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Comparative Assessment of Productivity Measurement Techniques inProduction Industries

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ABSTRACT: This study addresses effective measurement productivity in production firms; aiming at improving productivity growth of these firms. The main focus is on suitability of productivity measurement practices, in manufacturing firms of developing countries and compares with the current trends in developed countries. Presented in this paper also, are findings from literature and survey experiments. The experiment was focused on approaches used by industries to measure productivity. The achievable outcome served as a motivation for development of Nano-technique, which produced effective results forproductivity measurement process. Nano-technique was developed in order to assist in reducing the differences that exist between theory and practice of productivity measurement as well as bridge the gap of system evaluation approaches between small and medium size production firms in developing and developed economies.

Keywords: Effectiveness,Improvement,Measurement,Nano-Technique,Productivity.

I. INTRODUCTION

Every production system has a desire for continuous improvement, as well as increase in efficiency and effectiveness of its production process. This desire is simplified by strategy, and methods of operation. However, the major challenge of modern production systems is how to approach its production plan and implement developed strategies from the plan, for optimum service delivery. Productivity is a measure that shows the relationship of output produced to input resources consumed by the production process. But, the big question which most production firms are faced with is what are the inputs and outputs of the production process? In practice, productivity concept possesses a vague definition and poor understanding [1]. This poor understanding stems from the general perception of productivity concept, despite specific requirement in usage and application.

More so, [2,3] observed that productivity data from management literatures are case-study dependent rather than systematic empirical data.This has contributed to the misconception of productivity measurement in practice. In spite of diverse perspectives, strategies and approaches on measurement of productivity, most production systems still struggle with ways of combining key input factors to obtain maximum result[4]. The challenge of best input factor mix, indirectly affects productivity measurement process.Productivity measurement is easy to understand at a conceptual level; however in practise, certain problems can be encountered in the process [5] hence the need to adequately understand the system process, its characteristics and select effective and suitable approach for data collection and computation.Further, [6] noted that effective productivity measurement can be achieved and best controlledby proper involvement of all production units in effective data collection.

This paper proposes a technique for suitable productivity measurement and improvement at firm level. The technique presented, adopts a lean systematic approach which helps to identify inputs and outputs of a production process before measurement.Also, this outlines available productivity evaluation measures and measurement techniques that exist both in practice and theory thus provide a roadmap for productivity measurement in manufacturing and service industries. Further, an effort is made towards improving the overall productivity and performance of a production process by the use of a suitable productivity measurement approach is captured. The study objective is to indicate available measurement techniques and recommend suitable techniques for productivity evaluation and improvement in production firms. Emphasis is drawn to specific features, usage benefits and application of Nano-technique which is developed to effectively measure productivity.

II. PRODUCTIVITY MEASUREMENT

Productivity measurement is a quantification process where valid data and information are collected and computed for the

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purpose of effective decision making and overall management with improvement as an objective. […..] Many small and medium size manufacturing firms in developing world are faced with the challenge of system dynamics, such as the introduction of new technology in their production systems. A good production system is one with a closed loop network of all units of production. According to[6]; these units cannot be effectively networked and controlled for efficient production without adequate collection and analysis of data through productivity measurement process.

Contextually, productivity measurement is the main vein for informed decision process and effective management of operations. Although, there are different views of productivity by different disciplines of study, all views have improvement as a common aim as there is neither a unique purpose nor a sole measure of productivity [7].

2.1 Types of Productivity Measurement Techniques

There are two main approaches to measure productivity at a firm level: total productivity and partial productivity. Both approaches can be used at any level of the firm; either at the high organizational level or lower levels of management and operations. Accordingly, the choice of approach is predetermined by the aim and objective of measurement process, although organizational level measurement is considered to be different from lower levels [1]. Table 1 presents only examples of partial productivity measures, (Single-factor and Multi-factor productivity) that are frequently used by Small and Medium Enterprises (SME)s as indicated in Fig 1.

