(RESEARCH ARTICLE)

Project scheduling and staff assignment of selected manufacturing firms in Osun state, Nigeria

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Abstract

The study examines project scheduling and staff assignment in selected manufacturing firms in Osun State, Nigeria. To achieve this main objective of the study, three operational objectives are set out for the study. The study adopts descriptive survey design to gather data through the administration of questionnaire. Data collected were analyzed using chi-square analysis through SPSS. Results of the analysis revealed that there is a relationship between learning effect and lead time to perform a task & processing times and skills acquired by employees. The study concludes that scheduling tasks in a project and assigning the staff to these tasks must take account that a task can be performed only by employees with certain skills and that the length of each tasks depends on the number of employees assigned. Also, staff will perform a task more efficiently if he or she stays on the task longer. It was recommended that manufacturing firms should focus more on training their employees so as to minimize production costs in task scheduling and before assigning staff to tasks for each period, learning effect of staff should be considered to minimize outsourcing cost.

Keywords: Project scheduling; Staff assignment; Processing time; Leaning effect

1. Introduction

The scheduling of production is a difficult problem. Most businesses have a relatively stable capacity, but market demands for goods and services are frequently unpredictable. Because of this, it is imperative to respond to these erratic demands by utilizing the organization's staff and resources as efficiently as possible (Alabi Tjigah & Saka, 2018). Project scheduling and staffing are two of the fundamental components of management, and they both have a big impact on managing project performance. Mijinyawa, Modibbo, and Fimba (2019) emphasized that these two ideas are critical to accomplishing project goals, thus it is important to thoroughly assess them to avoid any potential hazards that might lower the quality of project scheduling and eventually impact project performance overall. Tasks for every project may occasionally need to be scheduled on a regular basis, with staff members assigned to each work. Furthermore, Glock (2012) said that efficient project scheduling is essential to finishing a project on schedule and under budget, and that this has shown to be one of the ways that businesses may gain a competitive edge. Depending on the product the firm produces, the personnel assignment and production plan may be carried out on a weekly, monthly, or annual basis. The distribution of available production resources over time is known as production scheduling, and it must meet a number of requirements, including supply, demand, and quality. According to Amponsah, Ofoso, and Opoku (2011), an optimal production schedule is one that effectively distributes resources across time to meet predetermined criteria, such as the plan, which distributed the optimal amount of production resources required to meet a particular demand at the lowest possible cost. Every production company wants to turn a profit and meet consumer demand, however

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Mohammad, Samson, and Hafisu (2015) assert that this objective isn't always met because of ineffective staffing assignments and poor production scheduling. The production divisions of brewing corporations are now dealing with the issue of sometimes producing too much beer in response to consumer demand, and other times producing too little. This research will assist management in finding a balance between overproduction and underproduction.

Lead times are closely correlated with task due dates, and task due dates are correlated with the number of personnel allocated to the assignment. According to Fernandez and Framinan (2016), the staffing levels assigned to the jobs and the task scheduling determine how long a project will take to complete. The researcher specifically takes this link into account in this work.

While research has recorded project schedules and personnel assignments in an organization, studies like those by Alabi, Ijigah and Saka (2018), Umoh and Wokocha (2013), Mijinyawa, Modibbo and Simba (2019), and Helmeri and Kolisch (2010) do not. To the best of the researcher's knowledge, however, a review of the literature on project scheduling and staff assignment in Nigeria showed that no prior studies had looked at these topics in Osun State. Umoh and Wokocha (2013) looked at scheduling and corporate productivity performance in Nigeria. In the Nigerian construction business, Alabi, Ijigah, and Saka (2018) studied project scheduling in Ibadan, Oyo State; Mijinyawa, Modibbo, and Fimba (2019) studied the process of project scheduling in the manufacturing and service industries in Adama leverage limited, Adamawa State. Descriptive statistics were also employed in earlier research that looked at their integration to determine how the two related to one another.

Examining the connection between staff assignment and project scheduling in a subset of manufacturing enterprises in Osun State, Nigeria, was the primary goal of this study. The particular objectives are as follows: To investigate the link between project lead time and staff assignment in manufacturing organizations; to find the relationship between learning effect and lead time to complete a job; to find the relationship between processing times and skills learned by employees.

