

The relationship between knowledge management practices and innovativeness: Insights from petroleum firms in Nigeria

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ABSTRACT

Determinants of firm innovativeness are said to be relatively understudied and little is written about firms from the oil industry within the context of African economies. This article attempts to fill that gap by investigating the impact of endogenous factors, particularly the impact of knowledge management practices (KMP) on the technological innovativeness of petroleum firms in Nigeria. Survey data collected from petroleum firms in Nigeria were used to examine the relationship between their technological innovativeness and the KMP engaged by the firms. Our analyses show that in the context of the study, KMP significantly impact the technological innovativeness of firms. The results were largely consistent with extant research on the role of knowledge management on the innovativeness of firms. Our findings provide valuable insights about knowledge as a strategic resource of the firm. Thus, under-taking the relevant KMP will enhance the technological innovativeness of petroleum firms operating in Nigeria.

KEYWORDS

technological innovativeness
knowledge management practices
knowledge-based economies
oil industry
developing economies
Nigeria

INTRODUCTION

As the global economy stands in the midst of sweeping economic and social transformations, knowledge has replaced physical labour and natural resources as the key source of sustained growth (Daghfous 2004). Again, the dynamics of this knowledge have furthermore led to a new paradigm – the knowledge-driven innovation economy – in which enterprises need continuously to adapt themselves for sustainable competitive advantage (Bullinger et al. 2004). Correspondingly, previously disparate and relatively independent activities are converging to become one, producing unimaginable amounts of creativity, innovation, productivity and performance with such fusion, creating an infinite supply of the new energy source of the new knowledge economy (Hodgins 2004).

On the other hand, innovation has been recognized as the crucial determinant of the knowledge-based economies (KBEs) because it helps firms to cope with the emergent challenges of the twenty-first century (Kaplan 2009). The author hinted that it has long been acknowledged that innovativeness is one of the most valuable assets of an organization. He concluded that, the increasing importance of innovations and innovativeness was directly linked to the development of the KBE. However, knowledge and the management of knowledge is fundamental to the innovativeness of firms, especially in this modern world that has largely become knowledge driven. This makes effective knowledge management processes as an imperative for firms to be considered innovative (Nonaka and Takeuchi 1995). Thus, the relationship between investments in knowledge, innovation and competitiveness has become a relevant topic in both academic research and economic policy and has been studied extensively over the past decades (Hemert and Nijkamp 2010).

In order to be regarded as an innovative one, a firm must recognize the factors contributing towards its innovativeness (Joshi et al. 2015). These factors or determinants are the preconditions or antecedents to innovativeness. They also help in identifying the system boundaries of the innovation systems (Edquist 2001) as well as define the characteristics of an innovative organization (Chutivongse and Gerdri 2014). However, a detailed study on the systemic determinants of technological innovativeness has been dealt with in separate paper and therefore will not be the focus of this discourse.

It has been noted that, the rationales on the relationship between a firm's innovation performance and knowledge management practices (KMP) were grounded in the resource-based view of the firm (RBV), agency theory, and contingency theory (Zhou 2010). However, studies specifically looking at the relationship between KMP and technological innovativeness of oil and gas firms operating in emerging countries of Africa are scarce. This study intends to fill that gap. Consequently, this article tries to explore the determinants of firm innovativeness through the lens of the RBV. In particular, this article aims to investigate the relationship between the technological innovativeness and the KMP employed by firms in the petroleum sector of Nigeria. First, the theoretical and practical understanding of the critical components that drive firm innovativeness are said to be somewhat underdeveloped (Gilbert 2006). Second, not much is known of KMP as a factor that can influence the technological innovativeness of firms in a resource-based industrial sector like petroleum in an African country context. Thirdly, our focus is on KMP alone, instead of looking at all possible endogenous factors. This was due to the inability or unwillingness on part of respondents to provide information concerning other endogenous innovativeness determinants. Lastly, because of the competitive

nature of the oil and gas industry, the petroleum sector is one area where KMP such as knowledge sharing was required (Iyama and Ohioyenoye 2015).