Table 1: Overview of main productivity measures.[after: [7]

TYPE OF OUTPUT MEASURE	**TYPES OF INPUT MEASURE**			
	LABOUR	**CAPITAL**	**CAPITAL and LABOUR**	**CAPITAL, LABOUR and INTERMEDIATE INPUTS (Energy, Materials, Services)**
GROSS OUTPUT	Labour Productivity (based on gross output)	Capital productivity (based on gross output)	Capital-Labour (MFP) [based on gross output)	KLEMS Multifactor productivity
VALUE ADDED	Labour Productivity (based on value added)	Capital Productivity (based on value added)	Capital-Labour (MFP) (based on value added)	
	Single Factor Productivity (SFP) measures		**Multifactor productivity (MFP) measures**	

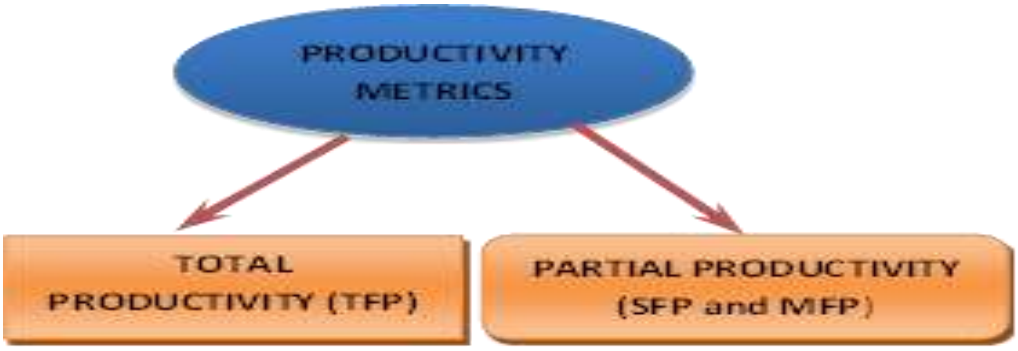

Figure 1: Productivity measurement Approach.

III. PRODUCTIVITY MEASUREMENT METHODS AND STUDY APPROACH

Due to changes in production system structure over time which occurs as a result of adjustments and additions of units, productivity measurement process can only be suitable when an adequate approach is selected to serve the purpose of measurement. Researchers [2-6] have revealed that there is neither unique purpose nor a single measure for productivity measurement. Thus, productivity measurement objectives include: efficiency, real cost savings, benchmarking, and other specific process improvements.

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The study approach presented here, adopted a descriptive aetiology to gather information on empirical techniques used in firms to measure and evaluate productivity. Data was collected with the use of questionnaire survey and review of literature on the subject.

3.1 Measurement Approach and Selection Process

Productivity measurement of a firm is classified under micro-level measurement. Indeed [5], revealed an increasing shift of Total Factor Productivity(TFP) study from macro and micro level towards firm/plant level due to many factors which include: improvement of data availability and computational power among others. Moreover, productivity measurement methods are classified into two main categories. This classification is done based on the size of the industrial system and its outputs.

3.2 Approach Selection and Firm Specifics

Figure 1 further presents measurement approach model of total factor productivity (TFP) and partial productivity which could either be measured by a single factor (SF) or multiple factors. In this model, a set of maximum outputs obtainable from a given set of inputs and technology.

There are different reasons for measuring productivity of a production firm. The defined purpose predetermines what components of production to select and measure. For the purpose of assessing the firm's productivity growth, two methods can be used as presented in a productivity growth measurement model[7,8].

From the model, Frontier approach identifies technical efficiency role in overall performance of a firm. Also, frontier approach is suitable for describing firm behaviour as a result of its benchmarking characteristics of comparing actual performance output to best while Non-Frontier assumes technical efficiency for firms [7]. This model can also be used as a guide for selecting an approach multifactor productivity Model based on the firm specifics (stochastic and deterministic) and their alignment with purpose of measurement. For- instance growth accounting measure is condemned for its inability to account for relationship between input factors and growth, [8].

A survey of some production firms revealed that the various reasons for productivity measurement by firms selected at random. Data from the survey is presented in Fig 2.

