

# TOWARDS THE SIXTH GENERATION OF R&D MANAGEMENT: AN EXPLORATORY STUDY.

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**Abstract** – It is apparent that understanding the link between the role of innovation in competitiveness and economic development is essential. This is because innovation ultimately holds the key to addressing the most pressing a nation's social and human challenges. In the past, some organizations viewed research and development (R&D) as an intangible, difficult to manage and measure process and do their best to stay away from it. On the other hand, organizations that have a clear understanding and mastery of R&D management seem to have great success in exploiting R&D in commercializing new technologies with speed and precision that enabled them to achieve numerous competitive edge, such as first-to-market advantages, greater market shares for their innovations, premium prices and dominant designs relative to their counterparts). However, the upsurge in enabling technologies such as the internet is changing the perceptions on managing R&D processes, moving from technology-oriented model to a more interactive and collaborative model. While it is evident that there is increased focus on fine-tuning R&D management processes the majority of these efforts were confined to the USA, Europe, Asia and other developed economies, with limited focus on R&D management on the African continent.

This paper evaluates and discusses relevant aspects of the five generations of R&D management practices using an exploratory research approach and attempts to predict some of the most appropriate practices R&D managers may adopt in the R&D sixth generation. The findings suggest that the sixth generation of R&D management will be characterized by greater multi-disciplinary approach emphasizing cross-functional communication, collaboration, greater inclusion of stakeholders, such as suppliers, customers and partners in the full life cycle of the R&D management process. That is, from conception to market development, evaluation, reporting and re-conceptualization. This research provides further insight into the next generation of R&D.

**Keywords** – Research and development (R&D); sixth generation R&D; collaboration; open innovation; case studies.

## **Introduction**

The trends in organizing, conducting and managing R&D have become apparent over the last two decades, together with a steady increase in R&D and innovation efforts and outputs (Busom & Fernandez-Ribas, 2008). Research and development (R&D) is the most popular means by which corporations and other institutions accumulate and increase the knowledge pool (Niosi, 1999).

Management of R&D takes various forms, A number of companies, even if engaged in multinational manufacturing and marketing of their products, made use of centralized research facilities, strategically located to enable easy access to external knowledge sources, such as leading universities, public research institutions as well as competitors' spillovers. The rationale behind this strategy was that, since knowledge is an intangible asset, it could be transferred at no cost by its proprietors when necessary. This is equivalent to saying that production and researching are subject to different location factors. However, a series of factors over the last two decades have forced the rapid modifications of the R&D management strategies, even for multinational firms (Campi & Bella, 1998:241 -242):

- the increase competition in the global market
- the growing diversification of even the most basic commodity, hence the growing need to tailor products to local market specifications.
- the increasing R&D contribution in the value chain of any product
- the attractive incentives offered by the governments of many countries to attract foreign investments in cutting-edge industries and/or research facilities in order to add to the advancement of indigenous technological base. Sometimes firms may be induced to set up local adaptive R&D by government regulations. There are two schools of thoughts about government industrial policies, viz. either internal investment in R&D are considered to fast-track economic growth, or foreign R&D units are viewed as a negative factor that does not contribute to the innovative capability and general welfare of the host country.
- the easy availability of well trained and educated personnel in many countries other than the few traditionally regarded as the most developed (Campi & Bella, 1998:241 -242).

Zhao (2003) further argued that the management of R&D requires the correct form of business organization in order to encourage innovation while controlling any associated risks.

Innovation was a term initially coined by Chesbrough (2005). The notion of open innovation entails collaborative endeavour while dealing with the issue of intellectual property rights

The next section provides critical review of various generations of R&D management strategies leaning onto the sixth generation, as well as the predictors of the sixth generation of R&D management strategies.

## **Literature Review**

Research and development (R&D) is the most popular means by which corporations and other institutions accumulate and increase the knowledge pool. However, R&D managing process is fraught with several operational, methodological, strategic and efficiency challenges (Nobelius, 2004).The most common channel used in the conduction of R&D is: through company research laboratories, government

research hubs and university laboratories. Within these three research channels, R&D management has undergone several metamorphoses.

Paraponaris (2003:96-98) argued that the models of R&D strategies have undergone several metamorphoses over the past couple of decades resulting in the current hybrid structures that combined a market-driven approach with networking practices.

### **Generations in R&D management**

According to Zhao (2003), the first generation of R&D management also referred to as push-technology approach, spans 1950s – 1960s. During this era, R&D management was characterized by lack of strategic framework, with R&D activities organized by scientific or engineering disciplines. R&D funds were allocated to cost centres with no specific profit objectives, resource plan, or time frame of budget. Furthermore, there was minimum evaluation of R&D performance other than by R&D function itself, coupled with little communication between R&D centres.

