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# Factors Influencing Engineering Assets Management Decisions in Food Manufacturing Companies in Nigeria

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## Abstract

This chapter assessed the factors influencing Engineering Assets Management decisions in small and medium-scale food manufacturing companies in Southwestern Nigeria. Data were collected from 30 selected food manufacturing companies registered with National Agency for Food and Drug Administration and Control in the study area. The data were analyzed using descriptive and inferential statistics. The results reveal that food manufacturing companies practice some elements of Engineering Assets Management. There were no explicit guidelines and policy statements that guide their decisions and actions. However, a) how maintenance was to be carried out; and b) the amount and intensity of service that maintenance was expected to provide in order to satisfy the need of production, were the major factors that guided ways of making Engineering Asset Management decisions.

**Keywords:** *Food Manufacturing companies; Engineering assets management (EAM); Decisions; Policy*

## 1.0. Introduction

Engineering asset management (EAM) has been described as a series of systematic and coordinated activities and practices through which an organization optimally manages its assets, and their associated performance, risks and expenditures over their lifecycles for the purpose of achieving its organizational strategic plan (PAS 55, 2004). It involves the acquisition, operation, maintenance, and disposal of assets, to make use of the most of their service delivery potentials and manage related risks and costs over the full lifecycle of the assets. The benefits desirable from the use of an asset depends on the quality of decisions taken at every stage of its lifecycle. Decision-making is moving from the routinely subjective to using systematic, holistic, data driven, lifecycle and risk-based decision processes that are clearly aligned with the organization's strategic plan. Moving away from subjective decision making requires skills, techniques and processes that may not be part of the historical toolbox of those currently responsible for operating and maintaining engineering assets (Hodkiewicz and Pascual, 2006). When deciding on the most appropriate asset strategy, a range of maintenance options is considered which includes condition monitoring and inspection, preventive maintenance, design-out maintenance, rework, replacement and fault finding. The arguments for and against a particular activity are considered at the same time, usually by a small, on-site team who have a good understanding and knowledge of the equipment to be assessed (McAllister *et al.*, 2002).

A well-defined maintenance policy is essential to provide the goals and direction for maintenance management in a manufacturing industry. The maintenance policy ensures that important aspects of the plant production strategy as they apply to maintenance are understood and followed throughout the organization. Three main questions are considered important in establishing a comprehensive maintenance policy for any manufacturing installation (Wild, 1995), that is, what is to be maintained, what type of maintenance will be applied in each case and how should maintenance work be organized? For effectiveness of asset maintenance management, the maintenance policy must be well defined and it must establish a framework for requesting, planning, scheduling, executing, controlling and measuring cost and performance of maintenance services. The policy must also show how key maintenance personnel interact and depict how key operating staff and management personnel utilise or support maintenance services/programmes (Tomlingson, 1993). Mobley (2008) further noted that in order to improve asset investment decision-making and achieve sustainable improvements in business performance, a holistic approach that addresses not only infrastructural assets, but also supports the critical people, business processes, data and enabling technologies should be adopted. The holistic approach to lifecycle asset management enables effective management of vast amounts of asset data so that it can be leveraged at a practical day-to-day business level. Then, one can institutionalize asset management and make it a focus of the day-to-day business. Only by incorporating asset management into the daily business routines can measurable cost savings and performance improvements that are sustainable over time be achieved. Engineering industries strive continuously to reduce costs and optimize the use of available assets (Oliver, 2004). It is important that all the details must be well communicated and understood by all personnel involved in the maintenance activities. The maintenance policy of an organization is determined by the management of the organization with very strong consideration of the overall production objective (or policy) of the organization (Okah-Avae, 1996). Asset Management policies force the stakeholders to detail and prioritize the services they are responsible for. The submissions must include a listing of the physical assets needed to deliver those services. The service delivery criteria then becomes a function of the status or condition of the assets. If the assets are neglected then the level of service will decline. Each year, the condition of the assets is inspected and appropriate replacement, repairs and maintenance strategies are implemented using the quality-of-service delivery as the benchmark. A high level of service requires assets that are reliable, effective and efficient (Wilson, 2004). Armstrong and Wilson (2004) stated that in formulating maintenance policies for any manufacturing, infrastructure, utilities, or building environment, the complete range of issues should be addressed. The policies developed may be unique for any individual maintenance operation, for each different situation or they may be copied from elsewhere. Whatever the origins, the policies and the associated best practices should be credible, and be designed and developed in a coordinated way. The more structured approach of scheduled, defined and documented inspection rounds was one of the fundamental concepts that came to be known as "Planned Maintenance".