2. Literature review

2.1. Concept of Scheduling

According to Umoh and Kiokocha (2013), scheduling is the process of determining the start date of operations for tasks so that they are finished by the deadline. activity scheduling, which includes the order in which each activity is to be completed throughout time, is typically considered a crucial component of industrial production and organization. Nestor and Francisco (2018) emphasized that the term "project" or "task scheduling problem" refers to any challenge that focuses on maximizing a number of factors, including project length, resource allocation, cost estimation, and cash flow. Project scheduling problems seek to provide a series of actions that are arranged according to a decision criterion in order to provide an appropriate solution to the problem at hand in order to accomplish these primary aims. The goal of task scheduling, as emphasized by Fernandez and Framinan (2016), is to establish the start and end dates of tasks in order to finish a project on schedule while incurring the least amount of overhead. According to Fitsun and Eshetie (2015), manufacturing companies are attempting to lower the risk of missing deadlines by managing their performance.

2.2. Scheduling Objectives

- Scheduling is the process of determining when particular resources—such as machinery, buildings, equipment, and human activities—are used within an organization. Regardless of the nature of its operations, it is essential in any organization (ICAI, 2016). According to Alabi Ijigah and Saka (2018), scheduling is the process of setting up a production unit to create goods on schedule while utilizing the fewest resources and least amount of time possible. The following were listed as the goals of scheduling by ICAI (2016).
    - To stop departments and work centers from using their time unevenly.
    - To boost productivity or manufacturing efficiency.
    - To schedule delivery times for different production processes as well as for completed goods.
    - To cut down on labor and machine idle time that might be brought on by waiting for supplies, for a move, for an interruption, or for a lack of employment.
    - To use labor and machinery in a way that produces the desired results within the predetermined lead time, ensuring on-time delivery of the product at the lowest possible total cost of production.

2.3. Importance of Project Scheduling

Project scheduling is referred to as the "heartbeat" of the manufacturing business by Alabi, Gigah, and Saka (2018) because it is a manipulable instrument that can be used to enhance and maintain the company's reputation for high-

quality delivery while also increasing profit without sacrificing quality. They contend that project timing is essential to achieving successful project delivery. According to Kerzner (2013), project scheduling plays a major role in ensuring that the production plan and project objectives work together effectively throughout implementation.

2.4. Project Scheduling Determinant Factor

The type of project being undertaken, its nature, task dependencies, resource availability, climate at the location, the company's financial strength, technological advancements, procurement strategy chosen, and contractual agreements are some of the factors that affect project scheduling and, in turn, the preparation of project schedules (Alabi, Ijigah, and Saka, 2018).

2.5. Managerial Consideration in Scheduling

- In production and operations management, scheduling, according to ICAI (2016), aids in the allocation of scarce resources. For example, machine time is a scarce resource that is assigned to various jobs, labor (employee) time is allocated to various activities, and facilities are scheduled for a specific activity at a specific time period. According to his opinion, there are six characteristics that may be applied while assessing various scheduling options. They are as follows:
  - o Developing the good or service when the client requests it.
  - o Cutting down on the amount of time needed to manufacture a good or service.
  - o Reducing the amount of inventory of work-in-progress.
  - o Reducing the amount of time that machinery or equipment is idle.
  - o Reducing the amount of time that workers spend idle and • Cutting expenses

2.6. Project life cycle

The project life cycle, according to Demeulemeester and Herroelen (2002) and Ajibola (2012), is as outlined below:-

- The initial concept phase: a customer must complete a project. After that, the need is assigned to the business.
- Definition Phase: The first step is to specify the project's objective. Creating the task approach to accomplish the goal comes next.
- After the planning phase, the project must be divided into tasks. Next, the estimated processing times are determined, together with the resources needed and the tasks' relationships.
- Scheduling phase: In this phase, the number of resources allocated to each time period as well as job scheduling are established.
- Control phase: at this stage, the project's implementation is governed by the stages of planning and scheduling.
- Termination Phase: This stage relates to the project's delivery of its outcomes.

