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Effect of Equipment Selection on Organisational Efficiency and Productivity

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Abstract

Equipment selection is a critical factor in the execution of many construction projects. A proper equipment selection is a very important activity for manufacturing systems due to the fact that improper equipment selection can negatively affect the overall performance and productivity of a manufacturing system. This paper critically examined the effect of equipment selection on organizational efficiency and productivity with a specific focus onCadbury Nigeria plc. This study employed a descriptive survey design. A sample size of 50 respondents was selected using a simple random sampling technique. Data from the questionnaire were analyzed using special software for statistics which is called statistical package for social science (SPSS) version 21. The study found out that there is a relationship between equipment selection and organizational efficiency and profitability. The study concludes that the final solution to selection and optimal disposition of equipment in production facilities includes detailed study made on the basis of technology, which is one of the most important aspects in the process of efficient investing. Therefore, it is important for the procurement department to reinforce and apply quality dimensions, such as performance, features, reliability, durability, prestige, serviceability, convenience, or aesthetics which define customers' satisfaction with the quality of goods or services in the selection of suppliers.

Keywords*: Equipment selection, Material handling, Organization, Profitability, Efficiency*

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Background to the Study

One of the parameters that provide minimum cost for the targeted production in a mine is surely the suitability of the machines/ equipment selected. Moreover, equipment selection directly affects the pit design and production planning. In open-pit mining, equipment selection is made according to many factors related to the ore and mining conditions. These factors can be qualitative and quantitative. The main purpose of equipment selection is to choose the optimum and cost-effective equipment by installing a decision-support system, which can analyze various and complex factors. The term optimum here reflects that the equipment selected must comply with the mining conditions/limitations and meet the basic requirements and preferences of the mine.

Various types of equipment selection models have been proposed to incorporate into a decision-support system for application to the selection of mining equipment. These models are life cycle cost analysis, net present value analysis, linear breakeven models, linear programming and decision making tools such as reliability analysis, knowledge-based expert systems and analytical hierarchy processes.

The basic principle in equipment selection is to define the degree of priority or governing factors among the ones given above and then determining the matching equipment and the alternatives to these parameters comparatively. In most instances, however, it is difficult to determine the equipment meets all the requirements stated.

A proper equipment selection is a very important activity for manufacturing systems because since the fact that improper equipment selection can negatively affect the overall performance and productivity of a manufacturing system. The outputs ofthe manufacturing system (i.e., the rate, quality, and cost) mostly depend on what kinds of properly selected and implemented pieces of equipment are used (Ayag and Ozdemir 2006). In addition to this, equipment selection has a major effect on the companies' global competitiveness. Using proper equipment can enhance the production process, provide effective utilization of manpower, increase production, and improve system flexibility. The importance of equipment selection cannot be overlooked. However, with the wide range of equipment available today, determination of the best equipment alternative for a given production scenario is not an easy task (Chan et al. 2001).

Selecting the new equipment is a time-consuming and difficult process, requiring advanced knowledge and experience deeply. So, the process can be a hard task for engineers and managers, and also for equipment manufacturer or vendor, to carry out. For a proper and effective evaluation, the decision-maker may need a large amount of data to be analyzed and many factors to be considered (Ayag and Ozdemir 2006). Although equipment selection plays an important role in the design of an effective manufacturing system, the publications on this subject are limited (Kulak et al. 2005). The studies performed could be classified into two groups as equipment selection and machine selection. One of the recent studies is by Standing et al. (2001) which uses multi-attribute utility theory to quantify the contribution of various structural and