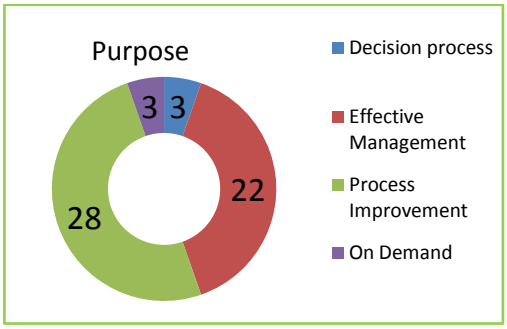

Figure 2(a)

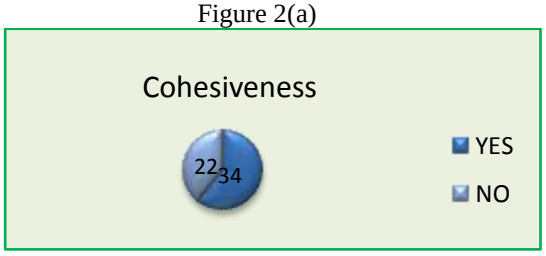

Figure 2(b)

Figure 2: (a) Firms Purpose of Productivity measurement. (b) Cohesiveness of factors used for computation of productivity measurement analysis.

Fig. 2 (a) shows that a fifty out of fifty-six surveyed firms conduct productivity measurement for the purpose of effective management and system improvement. While Fig. 2(b) presents that about 60% of the entire firms aligned the purpose of measurement to the approach adopted.

IV. FINDINGS

In this study, [2]labelled productivity as a measurement of ignorance, with reasons tied to the difference that exist in productivity results despite improvement made on measurement and control of technological factors of production. Variations in management practices and avoidance of management changes were provided as the explanation to prevalent differences in productivity measurement at a firm level.

The survey experiment result indicated that a greater percentage of Nigerian manufacturing firms have knowledge of system evaluation. About thirty-four representing (60%) of them conduct system evaluation annually as presented. Although, forty-six representing (80%) of these firms claim to have knowledge on productivity, most of them measure carry out performance measurement by use of overall Equipment Effectiveness (OEE) and Capacity Utilization (CU) measurement tools. This confirms the inference of [6] which referred to productivity as a measurement of ignorance.

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4.1: Awareness

Furthermore, Fig. 2 explains the knowledge of productivity techniques (TFP and MFP) are very low as compared to performance techniques (OEE and CU) having a combined ratio 1:8. This implies that, one out of every eight SME firms has knowledge of productivity measurement tools and technique. This revelation serves as an indicator, implying that increase in productivity of a manufacturing system can be triggered by creating an effective awareness on importance and application productivity concept in industries.

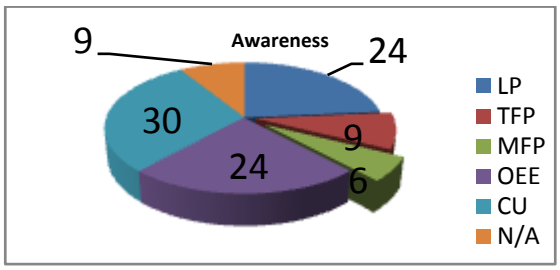

Figure 3: showing frequency of firms' awareness of productivity and performance measurement tools.

4.2 Significance of study and discussion

The perception of productivity measurement and adopted measurement techniques in industries has led to development of a systematic approach that includes lean manufacturing Plan-Do-Check-Act (PDCA) approach and six-sigma Define-Measure-Analyze-Improve-Control (DMAIC) improvement strategy. Nano-Technique is developed to assist manufacturing firms in Nigeria evaluate their production system on a nano scale. Study from [10], revealed the characteristic of scale point to far ground-breaking change that spreads to multi-industries. This technique is holistic, as it emphasizes adequate understanding of measurement purpose, proper selection of measurement tools, parameters to measure as well as methods for data collection. Apart from its importance, is quite necessary to ensure that data is periodically collected from a production system in order to inform decision process and enable effective management and adequate synchronization of most influencing input factors for improved efficiency. Production time and cost reduction, as well as resource utilization in production will be achieved.

4.3 Limitation

In this study, the technique proposed in this paper was tested by endorsement on small and medium production firms (SMEs) of a developing country in Nigeria. However, the technique can be used to evaluate other sizes of production firms as it is flexible enough to accommodate other firm specifics and deliver effective results.

V. CONCLUSION

Although there is a gap between academic framework and practical application of productivity theory due to certain misinterpretations in industry, technological changes and other intangible factors, Nano-technique has been endorsed as suitable for manufacturing firms' evaluation. Nevertheless, service firms can adopt this approach; owing to its holistic characteristics which can bring to bare relevant key production factors (KFPs/KPIs) that are intangible and extensively influence the productivity process of service firms.

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