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The impact of technological innovation on SME's profitability in Nigeria

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Abstract: There is no doubt that new or improved product or process of production continues to create firm's competitive advantage over others in the market. This study examined the impact of research and development (R&D) expenditure, product and process innovations on small and medium enterprises (SMEs) performance in the manufacturing industry in Nigeria using a survey of 1,000 SMEs with a response rate of 52.1% in year 2009. The results with least squares method showed that R&D spending by the firms as well as product and process innovation has significant impacts on the firm's performance with the probability value of 0.0529, 0.0624 and 0.0086 respectively at 10% level of significant. Also, training of workforce constitutes the major innovation activities in the Nigerian manufacturing SMEs as against in-house and outsourced R&D activities. This study suggests improvement in R&D spending and other technological activities which are expected to increase SMEs' profitability and thus generate more employment in the country.

Keywords: innovation; technological innovation; small and medium enterprises; manufacturing industry; profitability; research and development; R&D.

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1 Introduction

Globally, innovation is recognised as a vital driver of economic growth and development (Bosworth and Collins, 2003). The impact of which has been felt on business activities as it leads to new products and services with improve quality and lower cost of production (Rose et al., 2009). Based on Schumpeter's description of innovation, Organisation for Economic Cooperation and Development (OECD) *Oslo Manual* (2005) extracted four different innovation types which are grouped into technological and non-technological innovations. Product and process are closely related to the concept of technological innovation, whereas, marketing and organisational are referred to as non-technological innovation. This study focus on technological innovation, defined as the technical process through which new and/or improved technologies are developed and proliferated through commercialisation (Ambuj and Zwaan, 2006; Lee et al., 2011). Notably is the firms' deployment of technological innovation as a strategic catalyst to maintain sustainable growth in today's global and competitive business environments (Wei, 2012). This is apparently credited to two contending tendencies, the globalisation of economic activity and the localisation of industries. Globalisation fundamentally influences all fields of businesses, including production with the role of large multinational companies determining the development of their sectors globally by setting the trends of technical/technological innovation and also by applying and disseminating cutting-edge management approaches (Chikan and Demeter, 2003). While trends towards globalisation of industries and companies have appeared to reduce the importance and distinctiveness of regions, a tendency towards localisation of certain industries and economic activities seems to do exactly the opposite (OECD, 2000). By this we are referring to user-producer relationships syndrome in the innovation process that domestic demand gives local firms an advantage over the foreign counter-parts in perceiving the local demand preferences. This is so because user-producer interaction are more efficient within countries, but not in the case of exportation (Beise and Gemunden, 2004). Interest in localised groups of firms in related industries has grown in lips and bounds across countries with Nigeria inclusive. These successes have been recorded in form of clusters comprising of small and medium enterprises (SMEs) such as the one found in Otigba and Nnewi industrial estates of Nigeria. These firms mostly belong to the manufacturing sector have contributed marginally to the growth of the Nigeria's economies in recent times with their average contributions far less than 10% of the gross domestic products

(GDP) unlike their counterpart from Malaysia with about 45% GDP contributions (Atoyebi et al., 2014).

In today's growing multifaceted world, small and mid-size enterprises (SMEs) are concentrating more on using technology to spur growth, client value and market differentiation as such, these businesses are embracing innovative technologies for breakthrough change and diversification and this is eventually the case in a recovering global economy (Peter, 2011). Technological innovation is an important means to stimulate economic efficiency of SMEs and a source to attain a sustainable development (Bala-Subrahmanya et al., 2010). Essentially, if the SMEs must adapt to the changing external environment and meet market needs, they must take technological innovation as the basic way (Bala-Subrahmanya, 2012). In fact, the progressive development and growth of most successful SMEs is relying on continued technological innovation (Sun, 2009).

In advanced economy, SMEs played an essential role in driving economic growth through investment in fixed assets, generating exports and promoting technology integration. It is observed that in some newly industrialised countries like Taiwan, Malaysia, South Korea and Singapore, SMEs have powerfully dictated not only on industrial production strategies but also on the export earnings (Ehinomen and Adeleke, 2012). Notably, SMEs constitute the production wheels for the large scale enterprises of these countries, and as pointed out by Adeleke (2002), SMEs act as impetus of accelerated economic growth and development. However, the much anticipated accelerated pace of economic development through SME has not been reached in Nigeria (Awe, 2012).