infrastructural factors for an equipment selection decision. Tabucanon et al. (1994) developed a decision support system for multi-criteria machine selection problem for flexible manufacturing systems (FMS) and used the AHP technique for the selection process. Chen (1999) develops an integer programming model and a heuristic algorithm to solve the problem of multiple periods. Lagrangean relaxation is used to generate lower bounds for the integer programming model to evaluate the quality of the heuristicsolution. Machine selection from a fixed number of available machines is also considered by Atmani and Lashkari (1998), who developed a model for machine tool selection and operation allocation in FMS. Wang et al. (2000) proposed a fuzzy multi-attribute decision-making model to assist the decisionmaker to deal with the machine selection problem for an FMS. Dellurgio et al. (1997) present a Monte Carlo simulation model for designing and selecting integrated circuit (IC) inspection systems and equipment choices. Beaulieu et al. (1997) consider the cell formation and the machine selection problems for the design of a new cellular manufacturing system using a heuristic algorithm. Kulak et al. (2005) develop unweighted and weighted multi-attribute axiomatic design (AD) approaches for fuzzy multi-attribute equipment selection. These approaches include both crisp and fuzzy criteria.

The general Equipment Selection Problem (ESP) is to choose a collection of compatible, but not necessarily homogeneous, items of equipment to perform a specified task. In many applications, the task is to move a volume of material from a set of locations to a set of destinations. However, different equipment types have attributes that can interact in a complex way concerning productivity. In surface mining applications, the ESP addresses the selection of equipment to extract and haul mined material, including both waste and ore, over the lifetime of the mining pit. In this paper, we focus specifically on the truck and loader equipment selection problem for surface mine Before we discuss the literature on this problem or even define the problem and its solution formally, we provide a general background on surface mining and the parameters that are important in the quest to find a good ESP purchase the policy.

Research Objectives

The following are the knowledge gap the study intended to fill:

1. To determine the availability of raw materials components, tools, equipment influences organizational efficiency.
2. To know if maintenance and servicing of equipment improve organizational productivity.

Research Questions

The above-stipulated Objectives necessitate the need for the following research questions to be asked:

1. Does the availability of raw materials component, tools &equipment influence organizational efficiency?
2. Is there a significant relationship between maintenance and servicing of equipment and organizational productivity?

Hypotheses Formulation

The following are the tentative statement of the study:

- **H_{01}:** Raw materials component, tools & equipment does not influence organizational efficiency.
- **H_{02}:** There is no significant relationship between maintenance and servicing of equipment and organizational productivity

Literature Review

Since the 1990s, research concentrating on the selection and assignment of material handling equipment has been carried out, and significant achievements have been attained. Chakraborty and Banik applied the analytic hierarchy process (AHP) for selecting the best material handling equipment under a specific handling environment. The relative importance of each criterion and sub-criteria was measured using pair-wise comparison matrices, and the overall rankings of all the alternative equipment were then determined. To identify the most critical and robust criteria in the MH equipment selection process, a sensitivity analysis was also performed. Sujono and Lashkari proposed a method for simultaneously determining the operation allocation and material handling system selection in a flexible manufacturing environment with multiple performance objectives.

The selection and optimal disposition of equipment are important in any kind of work, especially in production jobs. They have the most important influence on the setup of a project when investment costs, which also include production costs, are calculated. The right selection and disposition of equipment demand a detailed study on the technology of the production process. Such an investment is a complex task and has to include methods of planning, project development, and evaluation, which provide accurate information about the effectiveness and exploitation effects of future investment. A specific methodology of investment project development, and evaluation is based on empirical methods, i.e. a method of individual expert evaluation. The process of planning depends on the research instrument this methodology provides us with. The selection and disposition of equipment in production facilities depend on the type of production, the kind of job and its complexity. It directly correlates with the job task and space where the equipment should be located.