The contributions offered by this study include four key points: First, it confirms that certain factors endogenous to firms, including knowledge and the way it is managed might enhance or restrain the technological innovativeness of firms (Subramanian and Nilakanta 1996; Joshi 2010; Azarmi 2016; Carayannis and Grigoroudis 2016). Second, the literature review is the empirical investigation help to elicit the perception of innovativeness and the factors that influence it in the petroleum sector. Third, understanding the endogenous factors influencing the technological innovativeness of firms in an empirical setting offers policy-makers and industry experts the possibility to fashion out the right management decisions, particularly on how best to manage knowledge to foster innovativeness. Lastly, focusing on a novel area of research, as represented by emerging country context allows us to shed new and important light on KMP as a factor shaping the technological innovativeness of firms in the petroleum sector of Nigeria. The hypothesized model drawn from our literature review is tested using multiple Pearson correlation analysis. To test our predictions, we sampled 57 petroleum firms from a sampling frame of 565 firms contained in the Directory of Oil and Gas firms in Nigeria.

The remainder of the paper is structured around five sections. Section 2 offers some theoretical backgrounds into technological innovativeness and attempts to draw links between technological innovativeness and constructs such as RBV, KBE and knowledge management. The main research hypothesis is also formulated in this section. Section 3 describes the materials and methods employed in the study; Section 4, presents an analysis and the empirical results. Finally, Section 5 provides a detailed discussion of the research findings and concludes with a discussion of theoretical and practical implications of the study, as well as the limitations and directions for future research.

THEORETICAL BACKGROUND AND RESEARCH HYPOTHESIS

Different scholars across diverse disciplines have stressed the crucial role that knowledge and its management play in innovativeness (Nonaka and Takeuchi 1995; Goh 2007; Joshi et al. 2015; Nikolova 2016). We integrate some of these theoretical underpinnings seeking to understand how aspects related to knowledge management processes and practices affect the innovativeness of firms. These issues are presented in the next sections which aim at exploring the linkages between technological innovativeness, knowledge-based economy, KMP and resource-based view.

Technological innovativeness

Tsai et al. (2008) in their study employed multiple viewpoints to define firm innovation by attempting to incorporate technical innovations as well as administrative innovations. But Zait et al. (2011) are of the view that, if one refers to the structural delineation of innovation, one then speaks about technological innovation and administrative innovation. The authors maintain that in such conditions, firm innovation (innovativeness) is mainly technological (with tangible results) and fundamentally administrative except in cases of accidental innovation, realized by hazard, by an employee who agrees to make it available for the organization in certain conditions.

In this article, Edquist's (2005) description of technological innovation weighs in strongly. The author considered technological innovation to strictly

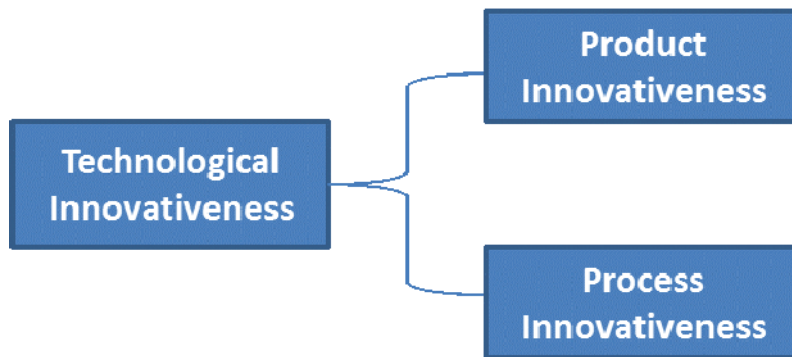


Figure 1: Schematic delineation of technological innovativeness.