Businesses competing at a global level can no longer rely on design and heavy maintenance regimes in order to meet the requirements of today's lean manufacturing environment. Hence, asset managers need to be in control of their business performance and ensure that maximum capacity is achieved for minimal capital invested (Drew, 2004). Modern management practices gradually drifted towards quarterly-adjusted business performance measures, with little room for long-term outlooks (Wilson, 2004). The activities involved in managing the performance of assets are many and varied. However, they can be divided into three distinct but overlapping, domains: strategize, execute, and evaluate as stated by Oliver (2004). Asset performance management involves activities that ensure that the asset management system and all of its subsystems (processes, practices, departments, teams, employees, etc.) are working together in an optimum fashion to achieve the desired results and are consistently met in an effective and efficient manner. Achieving the overall goal requires several ongoing activities, including identification and prioritization of desired results, establishing the means to measure progress toward those results, setting standards for assessing how well results are achieved, tracking and measuring progress toward results, exchanging ongoing feedback among those participants working to achieve results, periodically reviewing progress, reinforcing activities that achieve results and intervening to improve progress where needed (McNamara, 2008).

Literature describes the Nigerian manufacturing operating environment as being harsh (Olagunju *et al.*, 2020). Most firms use a mix of imported and locally made manufacturing equipment and machinery (Olagunju *et al.*, 2020). Imported machines have been reported to be very expensive due to unfavourable currency exchange rates. This also affects maintenance and repair activities as most firms find it difficult to procure needed parts. Locally fabricated machines have been reported to break down very frequently (Adejuwon *et al.*, 2014). This situation therefore makes it imperative to study the factors influencing EAM decisions in the manufacturing sector in Nigeria. This is with a view to informing management practice and recommending policy measures for improving assets management in the industry. The study is conducted in the food and beverage sector which is one of the most vibrant manufacturing segments in Nigeria.

## 2.0. Methods

### 2.1. Participants

The study employed a descriptive method of survey. It covered selected small and medium-scale food manufacturing companies in Lagos, Oyo, Ogun, and Osun States in Southwestern Nigeria. Purposive sampling was employed to select 30 small and medium-scale food manufacturing companies registered with the National Agency for Food and Drug Administration and Control (NAFDAC) within the study area according to their relative proportion. The proportions of the sample among the states were as follows; Lagos (40%), Oyo (20%), Ogun (25%), and Osun (15%). Data were obtained through a set of questionnaire. The questionnaire was administered on owners/chief executive officers and other top officials in the companies.

### 2.2. Design

A set of questionnaire and well guided oral interviews were used to collect data. The questionnaire was used to collect information on factors influencing EAM and replacement decisions in the food companies, and the level of importance attached to decision making factors during the process of equipment acquisition. It was also used to collect information on existing food manufacturing companies that have EAM policies in place and extent of consideration of various factors in formulating their maintenance culture.

2.3. Procedure

The existence of EAM policies among food manufacturing companies were determined using frequency distribution and simple percentage (descriptive statistics). This was with the view to knowing those that have them in place. Furthermore, analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) were carried out on factors influencing EAM and replacement decisions in the food companies, level of importance attached to decision making factors during the process of equipment acquisition and extent of consideration of various factors in formulating their maintenance culture. The DMRT and ANOVA was used to separate the means and establish the significant differences ($P<0.05$) that exist among means with different letters.

**3.0. Results**

Twenty-one food manufacturing companies responded out of 30 sampled in the following proportions among the states; Lagos (38.1%), Oyo (28.6%), Ogun (19%) and Osun (14.3%).

