KSFs of Collaborative Innovation for Companies in Developing Economies – A Case Study

Bang-Ning Hwang and Iain Coulson

***Abstract*—Multinational enterprises are expanding their global reach to new and diverse emerging economies, and there is a strong need for multinational enterprises to tailor their products (services) to those local preferences. Traditionally emerging economies have not been front runners in the innovation landscape. However, the unique opportunities offered by these emerging economies have encouraged multinational enterprises to develop innovative products (services) and/or innovative business models that will appeal to these new market economies. This paper pays particular attention to multinational enterprises working within the South African business environment. The research addresses the question – what key factors are required by a multinational enterprise to successfully implement and manage collaborative innovative products (services) in developing economies? This paper structures the KSFs for collaborative innovation into a multi-level model then explores a case study within South Africa where a multinational enterprise has had resounding success with different collaborative ventures. Each of the key success factors will then be discussed in depth to understand why they are vital for successful collaborative innovation.**

***Index Terms*—Collaborative innovation, key success factor (KSF), emerging economies, South Africa.**

I. Introduction

.Over the last two decades, there has been a major shift in the global innovation landscape. Emerging markets now represent the next big growth opportunity for multinational enterprises. Multinational Enterprises (MNEs) are expanding their global reach to new and diverse emerging economies, and there is a daunting challenge for MNEs to tailor their products (services) to effectively take advantage of these emerging markets.

Traditionally emerging economies have not been front runners in the innovation landscape and most of the research and innovative know-how has been based on the developed countries. Therefore theoretical and empirical literatures in the past have paid little attention to the needs for innovative products and the production of appropriate technologies in emerging economies [1]. However, the unique opportunities offered by these emerging economies have encouraged MNEs to try and develop innovative products (services) and/or innovative business models that will appeal to these new market economies, and further expand into the global market.

Since the advent of democracy in South Africa, the country has had large macroeconomic reforms. These reforms boosted competitiveness within the country, expanded the economy, and ultimately opened South Africa up to world markets. Not only is South Africa the economic powerhouse of Africa, it is also the gateway to entire African market. The country plays a significant role in supplying investments, energy, and communications to the continent. South Africa’s well-developed transportation links and infrastructure provide the platform to deliver products (services) to the rest of Africa.

This paper pays particular attention to a global company working within the developing economies. The research addresses the question – what key factors are required by a multinational company to successfully implement and manage collaborative innovation in a developing country and enable it to expand and compete globally. We’ll explore a case based in South Africa that has had significant amount of collaborative ventures both in South Africa and globally. This case investigates the various ways in which a company can collaborate with local and foreign institutions to develop innovative products that appeal to the global market.

II. Literature Review

Until the early 1990’s, business and academic literatures both portrayed that innovation was driven by entities acting alone. New innovations were thought to be the products of individual persons, small and medium enterprises, or business units within large enterprises. However, the increased complexities of technology as well as the increased demand of unique products make the individualized approach to innovation difficult [2]. Therefore, innovation is increasingly being recognized as a result of a combination of different expertise and knowledge that exist within different organizations. For example some organizational relationships may have complementary and interactive effects on technological innovation. Hence, it is not surprising that there has been a strong upsurge of various forms of inter-organizational collaborative ventures for innovation [3]–[5]. Companies that choose to pursue collaborative innovation as a strategy must be able to develop the capabilities, structures, and processes to support the collaborative approach [2]. It is vital that the management of particular organizations realize that collaboration with external institutions is far more demanding, and in reality totally different from mere cooperation. They need to take into account the other’s interests as much as their own [6], [7].

Earlier research has discussed various key success factors (KSFs) of collaborative innovative ventures. Müller and Herstatt [8] focused on KSFs required for the management

Manuscript received April 19, 2014; revised June 3, 2014.