It is important to remember that staff assignments must be made between the scheduling phase, when resource availability is known, and the control phase. The phase of resource assignment needs to come after the phases of scheduling and control. As an alternative, scheduling and resource assignment might be integrated.

2.7. Theoretical framework

Herman (1885) was the first psychologist to describe the learning effect hypothesis (learning curve), often known as the experience curve, cost curve, or productivity curve. Wright (1936) examined this idea. According to the hypothesis, employees' productivity will increase if they work harder. The hypothesis was predicated on the idea that employees would be more productive on a given activity the longer they worked on it. A thorough review has been published, and the learning curve has been widely used to many different fields (Yelle, 1979). According to the investigations, cumulative average consumption decreases throughout the course of all operating instances before reaching a constant state.

Since the theory may result in lower pricing because labor hours per activity are expected to decrease as activity increases, reducing labor costs and material waste, it is crucial to this study because organizations operate in a competitive environment where market participants are trying to outbid one another by lowering prices. Additionally, it will assist companies with more accurate cost forecasting, job scheduling, logistic scheduling, and production planning. Over time, a competent worker who is well-positioned for success will contribute to lowering the cost per output unit for the organization.

2.8. Empirical review

Task scheduling and staff assignment have been thoroughly examined by several studies in the past and present, who have concluded that task assignment is dependent upon task scheduling.

A staff assignment model that takes into account the preferences of multiskilled workers for certain tasks and skill-based processing time—that is, the task's processing duration depending on the worker's skills—was developed by Hachicha, Dafaoyi, and Mhamadi (2010). Heimerl and Kolisch (2010) examined a staff assignment problem without taking into account the learning impact on the workers. As a result, the processing times for the problem are now unpredictable and rely on the staff's experience. This challenge was solved by implementing a nonlinear model.

Shabtay and Stoner(2007) have examined the link between time and resource quantity using both linear and convex techniques. It was expected that there would be a linear relationship between the task's processing time and the resources allotted to it. According to Belbin (2010), there must be an ideal number of employees assigned to each activity in order to attain optimum worker productivity hence this strategy is not well adapted to many real-world situations. According to Shabtay and Kaspi (2004), the convex method assumes that processing times and allocated staff have an inverse relationship. The body of research on the exact nature of the link between personnel assignment and project scheduling is still lacking, though.

Assuming that project scheduling is accessible, Campbell and Dibay (2002) created mathematical models for the staff allocation problem that included accounting for variations in staff productivity across jobs. Given that they are integer algorithms, these mathematical models for staff allocation take a lengthy time to compute. A mixed integer linear programming model was put up by Bassett (2000) to address the staff allocation and project scheduling issues. An effective approach to solving the integer program was suggested using a heuristic.

Wu and Su (2006) introduced the combined problem of staff assignment and project scheduling, putting forth a nonlinear model that a genetic algorithm was able to solve. Despite taking into account the learning effect, which states that an employee's efficiency increases with task duration.

This study aims to investigate the relationship between learning effect and task lead time empirically, as well as the relationship between employee skill acquisition and processing times. Additionally, it seeks to determine whether task scheduling and staffing levels affect project lead times.

Production scheduling and corporate productivity performance in Nigeria's industrial sector were studied by Umoh and Wokocha (2013). The study's regression estimation approach showed that the corporate productivity performance of Nigeria's manufacturing industry is not significantly impacted by production scheduling. The report suggests that a complete reform should be carried out to realign and save the Nigerian manufacturing sector from complete collapse, particularly concerning scheduling.

Alabi, Ijigah, and Saka (2018) looked at how project scheduling was evaluated in the Nigerian construction sector. A case study of Nigeria's Ibadan. After analyzing the actual data with statistical methods, it became clear that the most crucial aspects influencing project schedule are the kind, complexity, and amount of materials needed for the task. The main things impeding project scheduling performance include unreliable human resource estimates, inexperience with scheduling, and poor managerial decisions on crucial tasks. The study suggests applying a scientific approach to labor and material demand estimation and using certified and competent people to manage project schedules.