The second generation of R&D management, also known as the market-pull approach, gained popularity between the 1960s-1970s to build upon the first generation. The second generation provides the start of a strategic framework for R&D at the project level, while seeking to improve communication between R&D and other functions for commercial purposes. The centralized model which characterized the first R&D generation limits the opportunities for business collaboration and prevents the diffusion of innovation into the market place. Second generation of R&D management attempts to correct these problems by linking R&D to commercial needs on a project by project basis, through measurement of R&D results in financial terms, such as net present value, ROI, and payback ratio. The second/third generation of R&D management improves on the first generation through the combination of emphasis on financial control as well as the separation of centralized and decentralized model of R&D management.

The late 1990s saw the emergence of the fourth-generation R&D management. This generation gave rise to the introduction of knowledge of the end-users and the suppliers as well as even competitors and other companies with other competencies. Knowledge produces in the Universities as well as government research labs were positively explored and utilised. The feedback system within R&D management became streamlined and more complex to manage, with the development of technological alliances. The frontiers of the corporation became more porous, as intellectual property (IP) emanating from technical partnerships is partially shared with external agents.

The conventional R&D management methods soon became obsolete and new routines emerged to cope with the new activities, new knowledge directions and new calibre of employees. In the new business atmosphere, nimble-footedness is the key characteristics of the emerging model of R&D. Through strategic alliances, corporations look for key complementary assets (in technology, marketing knowledge and financing) through the combination of internal and external resources (Niosi, 1999).

Sofa (2008), Hara, Blomqvist, Koivuniemi & Aijo (2004) presented a framework describing the five generations of R&D management. In summary, the new paradigm tends to limit the efficiency of the previous models of R&D management (Niosi, 1999).

## **Research Methodology**

There has been little empirical work done in examining the different generations of R&D management. This is mainly due to the difficulty in recognizing and making sense of the inconspicuous, multiple, open-ended and dynamic variables. Thus Exploratory case studies has been used in this research to absorb this complexity by directing the focus on mechanisms, i.e. what was done and how, instead of how many, how much and the frequency (Holt et al, 2009). Yin (2003) argued that multiple cases studies offer greater range of evidence as well as providing a single set of “cross-case” conclusions.

This research mainly focus on understanding the parameter behind changes in R&D management, thus explore more recent R&D management practices leading to the sixth generation of R&D management.

The following are the outline of this research resulting in aspects of this paper:

1. Step one involves an evaluation of the core literature on R&D management, of database searches.
2. Step two involves extensive read up on journals from the database searches. The author started with a systematic search of all the articles related to R&D management. The key words and phrases such as research and development, R&D, new product development and innovation. The next step was to read through all relevant articles in order to gain understanding of the topic. Due to the large number of journals available on topic related to R&D, the author had to limit the journals to be included in this study in order to concentrate on those that are specific to R&D management (Candelin-Palmqvist, Sandberg and Mylly, 2012).
3. The various results and findings from all the literature are then compiled to form the conclusion of this research; hence it may be assumed that the extensive read up and consultation with various findings and conclusions have increased the trustworthiness of the findings of this research.

## **Case Studies and Discussions**

The main goal of R&D management routines is to reduce lead times, improve just-in-time deliveries of new products, minimize the number of unsuccessful R&D projects, improve efficiency, and cut research cost (Niosi, 1999).

Nobelius (2004) argued that a generation in R&D management is the totality of the different types of approaches and the evolutions through various R&D eras – all with a single aim of assisting institutions in improving their R&D efficiencies while developing a lingua-franca for researchers and institutions to work with.

Holt and Jayawarna, (2009) re-enforced R&D multifaceted and complex nature by arguing that R&D is far from being a homogenous activity and can be described differently according to different disciplines (e.g. scientist, engineer, technologist etc.) that can persist within the same R&D organization. Each discipline has its own interests and perspectives on the nature of knowledge and hence how a quality system should be employed. Within such complex and multi-discipline environments coupled with differing attitudes, a one-size-fit-all set of routines cannot serve the entire spectrum, implying each must be utilized in a specific and limited way to have the desired beneficial outcome. Based on this, the sixth generation of R&D will need to fine-tune the consolidation of knowledge within R&D units, creating synergies among the sundry professional groups and making individual units’ competencies more

transparent, explorable and exploitable. Management of knowledge, quality and competencies within the next generation of R&D will take a solid form in:

- The co-ordination of actors (networking practices) as one of the major elements of the next generation of R&D (Paraponaris, 2003). In view of the increasing complexity and multi-disciplinarity of research, where speed to and innovative product combinations constitute major competitive strengths, firms' R&D management strategies in the sixth generation will involve actively knit networks of complementary assets and resources (Miotti and Sachwald, 2003).
- Introduction of flexibility into research facilities through integration of effective communication links within the network of all players (Holt et al, 2009).