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DOI: 10.7763/IJIMT.2014.V5.518

of R&D cooperation, including balanced partnerships, effective communication, conflict management, trust, effective learning procedures, and the installation of a collaboration champion to effectively manage the co-operation. Nelson and Winter [9] placed particular attention on the diversity of a collaborative network and how that influenced a firm's ability to successfully implement a collaborative venture. Dosi [10] had an evolutionary perspective view that innovation as a dynamic process, which continually developed over time with different patterns and paths for various organizations. So in other words, organizations that had the experience of innovative collaborations in the past would be able to gain "absorptive capacity" of innovation, and thereby increased their innovative capability [11]. Nelson and Winter [9] and Hoecht and Trott [12] argued that the innovative capability of a firm was highly dependent on the knowledge that they had cumulatively built up over time. This type of knowledge experience could be viewed as a gradual learning process, firstly in terms of the organization's technical learning ability of innovations, and secondly in the collaborative alliances that the organization had [13]. Additionally there are KSFs concerned with the diversity of the partnership network that a firm has. Nelson and Winter [9] suggested that institutions should continuously search externally for a variety of sources that would allow them to create new combinations of technology and knowledge. This variety of external options and sources should help an institution achieve sustainable innovations [14], [15]. Inter-organizational collaboration with different partners on research and development raises the likelihood of achieving product innovation [16]. Knowledge diversity also facilitates the innovative process by enabling the individual to make novel associations and linkages [11]. With regards to the partner selection prior to engaging in collaborative innovation, there are stark and major differences among various types of prospective partners that a firm could have. Each institution has specific characteristics and different objectives that it would like to achieve. Conformity and clarity about the partner's goals may prevent the imbalance that only one partner benefits during the collaboration [17]. Therefore, an organization should weigh the risks and expected results when choosing a collaboration partner [13]. There are differing opinions whether symmetries or asymmetries between the selected partners are more favorable. Kogut [18] and Harrigan [19] argued that symmetries among partners in terms of size and technological capability guaranteed stability of the collaboration process; however, some empirical findings indicated that asymmetries in size do not affect the success of collaboration [20]. Nevertheless, both sides of researchers agreed that there were advantages of pooling resources and creating synergies.

Throughout the collaboration process, managing collaboration ventures is a demanding task. Teichert [21] provided insight into how to manage a balanced relationship in terms of cost sharing, risk sharing, and exploitation of knowledge so that both partners could benefit mutually. Innovation processes are basically information exchange processes and thus efficient information trading between the collaborators is the cornerstone for a successful innovation implementation. In order to accomplish this, effective corporate communication behavior should be instilled within the firms. Ohmae [22] recommended that the management team needed to be attentive to the "softer" skills, such as frequent, rapport-building meetings at no less than three upper organizational levels. However without proper control, the leakage of confidential information could result in a competitive advantage loss. Therefore, it is critical for an organization to scrutinize the information content and restrict the scope and scale of information flow between collaborative partners in order to prevent the unauthorized information leakage [23]. The intellectual property protection mechanisms – such as patents, copyrights, trademarks, and trade secrets – are also considered to be important. Extensive economic literatures and business reports indicate that the proper use of intellectual property protection in research partnerships depends on factors relating to the type of knowledge to be protected, the kind of competition in the specific industry, the organizational characteristics, the nature and objectives of the partnership, and the position of the partnership in the continuum from the early planning stage to termination [24].

After reviewing the theory of collaborative innovation and its key success factors accomplished by prior researchers, we provide a summary and propose the following KNG (Knowledge Foundation, Networking, and Governance) models for the KSFs required for successful implementation of collaborative innovation, as shown in Fig. 1:

Level 3: Governance Level		
3.1: Contractual Agreements	3.2: Management of Collaborative Innovation	3.3: Protection and Ownership of IP
Level 2: Networking Level		
2.1: Diversity of Network	2.2: Partner selection	
Level 1: Knowledge Foundation Level		
1.1: Innovative Capacity	1.2: Continuity of Collaborative Innovation	1.3: History and Experience in Collaborative Innovation

Fig. 1. The KNG model of the key success factors required for collaborative innovation among organizations.

1) The first level looks at collaborative innovation from a knowledge foundation level, which includes the organization's innovative capacity, the continuity of capacity collaborative innovation, and the history and the experience in collaborative innovation that an organization has.
2) The second level deals with the networking level, which includes the factors of the diversity of the organizations collaborative innovation network and the collaboration partner selection.
3) The third level looks at collaborative innovation at the governance level which includes the contract agreements, the management of collaborative innovation, and the protection and ownership of intellectual property.