The Federal Government of Nigeria in its effort to make SMEs more effectual in the economy and in lieu to ensure balance industrial development has decided to promote their development in domestic industrial activities. This is aimed at repositioning the sector for international competitiveness and also to make it source of export earnings in a global economy (Ehinomen and Adeleke, 2012). To this end productivity of the SMEs can be further improved through technological innovation and engaging in research and development (R&D) related activities. Nevertheless, the innovative capacity of SMEs significantly varies depending on their sector, magnitude, target, resources, locations and the opportunities accrued to such business environment in which they operate (Burrone and Jaiya, 2005). It is in lieu of this that this study seeks to establish the magnitude and direction of relationship between firm's performance (profitability) and technological innovation in Nigeria.

Nigerian government has a vision of becoming among the top 20 economies by the year 2020 which is termed 'vision 20:2020'and manufacturing sector is being considered as a key sector in realising this vision. The Nigerian government has recently focused on the development of manufacturing sector so as to build indigenous capacities as well as preventing the country from 'Dutch disease' which arise as a result of over reliance on the petroleum industry. Despite the governmental efforts on this sector, the contribution of the sector to GDP is still relatively low (less than 5%) when compared to other Sub-Saharan African countries (average of 30%) (World Bank, 2010). SMEs dominate the large proportions of firms in the manufacturing sector in Nigeria, and there is dearth of studies in the area of harnessing technological innovations to drive profitability of SMEs in the Nigerian manufacturing sector. As a result, this study seeks to fill such gap in the literature by examining the technological innovation and profitability of Nigerian SMEs in the manufacturing sector.

2 Background to the study

This section discusses some basic concept of technological innovation as it affects SMEs as well as the literatures of some scholars.

2.1 Concept of technological innovation

Schumpeter (1939) defined technological innovation as a new means of combining factors of production resulting from a change in inputs to produce outputs. Schumpeter regarded the process of technological innovation as sequential and central to an understanding of economic growth.

Maclaurin (1953) identified five steps leading to technological innovations which are research on pure sciences, invention, innovation, finance, and acceptance (or diffusion). Such a standardised theory perceived innovation as a process of technological changes.

Jiaji et al. (2000) ascertain that technological innovation is a unified process which entails activities of technology, organisations, business and finance. It means that the entrepreneurs seize the market prospects for commercial benefits as the goal to create a stronger performance, more efficient and lower cost of production and operation system. From this process, new products and production method are introduced, new markets are exploited, new raw materials or semi-finished products are obtained and new business organisations are formed.

Jiang (2001) examines the dynamic mechanism of technological innovation activities. The work argued that the main driving force of technological innovation of enterprises consists of six important factors. These factors include the benefit drive, the market or social demand pull, the driving force of enterprise employees, the corporate image and the driving force of technological development, market competition and the driving force of government. The first four are the internal forces which make enterprises accumulate technological capability, carry on technological innovation, and rest are external which force enterprises to produce innovation behaviour.

Based on the relevance of technological innovation, Xiaoqiang (2005) noted that technological innovation capability should be defined to be under the condition of certain scale, technology and economy. It is pertinent that entrepreneurs should make good use of available resources for technological innovation.

Considering the economic nature of a developing country, technological innovation is referred to the process by which firms master and implements the design and production of goods and services that are new to them irrespective of whether they are new to their competitors, their customers or the world (Mytelka, 2000). Technological innovation involves a sequence of activities such as application of new technology and methods; adopting new techniques in production and new management tactic or strategy; improving quality of production; developing new production; providing new service; exploring new market and realising market value. It can be deduced that technological innovation of enterprises is the innovation in R& D, production, sale and management.

Also, according to Feifei and Li (2007), technological innovation encompasses a series of activities such as conceptualising new ideas, designing products, prototyping, producing in volume, marketing, and commercialising among others. It is a process of knowledge creation, conversion, and application. The essence of technological innovation is the emergence of new techniques in production and its commercial application. It is

only through continuous product innovation that SMEs can increase their competitive advantages and cope with market opposition (Dobbs and Hamilton, 2007). They also affirmed that the promotion of sustainable development of SME through technological innovation can be revealed through the application of information technology as a driving mechanism to stimulate industrialisation. The use of automated means in all types of industries will transform technology level of traditional industries so as to enhance and lay a solid foundation for industrial competitiveness as well as restructuring the old industrial enterprises thereby improving organisational structure of SME, boost the vitality of traditional enterprises and promote enterprise collaboration. More so, through technological innovation and transformation, SMEs are opportune to transform and improve the techniques of their processing equipment, manage resources, assess environmental protection, stimulate clean production, accelerate R&D of new materials and new energy sources (Feifei and Li, 2007).

2.2 Classification of technological innovation

Researchers in the past decades have given much more attention on technological innovation with concise literatures illustrating various types of innovations based on the several surveys conducted. According to *Oslo Manual* (OECD, 2005), technological innovations are broadly classified into product and process.