According to Busom et al (2008), new trends in the way R&D is managed and conducted have emerged over the last 20 years, along with steady increase in R&D and innovation effort and output. The development of networks or alliances among firms and public institutions or universities.

Management literature has identified three forms of R&D cooperation, namely;

- 1) Horizontal cooperation, i.e. between competing firms, stressing the importance of the degree of product market competition.
- 2) Vertical cooperation, i.e. between suppliers or customers and
- 3) Institutional cooperation, i.e. with universities and research institutions (Belderbos, Carree, Diederer, Lokshin and Veugelers, 2004).

Belderbos et al (2004) further argued that the type of partnership adopted by a firm for a particular R&D project depends on the goal to be achieved, however, the main goal of vertical cooperation with suppliers has been linked more to cost reduction, related to the tendency of firms to focus on core competencies, outsource activities to suppliers and/or develop close collaborative arrangements with suppliers to reduce cost. This sentiment is echoed by Busom et al (2008) who argued that customers and suppliers partnerships are the most frequently adopted by firms, followed by firms within the same enterprise group and then by universities or other higher educational institutions.

### **Elaboration on the elements of sixth generation managerial approach**

Using case studies, this section elaborates on some of the important managerial elements that will characterize the sixth generation of R&D using two case studies. Under the sixth generation model, organizations will develop methods to share IP as well as forms of collaborations that are new to previous R&D management practices.

The first case study describes the development of the Bluetooth technology through the formation of the SIG.

The second describes an initiative called the Innovation Mill (IM) that was established through collaboration among three Finland based companies, namely; Nokia Corporation, Technopolis and Tekes. This initiative was analysed and described by Hossain (2012).

#### *Case study 1: Bluetooth development and Evolution*

The development and the evolution of the Bluetooth technology have a number of sixth generation R&D management hallmarks (Nobelius 2004). Bluetooth is a wireless communication technology that enables

inter-communication between devices. Some of its common functions include data synchronization, such as cellular phones and computer or computer to computer, or cellular phone to cellular phone and connecting to the internet. It has very wide applications and works in the unlicensed 2.4 GHz frequency band. Unlike most devices, Bluetooth allows devices to automatically connect to each other.

Ericsson began researching into short-range wireless technology that could be used between their cellular phones and peripheral devices. In 1998, Ericsson, Nokia, IBM, Toshiba and Intel formed a coalition called the Special Interest Group (SIG). These companies were chosen because of their leadership in their respective technological fields. Ericsson and Nokia are leaders in the mobile phone technology field, IBM and Toshiba are leaders in laptop computing technologies while Intel's leadership resides in the digital signal processing technology. Each of these companies have a large number of employees, thus in four short years, the original five companies in the SIG have turned into 1500 personnel (Yen, Shih and Dursch, 2004). The developers immediately realised that Bluetooth technology is more capable than merely connecting peripheral devices. It is versatile in terms of application, allowing other types of wireless network connections. Up to eight devices can connect through Bluetooth, forming a small network call piconet. When more than eight devices need to be involved in the connection, a number of piconets can be connected together to form a network called scatternet (Yen et al, 2004). The Bluetooth technology came with the following advantages (Yen et al, 2004):

- Has great versatility and is very easy to use. Bluetooth frees up the end-user from being tied down by wires. With increasing need to connect several devices at once, wireless connection through Bluetooth technology has eliminated the complication that a wired connection would have created.
- Not only does Bluetooth allow seamless and wireless communications, it also allows devices to be connected automatically, hence making it very user-friendly.
- Other added advantages include, enhance security features.

#### *Bluetooth Analysis framework*

The continuous R&D into the Bluetooth technology is broadening its scope of use. What really makes Bluetooth such an important standard is its world-wide adoption and acceptance.

#### *Summary of managerial Implications for Sixth generation R&D management – Bluetooth SIG*

The formation of the SIG enables inter-industry collaboration and rapid global acceptance, adoption and standardization of a new innovation. Furthermore, both Ericsson and Intel were first to identify the choice of opening up the intellectual property as a basis of fast tracking global presence of an innovation (Nobelius, 2004). This has created a new product that has been formed through collaboration of more than a thousand companies that voluntarily came together with a common goal of developing a wide area wireless network (WAN). This technology quickly caught on to become a global standard for wireless personal area network.