include technological aspects such as product innovation which are new or better material goods as well as new intangible services; and process innovation which are new methods or techniques of producing goods and services. Equally, towing the line of literature, O'Brien (2016) referred to technological innovation as including product/service and process innovations. In the author's reasoning, technological innovation requires a high level of innovation capability by a firm and involves significant in-house development, and outputs that is characterized by a high degree of novelty. It encompasses activities that contribute to the research, development and design of new products/services or methods, or the improvement of existing products, and or creates new technological knowledge (Paiva and Lourenço 2015). It then makes it easier to categorize innovativeness into technological (technical) or non-technological (administrative) perspective (Liu et al. 2005) as schematically shown in Figure 1. Again, this is quite similar to the Oslo Manual's normative categorization of product and process innovations as being technological; and marketing and organizational innovations as being non-technological (OECD/European Commission 2005).

The resource-based view of the firm and innovativeness

In the opinion of some researchers, the argument of resource-oriented approaches was that the performance of firms was strongly dependent on resources or capabilities, located within the organization (Markard and Worch 2010). According to the authors, under this perspective, everything and anything can be thought of as a firm resource as long as it is of strategic relevance. Likewise, innovativeness is considered to be an integral dimension of organizational strategy (Li et al. 2006).

The RBV contends that such endogenous to firm factors constituting the dynamic capabilities of the firm determine its propensity to innovate. This view aligns with Subramanian and Nilakanta's (1996) position, that innovativeness is an enduring organizational trait. They claim some researchers have linked certain organizational characteristics to firm innovativeness. They also posited that such characteristics as – firm size, degree of centrality, resource slack, degree of specialization, structure, etc. have an impact on the innovativeness of the firm. Others have investigated determinants of firm innovativeness. For instance, Carayannis and Grigoroudis (2016) observed

that innovation emerges from three critical firm level factors, that is, posture, propensity and performance. The duo explained further that such inputs as intellectual, human and technological capital; and process factors like organizational and innovation management systems influence a firm's innovativeness. Therefore, such factors as the absorptive capacity; adaptive capability; innovative capability; and integrative capability determine the ability of firms to innovate. This view is supported by El Elj and Abassi (2014) when they posit that, technological capabilities, including the different technological, managerial and human capital skills, facilitate the adoption and mastery of external technologies and further enhance the propensity of a firm to innovate.

The foundations of the connections between knowledge, innovativeness and the RBV have long been laid by scholars when they started regarding knowledge as a firm's strategic resource. For instance, Paiva et al. (2008) suggested that a firm's strategic process may be analysed via lens of the RBV approach with knowledge being a resource for capability creation. In this regard, knowledge can be regarded as a strategic resource for the creation of innovative capability. This argument gives impetus to Azarmi's (2016) consideration of knowledge as the essence and foundation of technological innovation. Equally, the proposal by Nonaka and Takeuchi (1995) for a new kind of organizational model, one that focuses on knowledge as the resource for a company's innovative confirms Azarmi's reasoning. As acknowledged by Joshi et al. (2015), greater knowledge of market opportunities (customer needs, new technologies, services, and processes obtained via exploration) increases the stock of knowledge available to the firm, allowing it to be more innovative, and enabling it to exploit these opportunities by creating new products and services.

The knowledge-based economy and technological innovativeness

The KBE is an economy in which knowledge is created, acquired, transmitted and used more effectively by individuals, enterprises, organizations and communities to promote economic and social development (The World Bank 2003). The concept of the KBE has achieved extensive success as both explanatory and normative framework for explaining success in the contemporary economy as primarily dependent on investments in knowledge and technology (Cozzens et al. 2007). It describes the new economic environment in which the generation and management of knowledge play a predominant part in wealth creation compared with the traditional factors of production – land, labour and capital (Salami 2008). Such economy is characterized by the recognition of knowledge as the source of its competitiveness, the increasing importance of scientific R&D and innovation in knowledge creation, and the use of technology to generate, share and apply knowledge (Watkins 2008). Similarly, KBEs are mainly characterized by the presence of highly innovative firms, skilled labour-force and a vast knowledge base, all of which enhances competitiveness on the national, regional and local levels (Kaplan 2009).