Technological product innovation refers to the implementation of product that is new or significantly upgraded for its intended usage that may include the integrated technical applications, components and materials or other characteristics their-in. It integrates new knowledge or techniques, or a combination of the both existing knowledge and techniques (OECD, 2005).

Technological product innovation necessitates the firm to be technologically inclined thereby enabling them to serve their customers well based on their capabilities. This will inspire the firm to engage in innovative activities by boosting their internal competences so as to meet the market demands. Technological product innovation will arise only when a technically knowledgeable firm is able to recognise and respond to customer necessities by developing or improving products. Danneels and Kleinschmidt (2001) opined that markets and technology are core components that bring about development of new product.

Technological process innovation is the application of a new or significantly enhanced method of production or services delivery. It includes significant changes introduce in process of production, skills involved, equipment or software that are engaged during the innovation phase (OECD, 2005). Usually, it is used to reduce unit costs of production or services delivery, to improve quality or deliver new or significantly improved products or services. They are essentially introduced into firm's production or service operations that transform the way products are being manufactured.

Vonortas and Xue (1997) in their study of the technological process innovations of small firms in the USA observed that economic incentives, internal resources and technical abilities that a firm has gained or accumulated over time and a firm's external sources of expertise for learning through outsourcing about new technological advance were the major forces that drive these firms in embracing a technological process innovation.

2.3 Rationale for technological innovation

Technological innovation is a vital factor in a firm's competitiveness and it is inevitable for firms which want to develop and maintain a competitive edge in gaining entry into new markets (Becheikh et al., 2006). Technological innovation is said to have the potential or capability to stimulate growth both at the micro and macro level. Therefore, technological innovation is the heart of economic change and the ultimate source of productivity and growth. It is the only proven path for economies to consistently get ahead (Solow, 1987).

According to Latin American Economic Outlook (ECLAC, 2013), for firms to generate and accumulate technological capacities to function and trade, SMEs and technological innovation processes must be linked and be associated with knowledge flows to greatly impact the results of innovation activities, which in turn impact the flows. More importantly, training and knowledge accumulation are essential for a firm to develop its skills and innovative abilities. A learning process of a firm or company can be influenced from experiences and its interaction with other companies and other types of agents. Technological innovation processes are attainable from complex and social interactions that neither occur freely nor in isolation, but are the cause and consequence of knowledge flows and interaction between National Innovation System (NIS) agents. Variances in technological innovative behaviour also exist among SMEs. Those aiming international markets have a countless capacity or edge to innovate and diversify, especially if they operate in sectors dominated by dynamic efficiencies. Accessing international markets requires technologies which motivates firms to boost their technology base and improve their organisational and business specifications, paving way for them to innovate. Some SMEs are more likely to innovate often as they have a greater capacity to accumulate knowledge (Cimoli et al., 2011). The study also shows that financial support from Government towards innovation has positive effects on businesses. In Latin American countries such as Chile and Colombia, the enterprises that received financial support from Government usually invest 80% more in technological development than others. Costa Rican firms benefit most, with those receiving such fund investing twice as much as those that do not. In a country like Germany, Finland, Netherlands and Italy, firms that receive government financing invested 40–50% averagely, while in Austria, Belgium, Denmark, France and Norway the difference is up to 70%. This shows the great impact public innovation policies have on companies' innovative effort, which has a huge positive effect on investment in innovation (Crespi and Zuñiga, 2010).

Kirchhoff (1994) distinguished the effects of growth and innovation potential on small enterprises and he identified a set of small firm start-ups that are more prone to technological innovation. Spencer and Kirchhoff (2006) regard these firms as 'ideal types' of new technology-based enterprises that are key drivers of innovation and economic growth. These firms are characterised with the fast adopters of new technologies while 'ambitious' firms are likely to invest only in new technologies that can boost productivity and operational efficiency.

Many SMEs across industries and economies have the unrealised innovation potential (Chaminade and Van-Lauridsen, 2006). This is primarily as a result of their essential characteristics such as flexibility, better adaptability and receptivity, effective internal communication, simple organisational structure, quick decision making, etc. which are not properly harmonised to attain a desirable result or goal (Harrison and Watson, 1998).

There is ample empirical evidence that a number of SMEs in a wide variety of sectors do engage in technological innovations and that these innovations are likely to be a crucial determinant of their success (Hoffman et al., 1998).