III. Research Methodology

The research method employed in the article is the case study approach. According to Yin [25] case studies are distinctively needed to understand the complex social phenomena. The reason that we chose a single case is that single case study is a common design that it can be justified under certain conditions. These conditions can arise when a case is a unique event, or when a case represents a critical test of theory, or when a case serves a revelatory purpose [25]. In addition, the case study method allows for investigation of particular and specific issues within its real-life context. To testify the proposed 3-level model of KSFs, we'll use the case of Sasol. Sasol Limited, founded in 1950, has transformed itself from a local synthetic fuels producer operated solely in South African into an innovative MNE with reputation in the petrochemical industry worldwide. Sasol has successfully developed a variety of petrochemical products and engineering services through continuous collaborative innovation with partners in academic and industry globally. The data source of the case study includes primary data from interviewing with three senior managers in Sasol and secondary data from published technical and financial reports. The interviews were conducted in a semi-structured interview approach, where questions were designed for purpose of the particular research. The three interviewees were chosen because of their sound knowledge and experience of managing collaborative ventures at Sasol; they are respectively one senior manager of Fuels Research at Sasol, one senior scientist, and a senior process engineer at Sasol Technology. The design of the case study examined the broader scope of Sasol's collaborative innovation with various academic and private institutions to create innovative products and processes.

IV. Case Study: Sasol Limited

A. Case Background

Sasol emerged as a science based firm; this company was fairly unique compared to other international oil companies as it had limited conventional exploration and production operations. Its origins lay in the use proprietary technology, the Fischer-Tropsch (FT) process for generating synthetic fuels (Synfuels) and chemicals from low grade coal and natural gas. The Sasol group's structure is organized into four focused business clusters – South African energy cluster, international energy cluster, chemical cluster, and other businesses. Sasol's energy clusters are focused on the manufacturing, refining, and marketing of automotive and industrial fuels, oils and gas. The chemical cluster consists of business units that produce polymers, solvents, surfactants, alumina, waxes, fertilizers, explosives and phenolic. The final cluster which Sasol refers to as "other businesses" includes Sasol New Energy which is responsible of investigating, developing, and commercializing new technologies; Sasol Financing manages the group's central treasury and to ensure that Sasol can meet its funding requirements; Sasol Group Services coordinates and manages all group activities; and finally Sasol Technology manages Sasol's research and development, technological innovation, technological management, engineering services and project portfolios. For Sasol's financial year ending on 30th June 2011, its annual revenue stood at more than US $ 20 billion, and it had an operating profit of US $ 4.3 billion. Sasol has distributed research centers in Secunda (South Africa), Cape Town (South Africa), Netherlands, Germany, Scotland, Italy, and the United States. For the year ending 2010, Sasol had the R&D intensity (R&D expenditure as a percentage of growth margin or net sales) of 0.7 %. Compared this figure to other global players in the Oil and Gas Industry such as Chevron (0.3 %), Exxon Mobil (0.3%), and Royal Dutch Shell (0.3%), Sasol had invested relatively double the amount in R&D than its peering enterprises [26].

To explore how the KSFs being applied by the case company and led it to become an innovative global enterprise, we discuss the success factors in the context of the proposed KNG model.

1) Level 1: Knowledge foundation level

The previous South African government's apartheid policies affected Sasol right from its beginning. It was concerned with making South Africa become self-sufficient in terms of energy consumption, therefore the main concern and main achievement of Sasol from its establishment in 1950 was to make South Africa self-reliant in energy. When the global oil crisis hit in the seventies, Sasol had to deal with the deepening resistance against apartheid. The South African government developed an increasingly inward-looking and defensive mind set. Most learning during this phase consisted of incremental learning-by-doing in the course of production rather than significant technological advances. The year 1986 marked the beginning of official international economic sanctions against South Africa, accompanied by an academic boycott. Foreigners risked global censor and worse for continuing economic and intellectual engagement with South African firms. As a firm with close ties to the South African government, this presented an especially serious threat to Sasol. At first, Sasol managed to overcome the constraints and managed to sustain impressive technological growth. Sasol replaced its 16 Synthol reactors by eight SAS reactors (SAS TM are Fixed Fluidized Bed reactors with approximately five times the capacity of the Circulating Fluidized Bed Synthol reactors). As a result, Sasol could lower its initial capital investment as well as subsequent maintenance costs. Sasol has also managed to develop world-class polypropylene and propylene capabilities since then. The technological advances of which Sasol reaped the benefit during the late 1980s reflected the culmination of work done previously.