3.1. Existence of engineering asset management policies

Table 1 shows that 76.2% of the food manufacturing companies do not have EAM policies in place the guide their actions. The oral interview conducted and personal observations revealed that maintenance functions only operate through informed decisions on assets' maintenance activities. However, only 23.8% of the companies in the study area have EAM policies in place.

3.2. Factors Influencing EAM Decisions

The factors influencing engineering assets acquisition and replacement decisions were rated moderately high and significantly ($F=1.67$, $P<0.05$) the same (Table 2). These factors were operating requirements (3.86), maintaining requirements (3.81), equipment manufacturer (3.52), inflation and cost recovery possibilities (3.29), design considerations (3.19), possibilities of the introduction of new technologies (3.14), concept development of assets (3.00) and investment alternative competing for limited funds (3.00). The only factor that was significantly lower ($F=1.67$, $P<0.05$) was disposal possibilities – salvage value and use of assets market (2.90). This implies that the factor was usually given low consideration while taking decisions on assets acquisition.

Table 3 shows the mean ratings of factors that were considered while making decisions on the acquisition of the equipment and machinery by the companies. There were significant differences ($F = 5.44$, $P<0.05$) among the ratings.

**Table 1**: Existence of Engineering Assets Management Policy in the Food Companies

| Engineering Assets Management Policy | Frequency | Percent % |
|---|---|---|
| Yes | 5 | 23.8 |
| No | 16 | 76.2 |
| Total | 21 | 100 |

**Table 2:** Factors Influencing Engineering Assets Acquisition and Replacement Decisions in the Food Companies.

| Factors | Ratings: Frequency (%) | | | | | |
|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | Mean Rank |
| Operating requirements | - | 7 (33.3) | 7 (33.3) | 6 (28.6) | 1 (4.8) | 3.86[a] |
| Maintaining requirement | 7 (33.3) | 8 (38.1) | 3 (14.3) | 2 (9.5) | 1 (4.8) | 3.81[a] |
| Equipment manufacturer | 5 (23.8) | 8 (38.1) | 4 (19.0) | 2 (9.5) | 2 (9.5) | 3.52[ab] |
| Inflation and cost recovery possibilities | - | 2 (9.5) | 7 (33.3) | 10 (47.6) | 2 (9.5) | 3.29[ab] |
| Design considerations | 4 (19.0) | 4 (19.0) | 8 (38.1) | 3 (14.3) | 2 (9.5) | 3.19[ab] |
| Possibilities of the introduction of new technologies | 4 (19.0) | 3 (14.3) | 8 (38.1) | 5 (23.8) | 1 (4.8) | 3.14[ab] |
| Concept development of assets | - | 8 (38.1) | 9 (42.9) | 1 (4.8) | 3 (14.3) | 3.00[ab] |
| Investment alternative competing for limited funds | 2 (9.5) | 5 (23.8) | 7 (33.3) | 6 (28.6) | 1 (4.8) | 3.00[ab] |
| Disposal possibilities - salvage value and use of assets market | 3 (14.3) | 3 (14.3) | 7 (33.3) | 6 (28.6) | 2 (9.5) | 2.90[b] |

Key: very high = 5, high = 4, moderately high = 3, fairly high = 2, not at all relevant = 1'Means with the same letter are not significantly different (F=1.67, P<0.05).

Factors like functionality (3.90), equipment capacity (3.86), reliability (3.81), availability of spare parts (3.71), warranty (3.67), life of assets (3.52), lifecycle cost (3.48), operation cost (3.48), maintenance cost (3.48), ease of maintenance (3.43), and track record of the manufacturer (3.43) were rated important and significantly the same (F = 5.44, P<0.05). Strain characteristics (2.95), obsolescence (2.86), paints and sealants (2.86), and disposability/salvage value (2.76) were significantly lower than other factors in terms of their contributions to acquisition decision making.