The process of selection and optimal disposition of equipment in production facilities has to include an interdisciplinary approach, modern quantitative instruments for evaluating the goals and effects we want to achieve. It should also be mentioned, that the study of equipment selection is in correlation to other aspects of investing, which are not the subject of this paper. The main objective of this paper is to present a method of an analytical approach to the problem of selection and optimal disposition of equipment in production facilities. The intention also is to modify this method according to the demand of a particular investment, to rationalize the planned investment activities

Maintenance Approaches

A maintenance strategy involves the identification, researching, and execution of many repairs, replace and inspect decisions (Kelly, 1997). A maintenance concept can be defined as the set of various maintenance interventions (corrective, preventive, condition-based, etc.) and the general structure in which these interventions are foreseen (Pintelon and Waeyenbergh, 1999). Several maintenance approaches, i.e. strategies and concepts, have been developed and implemented through the evolution of maintenance. The maintenance has emerged from failure based maintenance, and has moved towards preventive and is now realized in the essence of process-oriented "holistic" approach (Alsyouf, 2007). Likewise, Waeyenbergh and Pintelon (2002) argued that maintenance has shifted from failure based on condition-based maintenance (CBM). The literature review can reveal the following concepts that underline maintenance discipline: reliability centered maintenance (RCM), total productive maintenance (TPM), business centered maintenance (BCM), Total Quality Maintenance (TQMain). Description of these maintenance concepts can be found in Kelly (1997), Waeyenbergh and Pintelon (2002), Swanson (2001) and Al-Najjar (1996). More recently, the focus has moved towards creating an internal and external Partnership.

The Relationship Between Quality, Productivity, and Maintenance

Much has been written in quality management literature considering quality. For instance, Flynn et al. (1994) define quality management as an integrated approach to achieving and sustaining high-quality output. Several studies have also investigated the link between quality performance and cost reduction. For example, Maani et al. (1994) showed that quality performance (in terms of scrap, rework, and customer complaints) has an impact on operational variables (i.e. production cost, on-time delivery, worker idle time, lead time, productivity), as well as the impact on business performance. However, interactions between quality and production can be also interpreted from the maintenance point of view. The primary output of production is the desired product and its secondary output is demand for maintenance, which is, in turn, an input for the maintenance function (Ben-Daya and Duffuaa, 1995). Hence, a strong maintenance program is needed to provide reliable equipment maintenance and reduce equipment process variation (McKone et al., 2001). Therefore, maintenance major role should be maintaining the quality of the elements involved in production instead of just jumping from one repair to another similar to fir men, according to Al-Najjar (2007). Also, it affects production by increasing production capacity and controlling the quality and quantity of output. When outlining the link between quality and maintenance, is also necessary to indicate that product quality, production cost, machine condition and its life length are not just influenced by the type of production machinery and maintenance policy, but also by the quality of the input of elements (such as raw material, production tools, methods and procedures, operating and maintenance staff competence and operating conditions) in the production process.

Methodology

Research Design

The research adopted the descriptive survey design and historical research design. Under the descriptive survey design, primary data was sourced with the use of questionnaires and personal interviews. The historical design helped source secondary data from logs, previous journals and report from the internet.

Data Source and Method of Collection

Data was obtained from primary and secondary sources. Questionnaires and personal interviews constitute the instruments used for primary data collection, while secondary data were obtained from journals, publications, newspaper, and internet facilities.

Sample Size and Sampling Technique

The convenience sampling technique was employed in getting the population sample. This technique involves the selection of respondents based on specific characteristics or qualities and eliminating those who fail to meet the criteria. The population for this study was estimated to be 1000 respondents, out of which 50 respondents were selected.

Research Instrument Specification

A questionnaire was used as a research instrument to collect data from the respondents. The questionnaire was divided into a section with respondents to decide on the choices of options as follows: Strongly Agreed, Agreed, Undecided, Disagreed, Strongly Disagreed. These questions were drawn from the research hypotheses of this study to elicit the view and opinion of respondents on the topic of the study.

Method of Data Presentation and Analysis

The correlation coefficient method was used in analyzing the gathered data and to test the research hypotheses through the use of an analytical software package: Statistical Package for Social Science (SPSS, Version 20). The regression coefficient is concerned with establishing the relationship that exists between the dependent and independent variables.

