study was the same as the population. 3 copies of structured questionnaire were distributed to Procurement, Logistics and Human Resource Managers of the 18 companies, making a total of 54 managers that provided data for the study. The research instrument was validated through vetting by subject specialists, while reliability of the instrument was determined using Cronbach's Alpha test with a threshold of 0.70. The hypotheses formulated for the study were tested using Pearson's Product Moment Correlation. The study found that a positive and significant relationship between MRP and project delivery effectiveness of civil construction companies in Rivers State, Nigeria. The study concluded that MRP positively and significantly relates to project delivery effectiveness of civil construction companies in Rivers State; and recommends that management of civil construction companies in Rivers State should focus on establishing frameworks and developing infrastructure that support MRP, if they seek to ensure effectiveness project delivery.

**Keyword:** Material requirement planning, project delivery effectiveness, project cost reduction, project time reduction, project quality

### **Introduction**

The building and construction sector is a highly dynamic component of national economies. This especially so in civil construction where effective project delivery is key to success and competitive advantage. Project delivery effectiveness entails how well a project is completed in relation to the objectives set out in its scope, including time, cost and quality while satisfying stakeholders' expectation (Shehu et al., 2020). It assesses whether a project was delivered on schedule, within budget and to the satisfaction of stakeholders while minimizing risks and maximizing resources efficiently.

Scholars listed key indicators of project delivery effectiveness to include meeting deadlines, staying within budgets, delivering desired quality and achieving stakeholders' satisfaction (Sinesilassie, & Jha, 2017; Vaux & Kirk, 2018). Organization of petroleum exporting countries (OPEC, 2021) stated that project delivery effectiveness can be influenced by team competency,

resource allocation, risk management, communication and stakeholder's engagement. In construction, delivery effectiveness often means successfully completing projects without significant delays, cost overrun or compromising quality standards.

Several challenges can hinder project delivery effectiveness particularly in a complex field like construction. These include poor planning and scheduling, resources constraint, communication gaps, risk management issues, scope creeps and inconsistent quality control (Gulghane & Khandve 2015). One of the essential factors influencing delivery effectiveness is proper planning and management of materials needed for work; and this is where material requirement planning (MRP) becomes relevant to project delivery.

MRP is a crucial supply planning system used primarily in manufacturing to manage inventory, production scheduling and timing of raw materials (Netsuite, 2022). This implies that MRP helps businesses to determine what materials are needed, how much is required and when they are needed, based on customers' demand and production schedule. MRP serves as a vital tool in ensuring that the right materials are available at the right time, minimize delays and enhance smooth execution of projects (Patil & Pataskar 2013).

The construction sector encompasses a number of entities and activities that contributes to the actualization of the built environment, including builders (contractors & subcontractors), manufacturers and suppliers of machinery and equipment, construction materials, construction workers and construction professionals. The construction industry plays an important role in the economy, and the activities of the industry are vital to the achievement of national socio-economic development goals of providing shelter, infrastructure and employment (Anaman & Osei-Amponsah, 2007).

The effects of the industry are felt mostly in areas of job creation, its contributions to the national gross domestic product, improved revenue generation and competitive advantage of firms, infrastructural developments and housing provisions. Thus, a vibrant construction industry is healthy for national and economic growth (Eriksson, 2013). However, many construction firms face challenges of project delays, cost overruns and inefficient resource management, often due to poor planning and procurement processes. That is why this study attempts to examine the empirical relationship between MRP and project delivery effectiveness of civil construction companies in Rivers State.

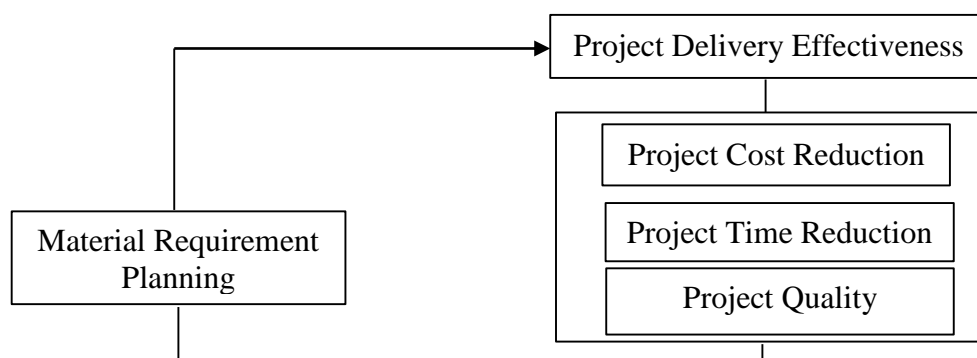


Fig. 1: Conceptual Framework of relationship between material requirement planning and project delivery effectiveness of civil construction companies in Rivers State.