Knowledge management and technological innovativeness

With the emergence of the KBE, organizations' need to apply KMP to their business activities has heightened (Goh 2007). However, Cope et al. (2011) opine that, whereas, the concept of KM has been around for decades, most organizations accept it only as theory and are yet to implement it. The authors maintain that most firms find it difficult to shift their organizational thinking

from an informational paradigm to that of a knowledge management paradigm. Innovation and knowledge creation are viewed as interactive and cumulative processes contingent on the institutional setup (Fischer 2001). Thus, innovating firms operate within a common institutional set-up, and they jointly depend on, contribute to and use a common knowledge infrastructure (Fischer 2001). That is why Spencer (2003) noted that under certain conditions, firms that share technological knowledge may achieve higher innovative performance than firms that do not share knowledge because knowledge-sharing strategies can help a firm shape the institutional environment in favour of its own technological design.

Knowledge is regarded both as key input to innovation and outputs of innovation (Stone et al. 2009). Knowledge plays an important integrative role in building and maintaining sustainable competitive advantages for firms (Nikolova 2016). It implies that both knowledge and technological innovation play vital roles in economic activities (Archibugi and Michie 1997). Thus, knowledge spill-overs (intended or unintended) are crucial for innovativeness (Erbaş et al. 2008), and these knowledge spill-overs serve as drivers of innovative activity, particularly at the regional levels (Caniëls and Romijn 2005).

On one hand, Nikolova (2016), knowledge management often refers to a wide range of activities related to different practices of organizing, generating, collecting, storing and using knowledge. The author further describes that the concept can be seen as a way to create such an organizational environment whereby people are encouraged to create, learn, share and use knowledge in a team and for the organization in order to create value clients. He added that knowledge management allows for the efficient and optimum maximum use of knowledge in the organization as well as creating new knowledge. On the other hand, KMP may involve a combination of ICT and non-ICT solutions (Zhou 2010) and strategies. The knowledge management process seeks the synergy between data capabilities of ICTs and the human skill to find new creative solutions (Nikolova 2016). It equally involves an orientation towards the development, transfer and protection of knowledge; continuous learning in the organization; an understanding of the organization as a global system; development of an innovative culture that encourages R&D projects; approach based on individuals; and competence development and management based on competences (Marqués and Simón's 2006).

Research framework and research hypothesis

The research framework is shown in Figure 2. This research framework demonstrates the influence of the KMP embarked upon by the firms in the petroleum industry and their technological innovativeness. This study develops the related hypothesis as follows:

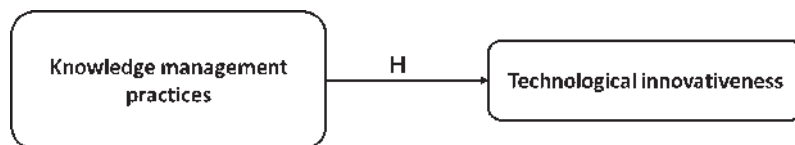


Figure 2: Research framework and research hypothesis.

The relevance of knowledge management to innovativeness has been explicated by other researchers. For example, Goh (2007) maintains that the importance of KMP in innovation over the years has reached significant proportions. The capacity of a firm to manage knowledge-related activities and processes, from knowledge production up to capturing and sharing is a measure of the firm's technological innovativeness (Azarmi 2016). Equally, KMP – acquisition, absorption and application of new knowledge results in high levels of innovativeness (Nonaka and Takeuchi 1995; Joshi et al. 2015). Dibrell et al. (2009) disclosed that, the inter-functional coordination disseminates knowledge gained from customers and competitors among individuals and departments within the company equip the firm with the knowledge and information necessary to facilitate innovativeness. Of course, this can happen as a result of continuous development of new knowledge and ideas and by creatively combining them with others already existing (Joshi 2010). Hence, according to Nonaka and Takeuchi (1995) as emphasized by Joshi et al. (2015), knowledge management becomes a crucial determinant of firm innovativeness. The conclusions of several studies indicate that KMP have a positive impact on a firm's innovativeness. This leads us to our research hypothesis which is stated in the null form:

Research hypothesis: There is no significant relationship between a firm's KMP and its technological innovativeness petroleum firms in Nigeria.

MATERIALS AND METHODS

The aim of this article is to shed light into the relationships between the KMP and technological innovativeness. In this context, the article proposes that the more robust and varied the KMP undertaken by a firm, the more innovative such a firm will be. To this end, we conduct both exploratory and explanatory research. The study is exploratory in the sense that it seeks insights into a phenomenon that only little prior knowledge exists within the context of the study. On the other hand, it is explanatory as we investigate the causal relationship between the KMP and the technological innovativeness of petroleum firms in Nigeria.

Variables definition

A critical mass of research is said to be available to interrogate the explanatory factors that arguably influence firms' decisions concerning innovation (Waheed 2011). The variables as contained in the main instrument already exist in the extant literature (see e.g., Slater and Narver 1995; North and Smallbone 2000; Sampaio and Perin 2004) and also by the painstaking efforts of a panel of experts. They are divided into explanatory and dependent variables, a summary of which is shown in Table 1.

Sample and sampling frame

The sampling frame considered for this study consisted of a total of 565 petroleum firms listed in the 'Directory of Nigeria Oil and Gas Industry' (Nigerian Oil and Gas Sector 2011).. However, this Directory is not by any means, exhaustive but contains all the major players and cuts across every facet of the industry. In order to ensure a sample that can be logically assumed to be representative of the population, a purposive sample of 50 firms were selected. Data collection was conducted through a questionnaire that was hand-delivered

Explanatory variables	Variable description
Knowledge management practices	Knowledge creation, knowledge accumulation, knowledge transfer and knowledge sharing mechanisms and platforms
Dependent (explained) variables	Definition description
Technological innovativeness	New product/services introduced, adopted and/ or ongoing innovation activities by end of 2013
Product/service innovativeness	
Process innovativeness	New methods or process of production implemented and/ or ongoing by end of 2013

Table 1: Explanatory and dependent variables.

to the physical addresses of the firms. The processes of developing the instrument has already been elaborated by Bubou and Amadi-Echendu (2016). Nevertheless, we provide detailed description of the survey instrument in the subsequent section.

Survey instrument

Data for this study were collected with a questionnaire and this process lasted from November, 2013 to middle of 2015. While the instrument starts with a preliminary section that contains the introduction and letter of consent for participation in the survey, the main questionnaire format consisted of four sections. Section A was designed to measure firm innovativeness encompassing the five innovativeness constructs and uses 49 items adapted from the literature and panel reviewed by experts as earlier stated. Sections B contains 5 open-ended questions seeking to know the total number of innovations (product/service, process, managerial, marketing and strategic) either introduced or adopted by the respondents' companies. Section C was intended to identify the KMP engaged by the petroleum firms. This section contained 23 items related KMP. Items relating to KMP included new knowledge management systems introduced to the firm, the impact of practices on the firm like its knowledge management strategy, transfer of knowledge and best practices, invention and knowledge creations, etc. others were: source of firm's knowledge, that is, whether obtained internally or externally, etc. Section D contains 24 items and was designed to understand the sectoral system of innovation and the common innovation infrastructure. In all, the research instrument contained 87 items.

The respondents

Despite the long time it took to receive the first response (about one and half years), only thirteen questionnaires were returned. One of the returned questionnaires was completely empty thereby making the effective sample size to be twelve and recursive rate of 24%. Responding firms included two major oil transnational corporations, one major government owned gas and pipeline development company, and nine other service firms operating in different sub-sectors of the petroleum sector of Nigeria.

