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Full Length Research Paper

Assessment of the capabilities for innovation by small and medium industry in Nigeria

Abereijo, Isaac Oluwajoba[1], Ilori, Matthew Oluwagbemiga[2], Taiwo, Kehinde.A.[3] and Adegbite, Stephen Akinade[4]

[1]Centre for Industrial Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria
[2]Technology Planning and Development Unit, Obafemi Awolowo University, Ile-Ife, Nigeria.
[3]Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria.
[4]Centre for Industrial Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria.

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The study assessed the ability and competencies of the manufacturing SMEs to innovate. A sample population of 100 companies located in Ibadan and Lagos cities were purposively selected among these manufacturing industries operating in the Food and Beverages; Pulp, Paper and Paper Products; and Plastic and Rubber Products industrial sectors. The primary data were collected through questionnaire, and then analysed using descriptive and inferential statistics. The results showed that none of them achieved major innovations that could be considered unique and science-based. However, some (43%) obtained average innovative index score ($\prod_2$) between 0 and 2, which showed that the innovation type in all these companies was mostly incremental. Among the few (14%) that showed some level of originality their innovative abilities was significantly related to some internal factors which included higher academic degree, education in science or engineering, and relevant working experience in large corporation/multinationals and university/research institute of the founder/manager. Other variables that significantly related to the innovative index $\prod_2$ are the extent of investment in the research and development, and on employees training. Similarly, an external factor, which was exposure to research and development outputs from the universities and research institutes, had significant relationship with their innovative ability. In addition, the results also indicated that the external inputs which the companies needed for internal learning and innovation came through interactions with other external agents. It could then be concluded that specialised knowledge, educational background in science and engineering, accumulation of the technological capabilities through continuous investments on research and development (R & D) and training, and experience from large corporations and the research institutes, are important in enhancing technological learning and achievement of innovativeness in SMEs.

Keywords: Technological innovation, innovative capabilities, innovation determinants, manufacturing SMEs, Nigeria

INTRODUCTION

This paper focuses on the assessment of the ability and competencies of the manufacturing small and medium enterprises (SMEs) to innovate in Nigeria. Though there are variety of definitions for small and medium enterprises (SMEs); however, using the number of employees to define, SMEs has been a common practice in literature (Adams and Hall, 1993; Freel, 1999; Rothwell and Zegveld, 1982). Other methods include using capital invested and turnover (Wijewardena and Cooray, 1995). But sticking to a single common definition of an SME might not be possible because of the variations in the definition from country to country and from sector to sector (Gunasekaran et al., 2000). In Nigeria, the number of employees, capital invested and turnover have been used to define

*Corresponding author. E-mail: abereijo@oauife.edu.ng. Phone: +234 – 803 – 668 6963

the SME sector. Therefore, based on the definition by the Nigerian National Council on Industry (NCI), a small scale enterprise is an enterprise with a labour size of 11 - 100 workers or a total capital of not more than ₦50 million, including working capital but excluding cost of land; while a medium scale enterprise is the one with a labour size of between 101 - 300 workers or a total capital of over ₦50 million but not more than ₦200 million, including working capital but excluding cost of land (Udechukwu, 2003).

The vital importance of innovation for industrial growth had been recognised in numerous studies. This is because successful innovation is associated with good performance and related to subsequent growth. Empirical studies support the existence of this relationship between innovative behaviour of SMEs and their performance (Gunasekaran et al., 2000; Olomi, 1999). In the Industrialised countries there is a consensus that economic growth stems from innovation, particularly in industry (Rothwell and Zegveld, 1982) and that the SMEs provided an important contribution to this growth.

However, since these SMEs are equally operating within a globalize economy, where there is an intensive competition, then they must develop competence require for enhancing products and processes development, implementing organisational changes and developing new links through the market (Yoguel and Boscherini, 2000). That is, developing their "innovative capacity will help them to acquire capabilities required for competitive pro-cess. Innovative capacity refers to the firms' capability to transform general knowledge into specific one, using their stock of competencies and dynamic assets, including formal and informal (both codified and tacit) learning (Ernst and Lundvall, 1997). In this sense, these competencies are not limited to information or equipment, but they include organisational capabilities, and behaviour and routine standards affecting the decision making process and the innovative development of firms.