### **Theoretical Foundation of the Study: System Theory**

This study is underpinned by system theory. System theory was developed by Austrian biologist Ludwig Von Bertalanffy in 1940s (Johnson et al., 1964). Bertalanffy (1968) asserts that systems operate as interconnected wholes rather than isolated parts, arguing that understanding the relationships between a system's components and their interactions is essential to understanding the system as a whole.

According to Kosekele and Howell (2002), systems theory promotes a holistic understanding of how various components (such as resources, timelines, and stakeholders) interact in a project environment. In construction, effective MRP involves coordinating resources to ensure timely delivery. Systems theory helps explain how MRP, as a subsystem, fits into the broader system of project management.

When materials are effectively planned and managed, it positively impacts project delivery timelines and efficiency. In the context of civil construction companies in Rivers State, systems theory helps to identify the interconnected factors that contribute to project delivery success, such as supplier reliability, workforce coordination, and project management efficiency.

Systems theory emphasizes feedback loops, where information from different parts of the system is used to make adjustments and improve performance (McShane & Von Glinow, 2003). Kerzner (2017) states MRP feedback loops are critical such that, real-time data on material availability or delivery delays allow project managers to adjust schedules or resource allocation, thus improving project delivery effectiveness.

In construction projects, unexpected changes like material shortages and weather disruptions appears to be common, hence adaptability as emphasized in systems theory aligns with the need to continuously update and adjust MRP to enhance delivery outcomes. Bellgran and Safsten (2015) asserts that in systems theory, different parts of a system are interdependent, and this reflects the way materials, labor, equipment and time are connected in a construction project.

Thus, systems theory is relevant to this study because it provides a robust understanding of the relationship between MRP and project delivery effectiveness. The theory's focus on interdependencies, feedback and holistic analysis aligns with the challenges of managing complex projects, making it a suitable lens through which to explore and improve MRP's role in project success.

### **Concept of Material Requirement Planning**

MRP is a technique that has been used since 1970 as an inventory management tool aimed at efficient scheduling of production requirements (raw materials, components, and subassemblies) to provide the right quantity at the right time (Bag et al., 2020) MRP ensures that needed materials are available for production and necessary products are available for customers in order to avoid shortages; minimizes waste by stocking only the barest minimum of materials and products; and assisting in planning manufacturing functions, delivery schedules and purchasing (Rouse, 2014).

MRP is designed to answer what is needed, when it is needed and how much is needed. Effective MRP is a powerful tool for operational performance, as it prevents inventory obsolescence, stock

outs, and excess stock, while improving material flow, customer satisfaction and product quality (Oztemel & Gursev, 2020; Katuu, 2020; Musi et al., 2018; Paul, 2017).

MRP helps the company make more accurate estimates about how long it will take to deliver products to customers, which in turn helps the company to be more successful. Thus, it helps to adjust production plans to counter adverse effects of unexpected disturbances or production uncertainties such as unexpected surge in demand, machine breakdowns, non-arrival of raw materials, and excessive rejects (Chadwick, 2013).

Kithure and Paul, (2022) states that MRP is part of supply chain management, but with a focus on efficient and effective forward and reverse flow and storage of goods, services, and related information. Thus, MRP create competitiveness that results in better quality of life for customers at lower costs. Modern MRP relies on software applications to manage materials and identify required resources for designated work centers and vendors for a specified period (Black & Schreffler, 2010).

### **Project Delivery Effectiveness**

Project delivery is a multi-faceted concepts driven by dynamic interactions between managerial skills, stakeholder needs and other broader environmental factors. It is conceived as the process of planning, organizing and controlling resources to deliver a specific project successfully. Project delivery define roles and responsibilities of project stakeholders (Fong et al., 2014).

Project delivery effectiveness is the extent to which a project is completed successfully, meeting its objectives, timelines, budget and stakeholders expectation (Jack et al., 2016). Effectiveness in project delivery is not only about the traditional iron triangle of cost, time and quality; but includes achieving long term benefits for stakeholders by positively influencing the environment where the project is executed. Effective project delivery is affected by clear project definition and scope, realistic project scheduling and timeliness, resources allocation, risk management, quality assurance, communication, continuous monitoring and process tracking and adaptability to change (Shehu, 2021)

Effectiveness is focused on doing the right thing; and doing the exact thing in project delivery requires applying improved strategies and approaches that support the achievement of specified goals using effective practices in the form of processes, standards and technological tools that enhance project delivery (Zheng et al., 2010). The goal of project delivery is to ensure that projects are completed on time, within budget, and to the required quality standards, while also meeting the expectations of stakeholders (Alashwal & Al-Ghassani, 2020).