Variables	Mean	SD	1	2
1. Technological innovativeness ³	32.00	4.411	1.000	0.695 ¹
2. Knowledge management practices ²	132.92	19.751	0.695	1.000

Source: Authors.

Note: SD – standard deviation; ^[2] – independent variable; ^[3] – dependent variable; ^[1] – significant at $p < 0.05$.

Table 2: Descriptive statistics and correlation matrix of the studied variables (N=12).

ANALYSIS AND RESULTS

The data gathered were analysed with IBM SPSS version 22. Correlation analysis was used to examine the nature of the relationships between the technological innovativeness of the firms and the KMP of the firms sampled. In order to identify the relative impact of KMP on the technological innovativeness of the petroleum firms, Pearson correlation coefficients were calculated. This analysis enables us to test the main research hypothesis. For this purpose, the two explanatory factors provided in Table 1 were applied as independent variables and technological innovativeness as dependent variable and the correlation matrix is provided on Table 2.

Correlation matrix (Table 2) reveals that, a strong positive relationship exists between KMP with the technological innovativeness of the firms studied. Whereas, all the relationships were positive, even for that between the two independent variables, they were not statistically significant. The results further indicate that, the coefficient of correlation was ($r=0.695$, $p < 0.05$). This confirms a statistically significant relationship between the two variables.

DISCUSSIONS AND CONCLUSIONS

Discussions

Our study was designed to empirically investigate the nature of the relationships between some identified systemic determinants of innovativeness and the technological innovativeness of petroleum firms in Nigeria. Using the statistical methods earlier discussed, the research objective was achieved when the hypothesis was tested. Our findings revealed that, even though the relationship between the systemic determinants and the technological innovativeness of petroleum firms was weak, there is indeed an impact.

Based on the findings, the research hypothesis: 'there is no significant relationship between a firm's knowledge management practices and its technological innovativeness' is rejected. This implies that the KMP undertaken by the petroleum firms contribute to their technological innovativeness. These results are consistent with previous studies that suggest that KMP has a remarkable influence on the technological innovativeness of firms (Griliches 1979; Nonaka and Takeuchi 1995; Joshi et al. 2015; Iyama and Ohioyoye 2015). For instance, Griliches' (1979) model of knowledge production function proposes that investments in knowledge-generating inputs have the greatest effect on innovative outputs.

Conclusions, limitations and direction for future research

Even though the results of this study should be viewed with a certain degree of caution, considering the limitations of sample size, they nevertheless offer some relevant theoretical contributions to the innovation, technology and knowledge management studies. The most important finding is the central role that KMP play towards the technological innovativeness of firms. As a theoretical contribution, this study provides evidence for the relationship between KMP and technological innovativeness of firms. Our model predicted that KMP undertaken by the petroleum firms contributed to their technological innovativeness. This also confirms the argument that appropriate management of knowledge can help improve a firm's overall capability to innovate (Zhou 2010). We conclude that, among other things, an effective knowledge management system can be a differentiating edge to enhance innovativeness of firms in the petroleum sector of Nigeria. It implies that KMP can be harnessed for innovation management processes as a corporate strategy (Goh 2007) of firms. The main limitation of this study was the small sample size. Another limitation was either the inability or unwillingness on part of respondents to volunteer information concerning other endogenous innovativeness determinants. Accordingly, further research should include the validation of the findings of this study, particularly with a larger sample size. Also, research is needed to retest the measurement framework used in this study in other related industrial sectors like – mining.

Managerial and policy implications

Findings from the study will assist managers of sampled firms to better undertake their KMP so as to enhance their innovativeness. It will enable them identify areas that require refocusing in order to maximize the innovation process. Lastly, it will provide policy-makers with the information to aid in evidence-based decision-making.

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