Since manufacturing SMEs in Nigeria, like those in other countries, are also part of the larger economic society, and are also driven by an intense competitive environment, they need to be continuously innovating to benefit from industrial technologies. Also, as technology complexity increases, the manufacturing SMEs have to develop flexible knowledge acquisition and technology development methods.

However, in most developing countries like Nigeria, manufacturing SMEs are operating in an environment with weak institutions for technical and financial supports (Oyeyinka, 2002). They face severe legal and regulatory constraints, and little institutional support is available for them for innovation. Hence, important characteristics such as technical affiliations, network capacity and ownership are crucial factors in the economic performance and innovative behaviour of these industries in such an environment. Since SMEs in Nigeria do not necessarily innovate in formally recognised ways it is likely that they make extensive use of external linkages. Therefore, the questions raised in this paper are:

i) With whom are these linkages formed?
ii) Of what type and with what purpose?
iii) What conditions helped in the successful transfer of technologies across the organizational boundaries of Nigeria national system of innovation to these SMEs?

Therefore, the focus of this paper was on the study of the capabilities possessed by the innovative manufacturing SMEs, in Nigeria, for identifying and acquiring innovations from the National Innovation System (NIS). That is, what conditions helped in the successful transfer of technologies across the organisational boundaries of Nigeria NIS to the SMEs?

Innovation capability in SMEs

Technological capability is defined as the knowledge and skills required for firms to choose, install, operate, maintain, adapt, improve and develop technologies (Romijn and Albaladejo, 2004). The need to acquire this capability has necessitated purposive efforts aimed at assimilating, adapting and modifying existing technologies and/or developing new technologies. Firms that are adept at this are called learning organisations, because they are skilled at creating, acquiring and transferring knowledge, as well as at modifying their behaviour to reflect new knowledge and insights (Garvin, 1993). In manufacturing SMEs, a substantial part of the learning may not take the form of well-defined research and development (R and D) programmes and other formalised 'technological effort'; but informal and incremental problem solving and experimentation taking place on the shop-floor, which are closely associated with production (Romijn, 1999). This is a fortiori the case in small companies that do not have the resources for human development programmes and organisation to mount large R and D.

Several kinds of technological capability are distinguished in the literature. These are production, investment, linkage and innovation capabilities (Lall, 1992). But for the purpose of this paper we are concerned about the innovation capability; which refers to the ability to make major improvements and modifications to existing technologies, and to create new technologies (Romijn and Albaladejo, 2004). The notion of innovation capability applies to process and product technology as well as the way in which production is organised and managed. Its importance derives from the fact that it is presumed to contribute to dynamic competitive advantage of companies since it enhances their capacity to keep up with, respond to, and initiate technological change on an ongoing basis (Romijn and Albaladejo, 2004).

A variety of factors internal and external to the firm may contribute to innovation capability. As far as internal fact-

Table 1. Conceptual model for explaining the innovative ability of an SME.

Manageable	Not Manageable
People characteristics	
Strategy Culture Structure	Innovation infrastructure
Availability of means	
Network activities Company characteristics	Market characteristics

ors are concerned, the entrepreneur(s) and workforce bring a certain stock of knowledge and skills into the firm, which they obtained through earlier experiences. Over time, the capability base of the firm is further enhanced through internal learning, involving investments in formal R and D, experimentations, making minor adaptations to products, processes and organisations, in-house staff training, among others.

Furthermore, interaction with suppliers, customers, public institutions and industry associations is also established to provide missing inputs into the learning process, which the firm itself cannot (easily) provide. This interaction may take place for the purpose of gathering information about technologies and markets, and also for obtaining various other inputs to complement the internal learning process, such as external staff training, parts and components, consulting services, and the like. The mobilisation of external resources for technological learning is called 'learning by interacting' (Lundvall, 1988).

METHODOLOGY

The sample consisted of purposively selected 100 small and medium companies in manufacturing activities from the database and directories of National Association of Small Scale Industrialists (NASSI), National Association of Small and Medium Scale Enterprises (NASME), and Manufacturing Association of Nigeria (MAN). These companies are those in Food, Beverages and Tobacco (FBT) industry, Plastic and Rubber Products (PRP) industry, and Pulp, Paper and Paper Products (PPP) industry. They are those whose manufacturing SMEs are strongly represented in Nigeria, as contained in the report of the baseline economic survey of SMEs conducted by the Central Bank of Nigeria (CBN) (CBN, 2004).