Projects are effectively initiated and delivered to achieve clear objectives such as revenue growth, improved efficiency, or innovation. Successful project delivery enhance a firm's reputation and credibility; drives business value by creating new products that generate revenue to improve operations; improves customer satisfaction and builds team morale (Shehu et al., 2020; Sinesilassie & Jha, 2017).

The success of a project is mostly determined by the project stakeholders and the project structure, which includes time, cost, and quality (Davis, 2016). Shehu (2021) states that stakeholder satisfaction and anticipated returns on investment are also essential criteria for assessing project

delivery. Therefore, in this study project delivery effectiveness was presented in terms of project cost reduction, project time reduction and project quality.

### **Project cost reduction**

Project cost reduction refers to strategies and actions taken to decrease the overall costs associated with a project while ensuring that quality, scope and objectives of the project are not compromised. This requires identifying and eliminating unnecessary expenditures, optimizing resource usage, and improving efficiency to deliver projects within budget.

Kerzner (2017) defines project cost reduction as a systematic process of identifying inefficiencies, redundancies and unnecessary costs in project execution in order to streamline operations and reduce overall expenditures. This implies that project cost reduction involves careful planning, resource allocation and cost control, ensuring that cost saving are reached without compromising project scope and quality.

Lock (2020) describe project cost reduction as a continuous effort to reduce project costs through effective budget management, process optimization and waste elimination. Project cost reduction is achieved by employing methods like value engineering, resource efficiency and risk mitigation to minimize costs while maintaining project deliverables (Badiru, 2019). This simply explains that using forecasting, risk analysis and efficient procurement practices can help achieve lower cost while adhering to project specifications.

Beste and Klakegg (2022) highlights that project cost reduction is vital for profitability particularly in highly competitive markets. According to Aboelmagd (2021) reducing project cost without compromising quality helps organizations reach project budget, improve resource allocation and achieve financial goals. Hence cost reduction can result in a competitive advantage, allowing firms to offer products at lower price, hence, attract more customers and improve market share.

Collier (2015) stress the importance of project cost reduction in enhancing resources and minimizing wastes, arguing that when cost reduction strategies are effectively implemented, project managers will be capable of allocating resources more judiciously. According to Aboelmagd (2021) and Meredith and Mantel (2018), project cost reduction is important for mitigating financial risks and ensuring long term organizational stability, arguing that keeping project costs under control prevents unforeseen financial burdens and support strategic goals of a business.

### **Project time reduction**

Time is crucial in assessing project deliveries. Successful project delivery include timely completion (Johnson & Babu, 2018). Time has been addressed as a criterion by which to evaluate a project's degree of success. It is the most critical constraints in construction projects, as delays adversely affect cost, scope and quality. Project time reduction is a process of managing time according to the requirements of different assignments and activities with the goal of ensuring success and maximizing benefits by utilizing, saving and not wasting time or energy (Sahito & Vaisanen, 2017).

Project time reduction is a systematic cutback of time that is required to complete a project through the use of scheduling techniques, resources allocation and process improvements (Kernzer, 2017).

According to Ruuska (2018), project time reduction concerns achieving project deliverables within a shorter time frame by eliminating inefficiencies and optimizing workflows, while ensuring the projects quality is not compromised.

Nicholas and Steyn (2020) states that project time reduction is a key project management objective that focuses on shortening project schedule through efficient planning, critical path analysis and eliminating non-value adding activities. This implies that managers can reduce bottlenecks to project delivery by significantly reducing the duration of projects. The time needed to finish an activity can be reduced by authorizing overtime to speed up an activity.

According to Lu and Liu (2014), techniques for successful project delivery are to avoid wasted time, assure quality, resolve conflicts through negotiation, and accelerate progress toward fulfilling work objectives. The most common method for shortening project time is to assign additional personnel and equipment to activities (Mäntyneva 2016).

Project time reduction has been acknowledged by practitioners as a key success factor in ensuring project success, improving efficiency and enhancing an organizations competitive advantage (Larson & Gray, 2021; Lysons & Farrington, 2020; Ruuska 2018). According to Larson and Gray (2021), project time reduction enables companies bring their offerings to market fast, gain competitive edge especially in industry where time to market is critical.