Empirical investigation showed that the relationship between technological innovation and profitability helps to ascertain actions and policies to improve the competitive position of firms. The impact of innovation on firm profitability seems to vary with different types of innovation. Firms that engaged in product and process innovation usually have higher profit than those that do not engage in innovation based on the studies that were carried out among the manufacturing firms in UK (Geroski and Machin, 1993; Geroski et al., 1993). They maintained that product and process innovation strengthened a firm's competitive advantage and profitability. Kongmanila and Takahashi (2009) examined the relationship between innovation and firm profitability and export performance of industrial cluster of Lao garment industry using resource-based view theory to posit the conceptual model. The findings suggest that innovations (product and production process innovations) are important factors in determining firm profitability and export performance.

2.4 Technology capability development of firms in the developing countries

It is well documented that science, technology and innovation (STI) do not only contribute to the growth of gross domestic product of a nation but also contribute to wealth creation and higher standard of living for the citizens of any country. So, any firm that wants to continue to remain relevant and successful in any economy must be able to use STI to drive all the sectors of the economy. The rates at which new technologies are produced nowadays have created a radical new environment especially for the late adopters, developing nations and their firms (Perez, 1989). This has led to the globalisation of manufacturing sector, the emergence of new systems of manufacturing based on flexible production processes and rapid advances in information-based technologies. This new environment presents both threats and opportunities to developing countries in taking advantage of their huge local demands. However, many of these developing countries such as Nigeria have not fully harness these opportunities as a result of cheap economic rent realised from the natural resources (e.g., crude oil) which have prevented them to strengthen their competitive advantage in the manufacturing sector.

There is no doubt that the situations that the firms in less developed countries (LDCs) face are quite different from that of the firms in developed countries (DCs) in terms of regulatory, infrastructural and institutional environment, nature of production processes in use, the quality of the factors of production, and the ease of doing business among others. The holistic view of these disparities has strong effect on the analyses of the technological capability and organisational performance of a LDC firms. According to Atul (1990), all firms regardless of the region are involved in the process of production and delivery of goods and services ostensibly for a profit or similar organisation goal. However, the LDC firms are different from DC firms as the latter operate in an environment where institutions, services and infrastructure have evolved as complementary, that is in a relatively 'friendly' environment – one where the supply of skills (e.g., from universities), resources (e.g., venture and risk capital), infrastructure (transport), institutions (banks, regulatory agencies) and values – complement its own. The DC firms also relate and confront technology in a very sophisticated manner which makes them to continuously survive despite stiff competition. Meanwhile, LDC firms

often operate in a typical 'unfriendly' environment characterised by poor infrastructures, hostile bureaucracy, disgusting laws and regulations and poor attitudes in relating to or confronting technology. Though the LDC firms may be far from world technology frontiers, but the firms still engage in various innovativeness in product and process development which keep them profitable and successful in the particular niche of their operation, which may also be referred to as technology capabilities.

Technology capability is a collection of equipment, skills, knowledge, aptitudes and attitudes that offer a firm ability to operate, understand, change and create production processes and products (Marcelle, 2005). It can be referred to as the technical knowledge about a production process which has been acquired through formal training and learning by doing (Chambua, 1996). This is the capability needed to acquire, assimilate, use, adapt, change or create technology. According to Ogbimi (1990), technological capability is likened to a ladder-climbing process which is rather a step-wise one than a haphazard process. Learning plays a crucial role in such climbing process. Learning is expected to move a sector from the learner's position to the expert's position (Stahl, 1990). One of the challenges of the developing countries is engaging in technological activities that are not scientific based whereas technology activity is a scientific process. Ogbimi (2007) expatiated that learning competencies of the LDCs can be improved through increasing capabilities of the scientific population. This implies that LDCs need to develop their scientific capabilities which serve as the basis for technological capabilities.

The LDC firms has some advantages as a latecomer by learning some technologies that have been developed by the DC firms, assimilate the technologies and adapt them to their own environment considering other factor in their own environment. Thus, the technological innovations in this paper are not mainly radical innovations that are mainly carried out in the DCs but incremental innovations which require adaptation and improvement of the existing technologies. Minor changes, adaptation, imitation and even acquisition of new machinery or equipment are treated as innovation within the developing country context (UNU-INTECH, 2004; Arundel et al., 2008). In the context of this paper, commercialisation of products and processes that are new to a firm irrespective of whether they are new to the market or world is termed technological innovation.

2.5 Overview of SMEs in Nigeria

Small and medium scale enterprises (SMEs) as defined by Lawal and Ijaiya (2007), refer to business enterprises whose aggregate amounts of assets is not more than two hundred million naira (₦200,000,000.00) only excluding land. Indeed, there is no universal or national acceptable standard definition for SMEs unless the scale or size of business needs is defined for a specific purpose. SMEs identification is a major problem in developing countries because apart from the fact that small and medium scale business are difficult to count, they are also problematic to quantify independently, hence data on the number, size, geographical distribution and activities of enterprises and the SME sub-sectors are difficult to obtain (Egbetokun et al., 2008).