The main instrument used in collecting data was questionnaire, which was self-administered by the owners/managers of these companies. The number of the questionnaire distributed in each Industry was 60, 25 and 15 to the FBT, PRP and PPP respectively. This is because within the study area the numbers of companies that may be categorised as SMEs (based on Nigerian definition) are more in FBT and less in PPP industry. Also, guided interviews were later conducted with the owners/managers of the few companies that were discovered to be innovative from the completed questionnaires. The focus of the interview was to probe further on the nature of such innovation and the source. The responses from the interview were used to supplement the data supplied in the questionnaire.

Model for estimating innovative capabilities of small and medium firms

About fifty organizational and general economic factors have been established to influence innovative ability (Romijn, 1999; van Dijk e. al., 1997; St-Pierre and Mathieu, 2003). To obtain an overview, a conceptual model, developed by Freel (2000) was adopted in this study, using nine categories that determine the innovative ability of an SME. In the model a distinction is made between manageable and non-manageable determinants of innovative ability (Table 1).

The determinants indicate that a number of important internal and external factors contributed, in varying degree, to the innova-tion capability of small firms. The analytical concepts and the relationships between these factors, developed by Romijn and Albaladejo (2004), are set out in Figure 1. The innovation capabilities of firms (shown on top) accumulate as a result of various internal and external inputs.

From this model, potentially important internal sources that are generated inside firms include:

i) The initial educational background and prior working experience of the founder(s)/manager(s);
ii) The professional qualifications of the workforce. iii) Various kinds of technological effort which induce further accumulation of technological capabilities, such as formal and informal R and D, formal and informal (on-the-job) training, acquisition of technological licences, among others.

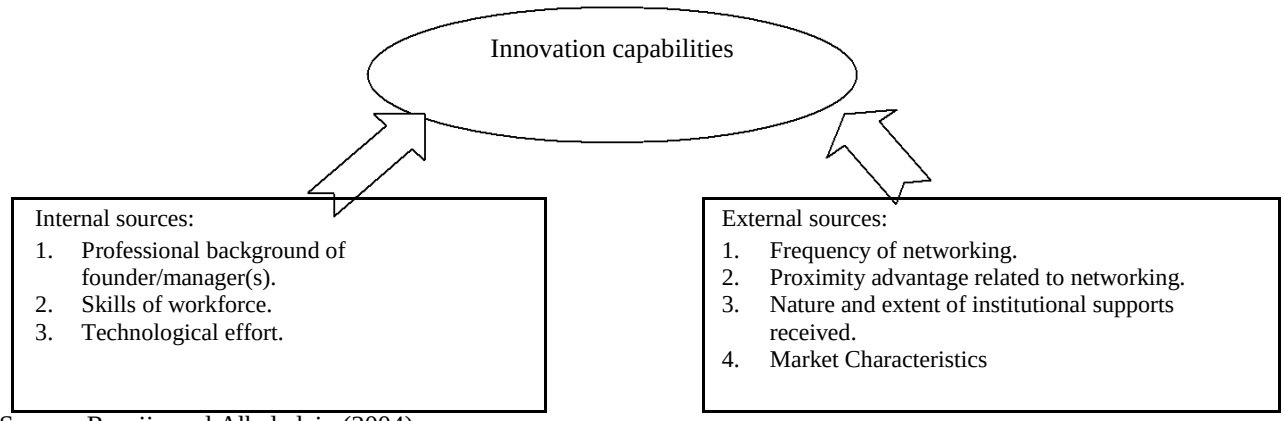
Those generated from external sources include:

i) Frequency of networking with a variety of other private-sector agents and various institutions;
ii) Any geographical proximity advantages associated with networking; and iii) The nature and extent of institutional support received.

Model for estimating innovative capabilities of small and medium firms

In operationalising the concepts depicted in Figure 1, two innovation indices were used based on the work of Romijn and Albaladejo (2004). The first, called Innovation Index 1 (Π_1), was based on a straightforward recording of the presence or absence of 'major' innovations during the last five years preceding the study. The variable is a simple unweighted average of the absence (scored as 0) or presence (scored as 1) for each of major product, process, and organisational innovations. Hence, the maximum score for the presence of innovation in all the three areas for any company was 3.