The factors that were considered in formulating maintenance policy and decisions are shown in Table 4. These factors were; how the maintenance was to be carried out (3.52), and the amount and intensity of service that maintenance was expected to provide in order to satisfy the need of production (3.14). The ratings of the extent to which these factors influenced policy decisions were not significantly different (F=3.60, P<0.05). Other factors that were significantly different (F=3.60, P<0.05) and less considered include; guidelines on the limits of expenditure within which maintenance is to operate (3.00), how operation is to support maintenance activities (2.90), and the appropriate levels of authority for maintenance crew to act (2.71). According to Wild (1995), all the factors are very important in designing an effective maintenance policy for organizations. Table 5 shows that there were significant differences (F=1.37, P<0.05) among the ratings of level of importance attached to factors in developing maintenance policy framework. The factors that were important and significantly the same (F=1.37, P<0.05) include; planning of maintenance services (3.67), controlling of maintenance services (3.48), performance of maintenance services (3.43), execution of maintenance services (3.38), requesting of maintenance services (3.33), and scheduling of maintenance services (3.29). The only factor that was significantly lower (F=1.37, P<0.05) and less important was the working cost of maintenance services (3.14).

## 4.0. Discussion

The study assessed the various factors influencing engineering assets management decisions in SMEs in the food processing industry in Southwestern Nigeria. The result of the study revealed that food manufacturing companies are practicing some elements of EAM. As EAM policy requires well-detailed and prioritized activities which people within the organisation are responsible for as the process goes on, the majority (76.2%) of the companies did not have an explicit maintenance policy. Engineering assets acquisition and replacement decisions in food manufacturing companies are highly influenced by operating requirements, maintaining requirements, equipment manufacturer, inflation and cost recovery possibilities, design considerations, possibilities of the introduction of new technologies, concept development of assets and investment alternative competing for limited funds. However, their decisions were not influenced by disposal possibilities (salvage value and use of asset market) of the assets.

During the decision-making process for equipment acquisition, food manufacturing companies used functionality, equipment capacity, reliability, availability of spare parts, warranty, life of assets, lifecycle cost, operation and maintenance costs, ease of maintenance and track record of manufacturer as important decision-making criteria.

**Table 3:** Level of Importance Attached to Decision Making Factors during the Process of Equipment Acquisition

| Decision Making Factors | Ratings: Frequency (%) | | | | Mean Ratings |
|---|---|---|---|---|---|
| | 4 | 3 | 2 | 1 | |
| Functionality | 19 (90.5) | 2 (9.5) | - | - | 3.90[a] |
| Equipment capacity | 18 (85.7) | 3 (14.3) | - | - | 3.86[ab] |
| Reliability | 17 (81.0) | 4 (19.0) | - | - | 3.81[ab] |
| Availability of spare parts | 15 (71.4) | 6 (28.6) | - | - | 3.71[abc] |
| Guarantee | 15 (71.4) | 5 (23.8) | 1 (4.8) | - | 3.67[abcd] |
| Life of assets | 12 (57.1) | 8 (38.1) | 1 (4.8) | - | 3.52[abcde] |
| Lifecycle cost | 12 (57.1) | 7 (33.3) | 2 (9.5) | - | 3.48[abcdef] |
| Operation cost | 11 (52.4) | 9 (42.9) | 1 (4.8) | - | 3.48[abcdef] |
| Maintenance cost | 11 (52.4) | 9 (42.9) | 1 (4.8) | - | 3.48[abcdef] |
| Ease of maintenance | 12 (57.1) | 6 (28.6) | 3 (14.3) | - | 3.43[abcdefg] |
| Track record of manufacturer | 11 (52.4) | 9 (42.9) | - | 1 (4.8) | 3.43[abcdefg] |
| Environmental factor | 11 (52.4) | 7 (33.3) | 3 (14.3) | - | 3.38[abcdefg] |
| Adaptability | 8 (38.1) | 10 (47.6) | 3 (14.3) | - | 3.24[abcdefgh] |
| Design limitations | 7 (33.3) | 11 (52.4) | 3 (14.3) | - | 3.19[abcdefgh] |
| Support documents | 6 (28.6) | 12 (57.1) | 3 (14.3) | - | 3.14[abcdefgh] |
| Stress characteristics | 6 (28.6) | 10 (47.6) | 4 (19.0) | 1 (4.8) | 3.00[abcdefgh] |
| Strain characteristics | 5 (23.8) | 11 (52.4) | 4 (19.0) | 1 (4.8) | 2.95[gh] |
| Obsolescence | 6 (28.6) | 7 (33.3) | 7 (33.3) | 1 (4.8) | 2.86[h] |
| Paints and sealants | 6 (28.6) | 7 (33.3) | 7 (33.3) | 1 (4.8) | 2.86[h] |
| Disposability/salvage value | 4 (19.0) | 10 (47.6) | 5 (23.8) | 2 (9.5) | 2.76[h] |