According to Oshagbemi (1983) and Owualah (2000), small and medium scale enterprises in Nigeria are mostly determined by various quantitative parameters. Such parameters include the number of people employed in the enterprises, the capital base,

the magnitude or size of the plant capacity, the sophistication of the equipment, sales turnover, profit margin and market share.

The recent national definition of SMEs in Nigeria as adopted at the National Council on Industry (NCI) in 1996 and as cited by the Central Bank of Nigeria (CBN, 1997) is to categorise small scale enterprises as those with total cost, including working capital but excluding cost of land exceeding ₦1.0 million, but not above ₦40.0 million with a labour capacity of between 11 and 35 employees. Medium scale enterprises are defined as those enterprises with total cost, including capital but excluding cost of land above ₦40.0 million but not exceeding ₦150.0 million with a labour size of between 36 and 100 employees.

Apart from a concise definitional issue of SMEs in Nigeria, there exists a high level of consensus of its importance, especially from the sub-sector to economic growth and development (Akingunola, 2011). Oluba (2009) observed that the importance of SMEs differs with sectors and with the developmental level of a country. He opined that what makes SMEs in Nigeria less amenable is the disappointing outcomes from their inappropriate developmental strategies they often adopt that focus on large capital base, capital intensive and high import dependency while they are supposed to take into consideration the level of capital allocation requirements, management size and arrangement as well as their market accessibility in decision making.

In measuring the organisational performance, accounting measures such as return on asset (ROA), sales and turnover, return on investment (ROI) were widely used in management study. By following the popularisation in the field, we measured profitability in terms of sales and turnover. This is unconnected with the nature of information that the SMEs in Nigeria usually kept.

Although SMEs are seen as the heartbeat and core prime mover of economic development, still Nigeria has been moving at slow pace in attaining growth in SMEs (Mohammed et al., 2012). This is notably as a result of problems and challenges experienced by almost all the sub-sectors of the economy. Some of the problems responsible for their slow growth and development include: limited capacity for R&D as well as low adoption of technological innovation, poor infrastructural facilities, poor financing and lack of government supports, inadequate managerial and entrepreneurial skills, limited demand for their products and services, inability to compete at international market, burden of multiple taxes; and imperious actions of government functionaries and agents. Others include problems connected with conforming with regulatory stipulations in the specific areas of operations of the SMEs; difficulties of under-capitalisation and inability to access bank credits; bureaucratic hurdles; corruption bottlenecks and lack of transparency arising from government regulation and regulators; as well as government's lack of interest or attention in addressing the specific factors responsible for the dreadful performance of the sub-sector (Kayanula and Quartey, 1999).

There is no doubt that the obstacles faced by the SMEs in Nigeria are numerous but some reengineered establishments are able to conquer them with rightful adoption and application of innovative techniques in their operations.

Small and medium industry equity investment scheme (SMIEIS) was initiated by the CBN in partnership with Bankers Committee in June 19, 2001. This was necessitated as a result of the Federal Government's initiative to make SMEs more productive and to create an enabling environment for them to operate in terms of policy measures thereby acting as vehicles for rapid industrialisation, sustainable economic development, poverty alleviation and employment generation. The scheme was officially launched on August

21, 2001 by the Obasanjo administration. The main purpose of its establishment is to leverage and develop the SME sector, by properly eliminating the problems of inadequate access to long-term credit; reduce burden of interest rate; and remove other charges associated with normal bank lending. It is essential that all banks in Nigeria must develop and package viable industries with private investors and to set aside 10% of their pre-tax profit for equity investment in SMEs. More so, financial institutions are expected to offer financial, advisory, technical and managerial support for the SMEs. Every business is covered under the scheme with the exception of trading/merchandising and financial services.

Also in 2012, the Federal Government granted the sum of ₦200 billion for the establishment of the small and medium enterprises credit guarantee scheme (SMECGS). To be functional, the eligibility condition for applying institution was to be formulated by the CBN together with appropriate agencies of government (Uko, 2012). SMECGS and the microfinance development fund (MDF) are required to support micro, SMEs but concerned SMEs may only enjoy from these funds if they are worthwhile and satisfy the expected eligibility conditions.

Several SMEs in Nigeria may not be aware of the existence of SMEDAN, the available sources of funds for SME development, the incentives made available for them and even the basic process for promoting an enterprise. Even when they are aware, most of SME promoters are not encouraged to enter into partnership schemes under the SMIEIS programme as most of them might not be able to meet up with the various stringent requirements of the scheme. This perhaps explains why all these schemes provided by the government should always relax their various policies so as to encourage SMEs to enjoy them.