After Nelson Mandela's release from prison in 1990, economic sanctions and the academic boycott were lifted. South African firms were free to resume international contact. Sasol was able to draw on a depth of expertise again, and continue to pursue and develop new technological capabilities. Sasol recognized that there was a need for urgency to re-establish formal international linkages in order to support its increasingly diverse undertakings and to regain ground on improving its absorptive and innovative capacities. Consequently, Sasol put a high priority on international joint ventures when apartheid officially ended. These included a joint venture with a German firm

Schumann in 1995 to form Sasol Wax, and another merger of Sasol Phenolic with the US-based Merichem (now Merisol) in 1997 [27]. In 1999, Sasol and Chevron agreed to form a joint venture for the identification, development and implementation of gas-to-liquids ventures worldwide based on Sasol's Fischer-Tropsch technology.

As Dosi [10] and Cohen and Levinthal [11] have pointed out that the innovation is a dynamic process and a function of prior learning and absorptive capacity. Sasol has had over 40 years' experience of intra or inter organizational collaborative innovation, and has accumulated a wealth of R&D experiences in the petrochemical industry. The accumulated innovation results can be manifested by the number of patents filed. Sasol's first patent was filed in 1968, and its absorptive capacity and innovative capacity grew. At 30 June 2011, Sasol's intellectual property portfolio included 490 registered patent families [28].

2) Level 2: Networking level

To meet its ambitious growth targets, Sasol acknowledges that it needs to collaborate with other technology providers. Since mid-1990, Sasol has collaborated with more than 80 different organizations. Sasol Technology alone is managing over 60 collaborative projects currently. Sasol's varieties of collaborative activities include ventures with local South African universities, foreign universities, and international corporations across industries. Sasol Technology has funded R&D programs at 11 universities in South Africa. Through these collaborations with academics, Sasol has been able to develop innovative products, processes, and inventions [28]. Taking one invention called Magnetometer as an example; it was developed in collaboration with the University of Cape Town in South Africa. This product invention is the first of its kind in the world that enables scientists to examine ferro-metallic catalysts [29]. Other noticeable collaborative innovations with South African universities include the establishment of a High Resolution Transmission Electron Microscopy (HR-TEM) Centre at the Nelson Mandela Metropolitan University, which hosts the only atomic resolution transmission electron microscope on the entire African continent. The collaboration between Sasol and the Department of Chemistry and Chemical Engineering at the University of Pretoria (UP) led to the commissioning of high-tech equipment to gain better insights into the properties and performance of synthetic diesel fuels [29].

In addition to collaborating with domestic academics, Sasol has forged links and collaborations with universities in United Kingdom, Europe, and the USA. In 2002, Sasol opened its European R&D centre at the University of St. Andrews, with the intention to establish medium to long term research projects in the research areas of catalysis and renewable energy. In Netherlands, Sasol has focused its collaboration innovation work on satellite research, whereas in the USA it has focused on reactor engineering and Synfuel analysis respectively. Table 1 highlights the diverse geographical locations and technological specializations of Sasol's research and development.

Through these collaborations with academia, Sasol has not only gained access to critical research equipment but has been able recruit and nurture new researchers and further influence their exposure to international expertise. Furthermore, Sasol has built considerable number of R&D laboratories worldwide to strengthen its collaborative innovation with international expertise in order to maintain its technological leadership.

TABLE I: SASOL'S R&D LABORATORIES WORLDWIDE

Sasol's Organizations	R&D Lab (Location)
Corporate R&D	Sasolburg (South Africa) Twente (Netherlands) St Andrews (Scotland)
Sasol Oil	Sasolburg (South Africa) Cape Town (South Africa)
Merisol	Sasolburg (South Africa)
Sasol Olefin and Surfactants	Sasolburg (South Africa) Lake Charles (USA) Moers (Germany) Brunsbuttel (Germany) Marl (Germany) Paderno (Italy) St Andrews (Scotland)
Solvents	Sasolburg (South Africa) Moers (Germany)
Sasol Nitro	Sasolburg (South Africa)
Sasol Polymers	Modderfontein (South Africa)
Sasol Wax	Sasolburg (South Africa) Hamburg (Germany)

When looking to invest in collaborative ventures, the Sasol management team performs thorough investigations into the prospective partners in terms of their corporate structure, culture, and innovative and absorptive capacity. With respect to that, Sasol defines the following crucial criteria when selecting a new collaborative partner:

- What skills and key capabilities does the partner have?
- In what way will the partner add value?
- What similarities are there between the partner and Sasol in management styles, philosophies and business approach?
- Are corporate cultures compatible?
- How is the partner perceived in the market place?
- What is the partner's reputation?
- What is the level of trust between the partner and Sasol?