The second, called Innovation Index 2 (Π_2), is more complex, and it recorded not only the incidence of major innovations, but also an assessment of their originality and technological complexity. This index is meant to reveal further details than Innovative Index 1 (Π_1). But this, as noted in the literature, inevitably comes at a cost of higher subjectivity (Romijn and Albaladejo, 2004). The results for the two capability indicators were presented side by side in the data analysis in order to facilitate comparison. The measurement of the sources of capability is based on the education background, area of specialisation, and working experience of the founder(s), which were represented by measures of different academic degrees obtained, and the area of specialisation, and the prior working experience in different professional environments respectively. Moreover, the human capital of the workforce was measured by the numbers of technicians, scientists, and engineers present in the companies. The internal technological efforts were measured by variables representing R&D investment, and training expenditure.



Source: Romijn and Albaladejo (2004)

Figure 1. Analytical concepts and the relationship between internal and external sources.

Table 2. Sample size in each sector/ownership and legal status of companies.

Sector	Frequency	Percentage (%)
Pulp, Paper and Paper product	11	12.4
Plastics and Rubber product	22	24.7
Food, Beverage and Tobacco	56	62.9
Total	89	100

Source: Field Survey, 2005.

RESULTS AND DISCUSSION

Out of the 100 questionnaires distributed, 95 were returned, with 89 usable ones. This represented 89% of the whole questionnaires administered. Within the usable ones, there were 11 (12.4%) from Pulp, Paper and Paper products industry, 22 (24.7%) from Plastics and Rubber product industry, and 56 (62.9%) from Food, Beverage and Tobacco industry (Table 2). As noted in the methodology, these three industrial sectors were the most predominant sub-sectors within the study areas (CBN, 2004). Further information on the sampled companies in Table 3 showed that the average age of the companies was 14 years, with average staff strength of 54 employees. Among those indicated the presence of technicians, engineers and scientists, the average number reported were 12, 3, and 3 employees respectively. The average amounts expended on R and D and training of staff were N186,000 and N305,645 respectively.

Indication of innovation

Table 4 indicates that 18% of the companies reported having achieved innovation in all the three areas of innovation, while 40.9, 52.8, and 21.3% of them achieved innovation in product, process and organisational innovations respectively. According to the scores on Innovation Index I ($\prod_1$) (Table 4), only 16.9% of the sampled companies had achieved major innovations of all types (product, process and organisation), while 59.6% acknowledged not to have innovated at all.

However, on the basis of Innovation Index 2 ($\prod 2$) none of the companies achieved a score above 3; that is, none had achieved major innovations that could be considered unique and science-based (Table 4). While 29.2% of the responded companies obtained an average score between 0 and 1, 13.5% obtained score between 1 and 2. That is, though there was indication of innovation in majority of the companies, yet most of the innovations were neither scientifically complex nor highly original.

The implication of these results, as equally reported by Belotti and Tunalv (1999), is that innovation in the companies is rarely strategically aiming to anticipate mar-ket demands on the basis of pre-competitive know-ledge that may be acquired from research and advanced technology producers.

Internal determinants of innovation capabilities

The firms' scores on innovative indices $\prod_1$ and $\prod_2$ were linked to the various determinant variables by means of simple Spearman Rank Correlations to determine statis-

Table 3. Basic data about the sample companies

Parameter	No of Respondent (N)	Percent(%)	Mean	Std. Deviation	Mode (Modal class)
Age of Business (years)	89	100.0	13.85	6.97	13
Size of permanent staff	89	100.0	53.59	23.90	1 – 50
No of Technician	45	50.6	11.76	11.92	5
No of Engineer	41	46.1	3.29	3.78	1
No of Scientist	25	29.2	3.08	2.66	2
Investment on R & D (₦)	26	29.2	186,000	118,251.9	0 – 100,000
Investment on Training (₦)	62	69.8	305,645	136,467.2	0 – 100,000

Source: Field Survey, 2005.

Table 4. Indication of innovation by the sample companies/innovation capacity scores

	Frequency	Percent (%)
A. Indication of Innovation in:		
1. Product, Process and Organisation (N = 89, 100%)	16	18.0
2. Product (N = 88, 98.9%)	36	40.9
3. Production process (N = 62, 69.7%)	47	52.8
4. Organisation restructuring (N = 89, 100%)	19	21.3
B. Contribution of Innovation to the Growth of the Business		
(N = 47, 52.8%)	33	70.2
1. Product Innovation	14	29.8
2. Process Innovation	-	-
3. Organisational Innovation		
Innovative Capacity Scores	No. of firms	Percent (%)
Innovative Index I ($\prod_1$)		
0.00	53	59.6
0.33	3	3.4
0.50	2	2.2
0.67	16	18.0
1.00	15	16.9
Total (N)	89	100.0
Innovative Index II ($\prod_2$)		
$\prod_2 = 0$	50	56.2
$0 < \prod_2 < 1$	26	29.2
$1 < \prod_2 < 2$	12	13.5
$2 < \prod_2 < 3$	1	1.1
$\prod_2 = 3$	0	0.0
Total (N)	89	100.0

Source: Field Survey, 2005

tically significant relationships and the strength of the associations (Table 5).