Usually, smaller enterprises are confronted with higher transactions costs than larger enterprises in obtaining credit from banks or other avenues majorly because of their sizes and the fear of the inability to repay the loans given to them (Olorunshola, 2003). More so, poor management and faulty accounting practices have hindered the ability of smaller enterprises to raise finance. Recent study has shown that a large number of small enterprises are unsuccessful in Nigeria as a result of non-financial reasons (Aigboduwa and Oisamoje, 2013). Likewise studies in the literatures have reported specifically the non-availability of innovation subsidies, weak linkages with knowledge centers, paucity in firm-level investment in R&D and poor firm's internal technological capabilities have been identified as factors impeding SMEs profitability in Nigeria (Ilori et al., 2000; Keizer et al., 2002; Oyelaran-Oyeyinka, 2003. 2005).

3 Methodology, conceptual model and hypothesis

The data for this study was obtained from an innovation survey conducted in 2010 by National Centre for Technology Management. The survey was the Nigerian component of the NEPAD African Science, Technology and Innovation (ASTII) Initiative undertaken among 19 African states covering a period 2005–2007. The survey was guided by the OECD third edition of the *Oslo Manual.* The paper employed a structured questionnaire to collect data from randomly selected manufacturing firms. Sampled firms were drawn from the Nigerian business directory published by Manufacturer Association of Nigeria (MAN). Albeit, only manufacturing SME's belonging to the International

Standard Industrial Classification (ISIC) Rev.3 code 15–37, were selected for the study. This was based on the definition of SME's by Nigeria National Council on Industry in terms of employee number as one between 11 and 100 employees (Udechukwu, 2003). A total number of 521completed questionnaire representing 52.1% response rate were used in this work. The least squares method of multiple regressions is adopted in estimating the first model while a binary regression is adopted in the second model. This statistical technique seeks to determine the nature of relationship among the selected variables (Brooks, 2008). For instance, Model 1 in the study examines whether each of the product and process innovations has a significant impact on the performance of the sampled small and medium manufacturing firms and also whether they jointly have impacts on firms' performance. Furthermore, it shows the direction of relationship between each of the innovations on firms' performance. The statistic aims to examine whether changes in one or more variables lead to changes in other variable(s). Linear multiple regression is employed in Model 1 as a result of more than one independent variable that is involved while the binary regression is employed in Model 2 as a result of only one independent variable. Generally, this statistic is necessary when there is a need to determine the level of direction and the significant impact of the independent variables on the dependent one. This paper focused mainly on technological innovations which are product and process innovations.

The firms were asked whether they introduced new or significantly improved goods or services within the period of the study with a binary response of yes or no which represent product innovation in the survey. On the other hand, the firms were also asked whether they introduce new or significantly improved methods of manufacturing goods or services as well as improved logistics and supporting activities for their processes. Table 1 shows that 63% of the firms sampled claimed that they engage in process innovation by introducing new or significantly improved methods of manufacturing goods or services whereas 53% of the firms asserted to be engaging in product innovation by the introduction of new or significantly improved goods or services.

Table 1 Innovation in Nigeria manufacturing SMEs firms

Nature of technological innovation	*% of manufacturing SME firms*
Product innovation	53.4
Process innovation	63.3

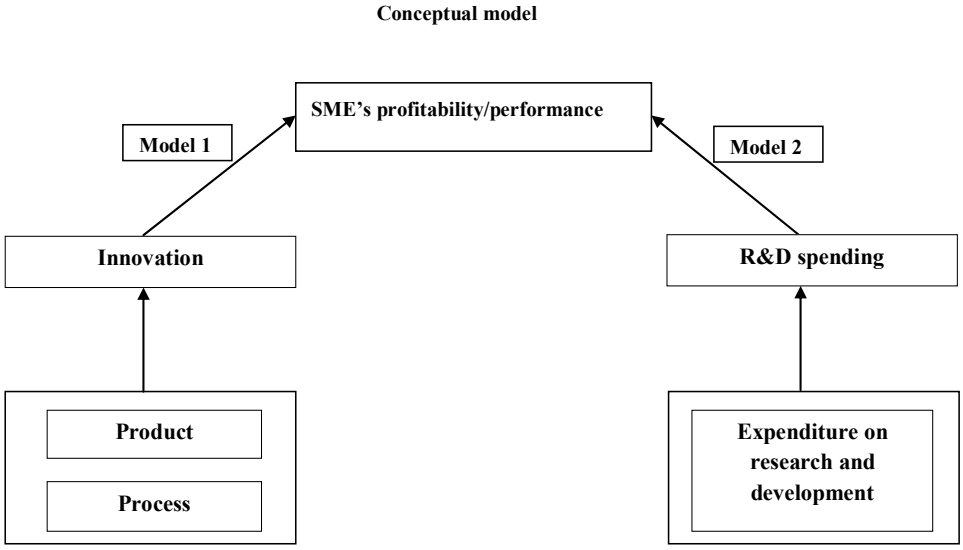
It was also observed from the survey that more than 90% of the SMEs sampled engage in incremental form of innovation rather than radical. The data obtained from the study also showed that an average of 80% of the innovation is originated from Nigeria.