Reducing project time allows companies to capitalize on market opportunities and meet customer demands more rapidly. This in turn, increase market share, improves customer satisfaction and profitability. It also lead to cost savings (Meredith & Shafer, 2021), minimizes risk associated with project delays (Turner, 2021) and enhance resource utilization (Heagney, 2017; Pinto, 2019).

### **Project quality**

According to ISO 9000 (2015), quality is the totality of characteristics that bear on a product's ability to satisfy stated or implied needs. Sahil and Samiksha (2020) describe quality as the degree to which a set of inherent characteristics meets requirements. It is a products positive worth in terms of conformance to specifications, suitability for use and possibilities for ensuring satisfaction.

Larson and Gray (2021) and Pinto (2019) argue that project quality describes how a project's deliverables to meet defined specifications and satisfy stakeholders. It is the extent to which a project as delivered, conforms to specifications outlined at the beginning of the project. This definition emphasizes that quality is not only about meeting technical requirement but also ensuring that projects deliver value to stakeholders. Abdul-Azeez (2022) argue that project quality to be closely tied to quality management practices, aimed at preventing defects and optimizing efficiency throughout a project's lifecycle.

Beyond technical specification, project quality also involves meeting expectations and needs of stakeholders; as well as continuous improvement to enhance efficiency and effectiveness of project processes. Heagney (2022) states that organizations adopt quality management practices that foster ongoing refinement of procedures. By continuously analyzing project performance data and learning from past projects, organization reduce errors, improve resource utilization and enhance project outcomes (Meredith & Shafer, 2021).

Quality assurance and quality control are keys to maintaining project quality (Harris et al., 2021; Ganaway, 2006). Quality assurance focuses on ensuring that processes are followed correctly to prevent defects, while quality control involves inspecting and testing deliverables to ensure they meet specified standards (Aenet & Maniha, 2022). Turner (2022) and Obunwo and Surash (2017) notes that incorporating both quality assurance and quality control ensures that quality is built into every stage of the project, from planning to execution and final delivery.

### **Material Requirement Planning and Project Delivery Effectiveness**

Adiele and Ihunwo (2022), examined the MRP and supply chain performance of oil and gas firms in Port Harcourt, Nigeria. The study found the existence of significant and positive relationship between MRP and supply chain performance. Similarly, Kithure and Paul (2022) probed the role of MRP in operational performance manufacturing firms; and established that MRP had significant positive effect on operational performance.

Likewise, in the study of Kaconco et al (2023) which investigated the relationship between master production scheduling and blood transfusion sustainability of blood banks in Uganda, it was observed that a significant positive relationship exists between master production scheduling and blood transfusion sustainability. This results imply that master production scheduling leads to timely delivery of blood products to healthcare facilities.

Also, Gicheru and Ngugi (2023) investigated effect of MRP on performance of food and beverage manufacturing firms in Kenya. The study found that MRP impact performance of food and beverage firms. Consequently, the study hypothesizes as follows:

- 1) Ho: Material requirement planning does not significantly relate with project cost reduction
- 2) Ho: Material requirement planning does not significantly relate with project time reduction.
- 3) Ho: Material requirement planning does not significantly relate with project quality.

### **Methodology**

The study adopted a correlational research design. The population of the study consisted 18 functional civil construction companies in Rivers State, as enlisted in Nigeria's directory and search engine ([www.finelib.com](http://www.finelib.com)). The entire population was used as the sample size with 3 managers (procurement, logistics, and the human resource) of each of the 18 civil construction companies serving as respondents. Data was collected using structured questionnaire. This study adopted face validity to guarantee instrument quality. Reliability test was done to test inter-item consistent reliability using a Cronbach Alpha test, with a threshold of 0.7 as recommended by Nunnally (1978). All item values which fall below 0.7 are generally considered as unreliable. Item values higher than the 0.7 threshold were considered reliable and were accepted. Data collected from respondents were analyzed using both descriptive and inferential statistical tool such as central tendencies and Pearson product moment correlation with the aid of a statistical package for social sciences version 25.0

**Table 1: Cronbach alpha reliability coefficients**

Constructs	Dimensions/Measures	No. of Items	Alpha Coefficients
Material Requirement Planning		3	0.824
Project Delivery	Project Cost Reduction	3	0.823
	Project time Reduction	3	0.900
Effectiveness	Project Quality	3	0.848

Source: Research Data (2024)

The result from the reliability test shows that the instruments for the research are reliable, following observed alpha coefficients that are revealed to be good or adequate (where  $\alpha > 0.70$ ) indicating the replicability of the instruments

## Analysis and Results

**Table 2: descriptive statistics of material requirement planning**

	N	Mean	Std. Dev.	Remarks
We ensure that appropriate materials are available for production.	51	4.0392	.72002	Agree
We minimize waste by stocking only the bare minimum of materials	51	4.0980	.70014	Agree
We establish delivery dates and order quantities based on expected demand.	51	4.1176	.68256	Agree
Valid N (listwise)	51			

Source: Research Data (2024).