Presentation of Findings

Analysis of Research Questions

Table 1: Availability of Raw Materials Component, Tools, Equipment Influence Organizational Efficiency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	STRONGLY AGREE	40	80	80	80
	AGREE	10	20	20	100.0
	Total	50	100.0	100.0	

Source: Researcher's fieldwork

Table 1 shows that 20% of the respondents agree to the claim that the availability of raw materials components, tools, equipment influences organizational efficiency, while 80% strongly agreed. This implies that the majority of the respondents strongly agree that the availability of raw materials components, tools, equipment influences organizational efficiency.

Table 2: Employee Safety has A Significant Effect on their Performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	STRONGLY AGREE	30	60	60	60
	DISAGREE	1	2	2	62
	AGREE	19	38	38	100.0
	Total	50	100.0	100.0	

Source: Researcher's fieldwork

Table 2 shows that 38% of the respondents agree to the claim that employee safety has a significant effect on their performance, 2% disagreed, while 60% strongly agreed. This implies that the majority of the respondents strongly agreed that employee safety has a significant effect on their performance.

Table 3: Maintenance and Servicing of Equipment improves Organizational Productivity

		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	STRONGLY AGREE	40	80	80	80
	AGREE	10	20	20	100.0
	Total	50	100.0	100.0	

Source: Researcher's Fieldwork

Table 3 shows that 20% of the respondents agree to the claim that effective layout helps to reduce the cost of supplying raw materials, while 80% also strongly agreed. This implies that majority of the respondents strongly agreed effective layout helps to reduce the cost of supplying raw materials

Test of Hypotheses

Hypothesis One

H_1: Raw materials component, tools & equipment does not influence organizational efficiency.

α =0.01

Decision rule: If sig value ≤ 0.01, reject H_0

Table 4: Correlations

		Equipment	Organizational efficiency
Equipment selection	Pearson Correlation	1	.333**
	Sig. (2-tailed)		.009
	N	102	102
Employee performance	Pearson Correlation	.333**	1
	Sig. (2-tailed)	.009	
	N	102	102

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

Source: Field Survey (2019)

Interpretation: From the table above, the Sig. value (0.009) is less than 0.01, we therefore, reject H_0. Therefore, we conclude that there is a significant relationship between equipment selection and employee performance at a 1% significant level, also the Pearson correlation coefficient (0.333) shows that there is an average positive relationship between equipment selection and employee performance.

Hypothesis Two

H_2. There is no significant relationship between maintenance and servicing of equipment and organizational productivity.

α =0.01

Decision rule: If sig value ≤ 0.01, reject H_0

Table 5: Correlations

		Maintenance	Organizational productivity
Equipment Servicing	Pearson Correlation	1	.673
	Sig. (2-tailed)		.000
	N	102	102
Employee Effectiveness	Pearson Correlation	.673	1
	Sig. (2-tailed)	.000	
	N	102	102

Source: Field Survey (2018)

Interpretation: From the table above, the Sig. value (0.000) is less than 0.01; we therefore, reject H_0. Therefore, we conclude that equipment servicing and employee effectiveness at a 1% significant level, also the Pearson correlation coefficient (0.673) shows that there is a strong positive relationship between equipment servicing and employee effectiveness.

Conclusion

The selection of equipment needed for the realization of an intended investment and its optimal disposition involves studying the technology of the given production process. The selection and the optimal disposition of adequate equipment are the basic conditions for a successful project. Knowing that, a methodological and skillful approach to this problem includes necessary analysis, to get those solutions, which will implement a rational production, which on the other hand, will affect the total cost of equipment and exploitation during the economic life of an investment. The final solution to selection and optimal disposition of equipment in production facilities includes detailed study made on the basis of technology, which is one of the most important aspects in the process of efficient investing. We must also have in mind that we can get a valid solution only if we also analyze the other investment aspects, which were not discussed in this paper.

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