Innovative indexes $\prod_1$ and $\prod_2$ had significant relationship with previous education and working experiences of the owner/manager(s), as well as the resources devoted to technological improvement and internal learning. On the basis of educational background of the founder / manager(s), the correlation coefficient between the previous education of the owner/manager and the innovative index $\prod_1$ was statistically significant when the qualifications of the founder and managing director were tertiary. Similarly, there was statistically significant relationship between the previous education and the innovative index $\prod_2$ for founder and managing director who had tertiary educational qualifications respectively.

This implies that possession of higher degree is very important for innovativeness. Speciality of the founders / managing directors in science/engineering was signi-

Table 5. Internal determinant of capability: cross tabulation and spearman correlations

Internal Sources of Innovation		Percentage of the Respondents based on Innovative Index I ($\prod_1$) of				Percentage of the Respondents based on Innovative Index II ($\prod_2$) of			
		0.50	0.67	1.00	Spearman correlation	>1 < 2	>2 < 3	> 3 < 4	Spearman correlation
Founder/ Managing (MD)	Highest Qualification of:								
	(a) Founder (N = 71, 80%)								
	* Primary	-	1.4	-	0.228 (0.121)	8.3	-	-	0.176 (0.322)
	* Secondary	-	1.4	-	0.221 (0.105)	-	-	-	0.364 (0.315)
	* Technical/NCE	-	-	-	--	-	-	-	--
	* Tertiary	1.4	12.7	12.7	0.350* (0.012)	75.0	8.3	-	0.420* (0.010)
	* Professional	-	-	-	-	-	-	-	-
	(b) MD (N = 23, 26%)								
Area of Specialisation of:	* Primary	-	-	-	-	-	10.0	-	-
	* Secondary	-	-	-	-	-	-	-	-
	* Technical/NCE	-	4.3	-	0.110 (0.236)	25.0	-	-	0.352 (0.430)
	* Tertiary	4.3	26.1	34.8	0.398* (0.011)	75.0	-	-	0.480* (0.014)
	* Professional	-	-	-	-	-		-	-
of									
	(a) Founder (N = 64, 72%)								
	* Science/Engineering	-	1.6	9.4	0.322* (0.020)	40.0	10.0	-	0.430** (0.001)
	* Management/Finance-related	-	9.4	3.1	0.234 (0.320)	40.0	-	-	0.350 (0.412)
	* Other Fields	1.6	-	-	0.067 (0.621)	10.0	-	-	0.098 (0.442)
	(b) MD (N = 25, 28%)						-		
	* Science/Engineering	-	-	12.0	0.129* (0.032)	-	-	-	0.246* (0.031)
	* Management/Finance-related	4.0	28.0	20.0	0.499* (0.015)	80.0	-	-	0.526* (0.020)
	* Other Fields	-	-	4.0	0.245 (0.543)	20.0		-	0.412 (0.601)

Table 5. contd.

	Prior Working Experience of:								
	(a) Founder (N = 47, 53%)								
	* SMEs company	2.1	2.1	2.1	0.193 (0.435)	18.2	-	-	0.210 (0.023)
	* Large corporation or Multinational	-	4.3	2.1	0.202* (0.026)	72.7	-	-	0.315* (0.036)
	* University or Research Institute	-	-	2.1	0.291* (0.018)	-	9.1	-	0.491* (0.025)
	(b) MD (N = 4, 5%)								
	* SMEs company	-	-	25.0	0.106 (0.432)	25.0	-	-	0.159 (0.512)
	* Large corporation or Multinational	25.0	25.0	-	0.191* (0.021)	75.0	-	-	0.285* (0.020)
	* University or Research Institute	-	-	-	-	-	-	-	-
Eff ort Tech ndo gical	(a) Amount of expenditure on R & D (₦)								
	* 0 – 100,000	20.1	12.1	2.1	0.231 (0.54)	2.1	2.1	2.1	0.128 (0.365
	* 100,000 – 500,000	-	24.3	2.1	0.383**(0.000)	-	4.3	2.1	0.549**(0.004)
	* 500,000 – 1 million	-	-	2.1	0.336 (0.654)	-	-	2.1	0.211 (0.360)
	* Above 1 million(b) Amount of expenditure on Trg (₦)								
	* 0 – 100,000								
	* 100,000 – 500,000	-	-	25.0	0.241 (0.451)	-	-	25.0	0.344 (0.412)
	* 500,000 – 1 million	5.0	35.0	-	0.321**(0.000)	25.0	25.0	-	0.431**(0.031)
	* Above 1 million	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-