The distribution for MRP as shown in Table 2 reveals strong affirmation for the properties of MRP. Results indicate that majority of respondents identify the related practices of MRP as evident attributes of their firms, and are linked to or are reflected in the behavior of their organizations. The property that tries to ascertain if organization establishes delivery dates and order quantities based on expected demand has the highest mean score of 4.1176 while question one that determines if companies ensures an appropriate materials are available for production has the highest standard deviation of .72002 depicting that question 1 has the highest data variation.

**Table 3: Descriptive Statistics of Project delivery effectiveness**

		N	Mean	Std. Dev.	Remarks
Project Cost Reduction	We offer prices as low or lower than our competitors.	51	3.9020	.85452	Agree
X = 3.9935	Our procurement cost has reduced	51	3.9020	.78115	Agree
SD = 0.71021	Our overhead cost has reduced.	51	4.1765	.84157	Agree
Project Time Reduction	Our company can quickly complete project to meet customer's needs.	51	4.1765	.79261	Agree
X = 4.1699	Our company has an outstanding time delivery record to our customers.	51	4.0784	.95589	Agree
SD = 0.78421	We are able to reduced development lead time	51	4.2549	.82081	Agree
Project Quality	We are able to compete based on quality.	51	4.0784	.86817	Agree
X = 4.0784	We offer projects of high quality to our partners.	51	4.0196	.78715	Agree
SD = 0.68828	We offer projects that are durable.	51	4.1373	.69339	Agree
	Valid N (listwise)	51			

Source: Research Data (2024).



The result for the analysis on the distribution of properties and measures of project delivery effectiveness is illustrated in the Table 3. The result presents all related indicators and properties for the construct to be reliable and as expressed as an outcome of the organizations. The result revealed aggregates which point to the position of the generality of the participants and their acceptance as well as agreement to the properties and dimensions of project delivery effectiveness, with project time reduction ( $x = 4.1699$ ), project quality ( $x = 4.0784$ ) and the project cost reduction ( $x = 3.9935$ ). The results point to the substantiality of project delivery effectiveness within the context of the firms and the extent to which these characterize the behavior of the firms as well.

**Table 4: Correlation for material requirement planning and project delivery effectiveness**

		MRP	Project Cost Reduction	Project Time Reduction	Project Quality
MRP	Pearson Correlation	1	.728**	.777**	.637**
	Sig. (2-tailed)		.000	.000	.000
	N	51	51	51	51
Project Cost Reduction	Pearson Correlation	.728**	1	.792**	.715**
	Sig. (2-tailed)	.000		.000	.000
	N	51	51	51	51
Project Time Reduction	Pearson Correlation	.777**	.792**	1	.868**
	Sig. (2-tailed)	.000	.000		.000
	N	51	51	51	51
Project Quality	Pearson Correlation	.637**	.715**	.868**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	51	51	51	51

Correlation is significant at the 0.01 level (2-tailed).

MRP is revealed in the Table 4 to significantly influence project delivery effectiveness, thus contributing to outcomes of project cost reduction ( $R = 0.728$  and  $P = 0.000$ ), project time reduction ( $R = 0.777$  and  $P = 0.000$ ) and project quality ( $R = 0.637$  and  $P = 0.000$ ). The results show that MRP significantly contributes to organizations capacity for effective project delivery, thus demonstrating the role of MRP as an imperative to project delivery effectiveness of construction companies in Rivers State. Following these outcomes, the 3 null hypotheses earlier formulated are, rejected.

### Conclusion and Recommendations

The relationship between MRP and project delivery effectiveness was observed to be significant, where MRP was observed to significantly and positively contribute to project cost reduction, project time reduction and project quality. These results demonstrate the positive role MRP in enabling project delivery effectiveness of civil construction companies.

Therefore, the study concludes that MRP enhances project delivery effectiveness of civil construction companies by influencing project cost reduction, project time reduction and project quality. MRP is fundamental to enhanced project delivery effectiveness in terms of cost reduction, project time reduction and project quality.

This affirms that management of civil construction companies' can rely on MRP to improve the effectiveness of their project deliveries. Consequently, the study recommends that management of

civil construction companies in Rivers State should focus on MRP, if they desire to achieve sustained operations hinged on project delivery effectiveness.

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