The increasing complexity of new innovations is continuously demanding that more parameters be taken into account to enable the sustainability of the innovation. Some of these parameters include: the interoperability with other technologies, industrial design, portability, universality, versatility, environmental, conformity to global standards and marketing considerations. All these demand that cooperation and interaction with more of both internal/external as well as commercial/industry key

players, such as suppliers, customers, competitors, distributors and even non-competitors, for an innovation to be sustainable (Nobelius 2004).

### *Case Study 2: The Nokia Innovation Mill (IM)*

The purpose of IM is to encourage Finland's innovation sector in the Information, Communication and Technology (ICT) sector in developing globally competitive products and services.

Nokia Corporation is a market leader in the mobile phone sector, teams with other organization such as Technopolis and Tekes to convert Nokia's good innovative ideas that do not form part of their core business. These ideas are made available to companies throughout Finland, who might have the capability to turn these ideas into an innovative products and services.

Technopolis is an organization that specialises in providing business environments and services for knowledge-intensive organizations while Tekes is a government funding agency for Technology & Innovation, hence specializes in financing R&D and Innovations in Finland. Each of these organizations has a large number of employees. Tekes finances industrial R&D projects, universities as well as other R&D institutes (Hossain, 2012).

Although the collaboration is among these three companies, Nokia is the custodian of IM. Nokia makes available the patent rights of these ideas and then transfer them to companies who are able to convince the innovation board of their ability to successfully convert these initial ideas into innovative products and services. This is a unique example of open innovation and partnership among different stakeholders in both the government and the private sector. This type of collaborations will characterise the sixth generation of R&D management. The IM initiative has created a unique R&D model that fosters collaboration among Finish companies, an element that is predicted to be prevalent in the next generation R&D. Hossain (2012) cited other companies like Cisco, Dell, Nokia and Motorola that have acquired ideas through the partnership engagements with other companies.

### *Summary of Managerial implication Sixth generation R&D management - IM*

IM is a unique example of open innovation that is predicted by Nobelius (2004) to characterize sixth generation R&D management. According to Hossain (2012), the open innovation concept generally comprises spin-off, licensing inbound or outbound flows of knowledge, technology and information. Thus companies consider open innovation with the objective of gaining competitive advantage or market leadership in their business. However, the IM initiative goes beyond the idea of gaining competitive advantage by making available ideas, funds and support whilst at the same time fulfilling its social responsibility role. This case study is selected because it has the hallmark of the sixth generation of R&D management. The framework of Nobelius (2004) predicted open innovation and collaboration as some of the key characteristics of the sixth generation of R&D management and the IM initiative demonstrates these characteristics.

Both case studies demonstrated the need to create an environment for collaboration and idea sharing among different organizations to develop a new product. This strengthens the idea that successful innovations do not necessarily need to come from one company.

The success of both the Bluetooth and the Innovation Mill case studies demonstrated that next generation of R&D approaches may be characterized by network-based settings, where open innovation, idea sharing, joint research efforts, and cross-industrial commitment could become the norm.

### **Concluding Remarks**

The main goal of R&D management is to achieve maximum efficiency for the organizing and controlling efforts applied to the core activities. According to Sofo (2008), analysis shows that the transformation of R&D management is increasingly characterized by greater strategic focus, more holistic and multi-disciplinary approach emphasizing cross-functional communication, collaboration, greater inclusion of community experts and stakeholder such as suppliers, customers, government and partners in R&D in the full life cycle of R&D process, i.e. from conception to market development, evaluation, reporting and re-conceptualization. The sixth generation of R&D will be characterized by inclusiveness of various stakeholders and partnership endeavors. This is in clear contrast to the previous R&D generations which were more characterized by individual companies or entities trying to develop new propriety products single-handedly. The Bluetooth case study demonstrates the mixture characteristics that will prevail the next generation of R&D.

This research has reviewed a number of available literature on the characteristics of various generations of R&D management. The argument is that the attempt to predict the routines the will dominate the sixth generation of R&D management based on the literature of the previous five generations from the literature reviewed in this paper.

In broader terms, this study has offered several contributions which can serve as basis for future research. Firstly, this study has demonstrated the fundamental theoretical framework of the last five generations of R&D management, and has shown the usefulness of this framework in the context of the fast-paced development of new innovations. The discussion in this study could serve as a starting point the derivation of future research models on the evolution of R&D management.