Source: Field Survey, 2005 Note: p-values in parentheses ** Significance at the 0.01 level (2-tailed) * Significance at the 0.05 level 2-tailed).

ficantly related to the two innovative indexes. However, the impact of the science/engineering degree was stronger with respect to innovative index $\prod_2$ than innovative index $\prod_1$. The previous experiences of the founders and managing directors only showed a significant relationship with the innovative indexes $\prod_1$ and $\prod_2$ when the experience was acquired from large corporation/multinational and university/research institute. This implied that experience acquired from large corporation/multinational and university/research institute had presented opportunities for technological learning relevant for innovativeness. But this might not have been possible when the previous experience was in SMEs companies, because SMEs firms might not have provided enough skills and knowledge needed to run an innovative business. This result is in agreement with the work of Romijn and Albaladejo (2004) who stated that experience required to achieve truly original and complex innovations seems to be built up in multinational or large companies and public or R and D institutions. This is because the owners would have built up in-depth expertise about a particular product or process over a number of years in their capacity as employees of these sectors, using the internal facilities and resources available.

Finally, the increase in the amount of expenditure on R and D and training showed significant ($p<0.05$) relationship with both innovative indexes (Table 5). This implied that R and D efforts and training had assisted in expanding company skills. This fact was equally recognised by Karlsson and Olsson (1998), Freel (2000), and Brouwer and Kleinknecht (1996), who observed that exp-erience and knowledge gained from R and D activities usually, spur innovation. Also the works of Karlsson and Olsson (1998) and Tether (2002) established that custom - made training or special collaborations with research centres may compensate for the lack of competent personnel (Tether, 2002).

Conclusion

The results of this study showed that a range of factors that are both internal and external to the SMEs were found to be statistically related to the two indices used in measuring the innovative capabilities of the companies. Among the internal factors were the higher academic degree, education in science or engineering, and previous working experience of the founder/manager(s) in large corporation/multinationals or university/research institute. In addition to these internal factors, the extent of investment on R and D and training of employees were equally important.

Therefore, these results point towards the importance of specialised knowledge and experience in science and engineering as condition for technological learning and achievement of innovativeness in SMEs. Hence, innovativeness in SMEs requires more than having practical, intermediate-level technical skills or general managerial capabilities. The results equally suggest that large corporations and the research institutions are good breeding grounds for SME entrepreneurs who will be able to run and develop knowledge-based and innovation-driven companies that the Nigerian government is trying to promote. Similarly, the importance of technological improvement, through the R&D efforts and on-the-job learning, is equally established to be required for increasing the technological capabilities of the innovative company.

Policy recommendations

Consequent on the above, some important policy issues are being raised for the Nigerian governments, at all levels, especially in their efforts at achieving one of the primary goal of the National Economic Empowerment Development Strategy (NEEDS) of 'building a private sector that can take advantage of the opportunities that abound in the domestic, regional, and global markets'.

Firstly, there is need for a well structured mechanisms or interfaces and intermediary agents for effective and efficient interaction between the SMEs and the research institutes in Nigeria. Since innovation system is a product of the interaction between the science and technology system and the production system (that is, the SMEs), then R&D must be brought closer to the production system. All over the world the university-industry corporate research centres, incubators, technoparks, technology centres, technology counsellors, consultants, information networks are the well-known examples of this interaction. Therefore, this calls for the need for constant re-tooling and re-engineering of the country's SMEs' development agencies, especially the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN), to be able to respond to this need.

Secondly, developing the innovative ability in the SMEs will require strategic training for the owners of the small firms in Nigeria so as to increase their absorption capacity for innovation. Moreover, the SMEs associations should be strengthened to provide opportunities for their members to continuously learn about new technology developments and opportunities.

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