In their 2019 study, Mijinyawa, Modibbo, and Fimba explored the scheduling of production processes in the manufacturing and service sectors, and they developed an effective scheduling method that lowers the overall cost of production for the business. Windows-based quality management software was used to get optimal solutions. The findings showed that the company could still satisfy its demand while lowering its manufacturing cost for that year, which came to N54,398,112. The study suggested that in order to meet client demand while lowering manufacturing costs, the corporation should implement the approach.

3. Methodology

This study's purview is restricted to ten (10) of the thirty (30) manufacturing firms that were specifically chosen from the cities of Ilesa and Osogbo. Responses from the selected respondents are thought to be indicative of the views of all manufacturing enterprises in Osun State's other cities.

The survey design used in the study was descriptive. Self-administered questionnaires were employed in this design in order to gather data. This design was deemed suitable since it allows the researcher to get real data from the participants to determine the correlation between the lead time to complete a task and the learning impact, as well as the link between employee abilities and processing times. In Osun State, the study was conducted in the towns of Ilesa and Osogbo.

The study location was selected based on the researcher's observation that most firms were struggling because of their high failure rate in meeting deadlines. The study's target demographic comprised all personnel working in the human resources and production departments. A simple random sample approach was used to choose one hundred employees from ten (10) enterprises located in Osogbo and Ilesa, Osun State. The research instrument was meticulously developed, taking into account the study objectives and seeking advice from a measurement and evaluation department to enhance the quality of the questions, in order to guarantee the validity of the instrument.

A two-point rated structured questionnaire titled "Project Scheduling and Staff Assignment" The workers was asked to respond using a questionnaire. Chisquare correlation was used in SPSS to examine the data as soon as the instrument was administered and collected.

4. Result and discussion

4.1. Test of Hypotheses

4.1.1. Hypothesis One

Hoi: There is no significant relationship between learning effect and lead time to perform a task.

Level of significance = 0.05.

Decision rule:- Accept Ho if X2c < value X2t or Significance is greater than 0.05.

Reject Ho if X2$_c$> value x2$_t$ or level of significance less than 0.05Hypothesis was tested using SPSS version 19 at 95% confidential interval. The result is depicted below.

Table 1 Relationship Between Learning Effect and Lead Time to Perform a Task.

Statement	Agree	Disagree	Total
Assignment of certified workers will minimize the total time required to finish the project.	78	22	100
The skills of a staff affect the make span of a project	50	50	100
Tasks are scheduled based on the skills of the workers	55	45	100
Dedication of staff to a particular task will increase efficiency.	60	40	100
Employee will perform a task more efficiently if he/she stays on a task longer.	65	35	100
Total	373	227	600

Survey Analysis 2023.

Table 2 Chi-square tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-square	20.019[a]	5	0.001
Likelihood Ratio	20.671	5	0.001
Linear-by-Linear Association	0.136	1	0.712
N of Valid Cases	600		

a.   0 cells (0.0%) have expected count less than 5. The minimum expected count is 37.83.

4.2. Interpretation of result

From the result in the chi-square table above, X^2c 20.019 while it is 11.07 from Chi-square table at the level of significance of 5%. Since the x^2 calculated of 20.019 is greater than the X^2 tabulated of 11.071 then the null hypothesis which states that there is no significant relationship between learning effect and lead time to perform a task is rejected. This indicates that there is a significant relationship between learning effect and lead time to perform a task.

Decision: Therefore, Null hypothesis is rejected and alternative hypothesis Is accepted according to the decision rule stated above.

4.2.1. Hypothesis two

Ho₂: There is, no significant relationship between processing times and skills acquired by employees.

Level of significance = 0.05.

Decision rule:- Accept Ho if X2c < value X2t or Significance is greater than 0.05.

Reject Ho if X^2_c> value x^2_t or level of significance less than 0.05

Hypothesis was tested using SPSS version 19 at 95% confidential interval. The result is depicted below.

Table 3 Relationship between Processing Times and Skills Acquired by Employees.

Statement	Agree	Disagree	Total
Lead time depend on the processing time of a task	55	45	100
Processing time depends on the number of employees assigned to the task	60	40	100
Processing time determined the lead time of a task	55	45	100
Processing time of a task decreases when the number of employees increases.	60	40	100
In staff assignment workless satisfaction tend to be maximized whereas makes pan and production costs are often minimized in task scheduling.	80	20	100
Total	310	190	500

Survey Analysis 2023.