Table 2 shows that the most common innovation activity among the manufacturing SMEs in Nigeria is training of workforce with a positive response of an average of 60%, followed by acquisition of machinery (50%) and in-house R&D activities (34%). However, lease or rental of machinery and equipment as well as outsourced R&D are the least form of innovation activities engaged by these firms with an average of 14% and 23% respectively. Table 2 generally depicts that the level of usage of innovation activities by the SMEs to drive their productivity is relatively low. Though, more than 50% of the SMEs claimed to engage in product and process innovation as shown in Table 1 but majority of such innovation activities go into the training of workforce and acquisition of machinery.

Table 2 Innovation activities among SMEs in Nigerian manufacturing sector (% of firms)

Activities	*Content*	*% of firms*
Intramural (in-house)	Creative work undertaken within an enterprise to increase the stock of R&D knowledge and its use to devise new and improved products and processes	34.2
Extramural (outsourced R&D)	Same activities as above , but performed by other companies or by public or private research organisations for the enterprise	22.5
Training	Internal or external training for the enterprise personnel specifically for the development and/or introduction of new or significantly improved products and processes	59.6
Acquisition of machinery and equipment	Acquisition of advanced machinery or equipment to produce new or significantly improved products and processes	49.8
Lease or rental of machinery, equipment or other capital goods	Lease or rental of machinery or equipment to produce new or significantly improved products and processes	14.0
Industrial design and engineering activities	Industrial design and engineering activities to implement new or significantly improved products and processes	31.7

Figure 1 Conceptual framework for the study



This model examines the relationship between the SME's performance and the product and process innovations.

Turnover of the SME is used as a proxy for firm's performance while information on new or significant improved products/services and new or significantly improved methods of production are used as proxies for product and process innovation.

Model 1 can be written as:

$$TNO = f(PRDINNO, PRCINNOV) \tag{1}$$

where

TNO turnover of the firm

PRDINNOV product innovation

PRCINNOV process innovation.

Equation (1) can be logged, so as to reduce the stochastic error term and expressed as

$$LTNO = \alpha_0 + \alpha_1 LPRDINNOV + \alpha_2 LPRCINNOV + Ut \quad (2)$$

where

α_0 constant factor

α_1 and α_2 coefficient of product and process innovations respectively.

Three hypotheses were formulated to examine the impact of the product and process innovation on the performance of the firm. These are stated below:

Hypothesis 1 H_0: $\alpha_1 = 0$; H_1: $\alpha_1 \neq 0$

Hypothesis 2 H_0: $\alpha_2 = 0$; H_1: $\alpha_2 \neq 0$

Hypothesis 3 H_0: $\alpha_1, \alpha_2 = 0$; H_1: at least one $\alpha k \neq 0$, where K = 1 and 2.

From Hypotheses 1 to 2, H_0 is the null hypothesis and it states that each independent variable has no significant impact on the firm's performance while the alternative hypothesis H_1 means that each independent variable has a significant impact on firm's performance. Meanwhile, H_0 in Hypothesis 3 shows that the independent variables are not jointly significantly important in explaining changes in SME's performance while H_1 in Hypothesis 3 illustrates that at least some variables in the model are jointly significant in explaining the SME's performance. The result is shown in the Table 3.

Table 3 Regression results for the study

Method: least squares				
Dependent variable	LTNO			
Sample	295			
Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob. (p-value)*
LPRDINNOV	0.8760	0.4683	1.8703	0.0624
LPRCINNOV	–1.2291	0.4647	–2.6451	0.0086
C	16.4697	0.2067	79.69075	0.0000
R^2	0.62			
F-statistic	3.69			
Prob. (F-statistic)	0.02			