Key: Very Important = 4, Important = 3, Fairly Important = 2, Not Important = 1. Means with the same letter are not significantly different (F = 5.44, P<0.05).

**Table 4:** Extent of Consideration of Various Factors in Formulating Maintenance Culture in the food Companies

| Factors Considered | Ratings: Frequency (%) 4 | 3 | 2 | 1 | Mean Rank |
|---|---|---|---|---|---|
| How the maintenance is to be carried out? | 12 (57.1) | 8 (38.1) | 1 (4.8) | - | 3.52[a] |
| Amount and intensity of service that maintenance is expected to provide in order to satisfy the need of production. | 6 (28.6) | 12 (57.1) | 3 (14.3) | - | 3.14[ab] |
| Guidelines on the limits of expenditure within which maintenance is to operate. | 5 (23.8) | 11 (52.4) | 5 (23.8) | - | 3.00[b] |
| How operation is to support maintenance activities? | 6 (28.6) | 7 (33.3) | 8 (38.1) | - | 2.90[b] |
| The appropriate levels of authority for maintenance crew to act. | 3 (14.3) | 11 (52.4) | 5 (23.8) | 2 (9.5) | 2.71[b] |

Key: greatest extent = 4, greater extent = 3, great extent = 2 and no consideration = 1
Means with the same letter are not significantly different (F=3.60, P<0.05).

**Table 5:** Level of Importance Attached to Factors in Developing Maintenance Policy Framework in the Companies

| Framework | Ratings: Frequency (%) 4 | 3 | 2 | 1 | Mean Rank |
|---|---|---|---|---|---|
| Planning of maintenance services. | 14 (66.7) | 7 (33.3) | - | - | 3.67[a] |
| Controlling of maintenance services. | 10 (47.6) | 11 (52.4) | - | - | 3.48[ab] |
| Performance of maintenance services. | 10 (47.6) | 10 (47.6) | 1 (4.8) | - | 3.43[ab] |
| Executing of maintenance services. | 10 (47.6) | 9 (42.9) | 2 (9.5) | - | 3.38[ab] |
| Requesting of maintenance services. | 9 (42.9) | 10 (47.6) | 2 (9.5) | - | 3.33[ab] |
| Scheduling of maintenance services. | 10 (47.6) | 7 (33.3) | 4 (19.0) | - | 3.29[ab] |
| Working cost of maintenance services. | 7 (33.3) | 10 (47.6) | 4 (19.0) | - | 3.14[b] |

Source: Field Survey 2009
Key: very important = 4, important = 3, fairly important = 2 and not important = 1
Means with the same letter are not significantly different (F=1.37, P<0.05).

However, there is still much need to take stress and strain characteristics, obsolescence (functional and economical) and disposability/salvage value into consideration.

When formulating maintenance culture in food processing companies, guidelines about limits of expenditure within which maintenance is to operate, how maintenance is to be carried out, how operation is to support maintenance activities, and the amount and intensity of service that maintenance is expected to provide in order to satisfy the need of production are considered to a great extent. However, emphasis should be placed on appropriate levels of authority for maintenance crew to act. However, in developing maintenance policy framework, the results reveal that planning of maintenance services, controlling of maintenance services, performance of maintenance services, execution of maintenance services, requesting of maintenance for services, scheduling of maintenance services and the working cost of maintenance services are very important.

## 5.0. Conclusion

In conclusion, food manufacturing companies have to be more explicit when formulating their EAM guidelines and policy statements rather than informed instructions on how EAM decision and actions are to be taken. Also, important factors like asset obsolescence and disposability should be taken into consideration when making decision on equipment acquisition in food manufacturing companies.

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