Table 4 Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	18.251[a]	4	0.001
Likelihood Ratio	19.523	4	0.001
Linear-by-Linear Association	10.590	1	0.001
N of Valid Cases	500		

a.   0 cells (0.0%) have expected count less than 5. The minimum expected count is 38.00.

4.3. Interpretation of result

From the result in the chi-square calculated above, it can be observed that the X^2_c 18.25, is greater than the Chi-square tabulated of 9.448 at the level of significance of 5% therefore, the null hypothesis which states that there is no significant relationship between processing times and skills acquired by the employees will be rejected. This indicates that there is a significant relationship between processing times and skills, acquired by employees.

4.3.1. Hypotheses Three

Ho₁: There is no significant relationship between project lead time and staff assignment.

Level of significance = 0.05.

Decision rule:- Accept Ho if X^2_c< value X^2_t or Significance is greater than 0.05.

Reject Ho if X^2_t> value X^2_t or level of significance less than 0.05

Hypothesis was tested using SPSS version 19 at 95% confidential interval. The result is depicted below.

Table 5 Relationship between Project Lead Time and Staff Assignment.

Statement	Agree	Disagree	Total
Staff assignment have direct influence on task scheduling	80	20	100
Staff assignment determine the due data	55	45	100
Task scheduling and staff assignment are closely related.	60	40	100
Integration of project scheduling and staff assignment can minimize cost	65	35	100
Project lead time depend on task scheduling and allocation of staff to the task	61	39	100
Total	321	179	500

Survey Analysis 2023.

Table 6 Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	15.785[a]	4	0.003
Likelihood Ratio	16.709	4	0.002
Linear-by-Linear Association	3.404	1	0.065
N of Valid Cases	500		

a.O cells (0.0%) have expected count less than 5. The minimum expected count is 35.80.

4.4. Interpretation of result

The chi-square table above indicates that, at the 5% level of significance, the X2c computed value of 15.785 is bigger than the X2 tabulated value of 9.448. As a result, the null hypothesis—which claims that there isn't any meaningful connection between project lead time and staff scheduling—is rejected, suggesting that there is in fact a meaningful association.

4.4.1. Summary of findings

The following conclusions were reached after reviewing and analyzing the data

- There is a strong association between learning impact and lead time to accomplish a task.
- Processing times and staff skill acquisition are significantly correlated.
- Staff reductions and project lead times are significantly correlated.

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5. Conclusion

This study looks into the staff learning impact, processing delays, and project scheduling issues related to staff assignments. The goal of this choice is to keep project costs as low as possible. The labor cost savings are attained by choosing a labor-saving start time and labor level for every job. Based on this, the study concluded that since tasks in projects are often completed by teams, teamwork would become less efficient as the number of team members grows. It has been noted that when staff members are cognizant of the learning impact on them, they will carry out tasks more successfully and effectively. It was also shown that an employee's competence level affects how long the work takes to process.

Recommendation

The researcher offered the following suggestions in light of this. In industrial organizations, the goal of staff assignment should be to increase worker happiness. Manufacturing companies should prioritize staff training in order to reduce manufacture span and production costs when it comes to job scheduling, since the results of this study indicate that processing durations are dependent on the abilities of the individual assigned. In order to cut down on outsourcing costs, personnel learning effects should be taken into account prior to allocating workers to tasks for each period.

Compliance with ethical standards

Disclosure of conflict of interest

The authors report no potential conflict of interest and this work did not receive funding beyond the contributions of the authors.

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Appendix 1

Sample of the study

No.	Name of company
1.	Nigeria Breweries Plc, Ilesa
2.	Yinka Oba Foam, Ilesa
3.	Twins Farm Nigeria Ltd Osogbo
4.	Eagle Company Soap Ltd Osogbo
5.	Moshola Agro Allied Company Osogbo
6.	Oriyomi Art Gallery Osogbo
7.	Asodedero Ventures Osogbo
8.	Aderigbigbe Soap Company Osogbo
9.	Glorion Ventures Osogbo
10.	Rainbow Paint Ilesa