Source: Authors' analysis (2013) using Eviews 7.1

10% level of significance is adopted for this study. The result shows that product innovation has a direct relationship and process innovation has an inverse relationship with the firms' performance. If the product innovation increase by 1 unit, the firms' performance will improve by 0.88 units, and if the process innovation increase by 1 unit,

the firms' performance reduce by 1.22 units. The a priori expectation of the direction between process innovation and firms' performance is positive, thus the explanation of the result requires caution. This may arise as a result of the low investment of SMEs in their production process and that the little investment requires a time lag before the process could have effect on the performance of such firm. This result corroborate the study carried out in Lao garment industry by Kongmanila and Takahashi (2009). The probability value (P-value) of 0.06 which is less than 10% shows that product innovation has a significant impact on the firms' performance. Also, the P-value of 0.0086 shows that process innovation has a significant impact on the SMEs' performance. Moreover, the P-value of the F-statistics (0.02) shows that variables jointly have a significant impact on the firms' performance. The coefficient of determination (R^2) showed that the proportion of variation in firms' turnover that can be explained by product and process innovation is 62%. This implied that there are other variables that explained the firms' performance which are not considered in this paper. These variables might include marketing, sales distribution, strategic behaviour of the firms, large capital base, and customers' loyalty among others. However, these results have been able to show that technological innovations (which are product and process) have a significant impact on the performance of SMEs in manufacturing sector operating in Nigeria.

Model 2

This model observes the relationship between the SMEs' performance and the expenditure of SMEs on R&D activities. Information about the expenditures that the firms incurred on the R&D activities were collected which is used as proxy for R&D expenditure; and the information on the turnover of the firms was used as the proxy for the firms' performance. Only 91 firms supplied the required information about their expenditure on R&D activities. This model can be written as:

$$TNO = f(ERD) \tag{3}$$

This implies that firms' turnover is a function of expenditure on R&D activities carried out by the firms. This can be further expressed, after the introduction of log, as:

$$LTNO = \alpha_3 + \alpha_2 LERD + Ut$$

where

α_3 constant factor

α_4 coefficient of expenditure on R&D

Ut error term.

Hypothesis 4 is formulated to examine whether expenditure on R&D has a significant impact on the performance of SMEs or not.

Hypothesis 4 H_0: $\alpha_4 = 0$; H_1: $\alpha 4 \neq 0$

Followed from the previous explanation, H_0 is the null hypothesis and it states that expenditure on R&D activities does not have a significant impact on the firms' performance while the Alternative hypothesis H_1 means that expenditure on R&D activities has a significant impact on firms' performance. The result is shown in Table 4.

Table 4 Regression result for the study

Dependent variable	LTNO			
Sample	91			
Variable	*Coefficient*	*Std. error*	*t-statistic*	*Prob. (p-value)*
LERD	0.203185	0.103527	1.962623	0.0529
C	13.43408	1.603904	8.375859	0.0000
R^2	0.58			
F-statistic	3.85			
Prob. (F-statistic)	0.05			

Source: Authors' analysis (2013) using Eviews 7.1

This result shows that expenditures on R&D have a direct relationship with the SMEs' performance. This means that firms should increase their expenditures on R&D, so that their turnovers improve. If there is an increase in R&D expenditure by 1 unit, turnover is expected to improve by 0.2 units. Also, using 10% level of significance for Hypothesis 4, the result shows that expenditures on R&D have a significant impact on the firms' turnover. This implies that firms should concentrate lots of efforts on R&D activities so as to improve their sales and productivity.

4 Conclusions

This paper has been able to explore the concept of technological innovation in Nigerian manufacturing SMEs. The paper showed the relationship between technological innovation (product and process) and SMEs performance (measured as firms' turnover). Based on the outcome of the study, it can be concluded that product and process innovations with p-value of 0.0624 and 0.008 have significant impact on SME performance at 10% level of significant. The expenditures on R&D also have significant impact on SMEs performance in Nigeria. The level of innovation activities such as in-house (34.2%) and outsourced R&D (22.5%), industrial design (31.7%), lease and rental of equipment (14%) are relatively low in the SMEs sampled. Though training of workforce (60%) is the commonest among the SMEs, however 40% of the SMEs not engaging in this is also worrisome. It becomes necessary for SMEs in the manufacturing industry to intensify their innovation activities so as to create a competitive advantage environment which will further improve their turnover and profitability. This implied that innovating firms in the manufacturing industry which allocate their assets more effectively are more profitable. The firms are encouraged to spend more on research that relates to the improvement of their products as well as improve the level of production process to enhance their productivity. Any enterprise that refuses to engage in R&D and innovation activities will find it very difficult to compete with its rivals in the industry. Nigerian government can provide tax rebate and other forms of incentives for the SMEs that engage in technological innovation in the short run as this will ensure them to break even. There is limitation of considering only R&D expenditure, product and process innovations as the independent variables of SMEs performance in which other variables like marketing, organisation behaviours among others can be considered in further research. Therefore, the paper concludes that technological innovation is important for

SMEs in Nigeria to achieve profitability. This leads to the growth of firms hence, employment generation.

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