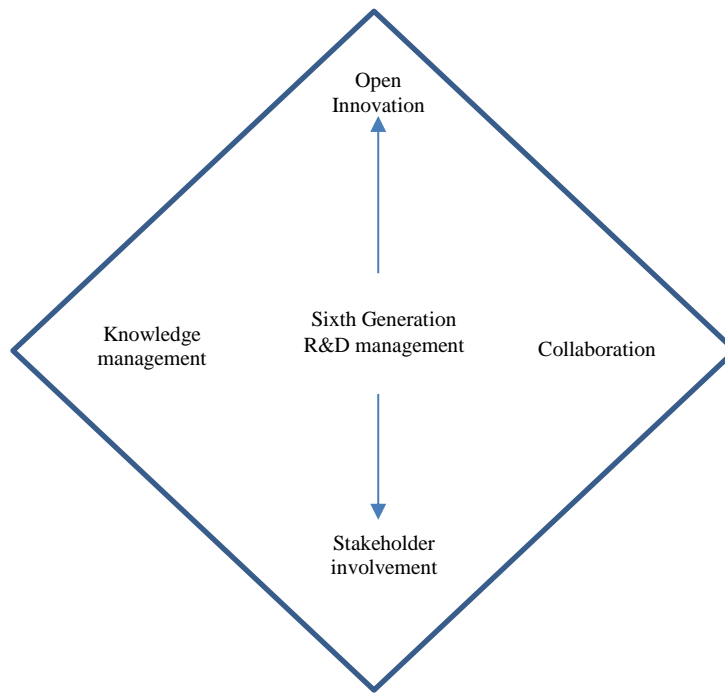
Previous studies on R&D managements are mainly conducted in either Europe or America. Furthermore, there is limited research undertaken to predict the R&D management practices that will be adopted in the sixth R&D generation. This study will therefore serve as a contribution of the work started by Nobelius (2004) to predict the likely prevailing management practices in the next R&D generation.

Throughout this study, attempts have been made to explore the factors the will necessitate the migration to the next generation of R&D management. By studying the different streams and generations of research on R&D management, the authors suggest that partnerships/collaborations, focus on knowledge management and open innovation will dominate the sixth generation of R&D management. This prediction is in line with Nobelius (2004) assertion that it will be difficult for a company to single-handedly create successful and sustainable innovation. This assertion is backed by Sofo (2008). Based on the review of the various literature, figure 1 describes a framework for the next generation of R&D management.

Berchicci (2012), who stated that the conventional paradigm of having a company's core R&D activities exclusively in-house is becoming less prevalent, while current models of innovation suggest how firms are opening up their R&D borders to harness external knowledge. Adoption of an open R&D system will enable a firm to outsource R&D projects or technologies which might previously have no clear



gateway to commercialization. The IM case study point to this fact. By exposing R&D projects or technologies to external partners, these projects find their way to market faster. It further allows firms to in-source external ideas through the integration of suppliers, customers and external knowledge sources to augment firm's innovativeness while keeping up with novel developments so that the firm can increase learning acquired from partnerships (Berchicci, 2012), (Aasen, Molnvik, Aarli, Bredesen, Munkejord, Brunsvold & Gundersen, 2012).



Source: Sofu (2008)

Figure 1: Framework for sixth generation

The Bluetooth SIG case cited in case study 1 firmly support this notion of open innovation. Chesbrough (2005), defined open innovation as the use of purposive inflows and outflows of knowledge to speed up internal innovation, while broadening the markets for external use of innovation, respectively. Chesbrough (2005) further stated that open innovation is a model that is based on an assumption that firms can exploit both internal/external ideas and paths to market, while they shape to their technology. Market is changing so rapidly through the advent of new technologies, hence, ideas that are not capture and promptly implemented soon fades away. It has thus become important issue for corporate strategist to swiftly act on ideas and convert them to commercial products (Hossain 2012).

Successful R&D activities are vital for national as well as firms' sustainable competitive advantage. The transition from one generation of R&D management to the next is not a tangible process. Furthermore, R&D management activities within firms is made up of a mixture of routines from more than one generation. Moreover, R&D managers need to be guided by operational environment and context (e.g. geographical location, government legislation, country, prevailing R&D practices in the area and the industry), when attempting to adopt specific R&D practices geared at making a transition into the sixth

generation. It is therefore imperative for R&D managers to be able to design and adapt the latest and most proven R&D management strategies in order to maintain a competitive edge.

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