3) Level 3: Governance level

Since its establishment, Sasol has focused on advancing its technological competence, but formal IP management was either not done at all, or done very haphazardly. Due to the complex nature of managing a large amount of collaborative ventures and their intellectual properties, Sasol decided to extend Sasol Technology's functions from spearheading Sasol group's technology capability growth and diversification to managing the collaborative innovation with partners. The augmented responsibilities includes acquiring external innovative ideas and/or technologies, managing all of Sasol's collaborative research and development portfolios, and commercializing the developed innovative products and engineering services. One of the major functions that Sasol Technology perform is to draw up the memorandum of contract initiation and termination agreements for all kinds of collaborative ventures that Sasol headquarters intends to engage. At first Sasol relied on external law firms to provide the legal service, and gradually Sasol has built its own knowledge base and has developed in-house legal capabilities. Now Sasol Technology is proficient in contractual risk management, IP licensing, and IP protection. The successful experience of Sasol Technology is also shared within the Sasol headquarters. In 1996, Sasol introduced a formal IP function, starting the process of actively managing the disclosure of its technological inventions. Together, these collective efforts direct Sasol's collaboration strategy and planning process as well as smooth Sasol's implementation of collaborations with partners. As shown in the Fig. 2, the number of patent applications had increased significantly during the period of 1996 to 1999 after Sasol's forming the formal IP function.

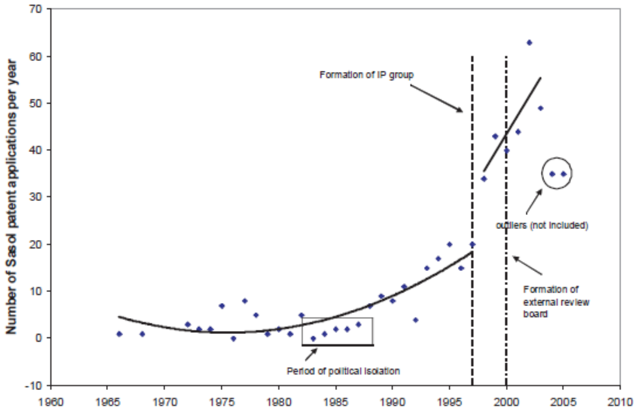

Fig. 2. Number of sasol patents per year (source: [27]).

In order to improve the quality of these fast growing patents, Sasol further refined its IP management process by introducing governance principles gleaned from one of its strategic collaboration partners, i.e., Chevron, in 2000. Chevron's IP review practice was served as the benchmark for Sasol IP review team to formally decide, per area of technical capabilities, on the best possible way to protect its IP as well as manage its business and technological risks associated with the proprietary information disclosure [27]. The review process conducted by the joint Sasol/Chevron review board adjusted down the patent application number but toward a more structured and competitive direction. In 2000 Sasol also formed the Heterogeneous Catalysis Advisory Board aiming to extend its access to international corporations and dedicated R&D organizations in certain special technology domains to explore the opportunities of knowledge sharing and collaborative ventures.

As we can see from the illustrated case, Sasol has matured into a fairly typical international corporation in the petrochemical industry from a local synthetic fuels producer operated solely in South into an innovative MNE with reputation in the petrochemical industry worldwide. The Sasol case study does provide evidence of how a company in a developing economy can evolve from a single process and a single product company into a multiple-product enterprise through intensive collaborative innovations.

V. Conclusion

For companies in developing economies, such "currency" as knowledge and experience of collaborative innovation is extremely important to gain competitive advantage effectively and efficiently. This paper's major contributions include: Firstly, it explores the KSFs needed to successfully implement collaborative innovation within an emerging economy. Secondly, it structures the KSFs for collaborative innovation into a multi-level KNG model. Such well-organized multi-level model has not been found in prior research literatures. Thirdly, this paper justifies its standpoint through a MNE case in South African, yet seldom South African enterprises are examined by prior researchers.

Although the authors have done extensive works to probe the most essential KSFs for the collaborative innovation, the three-level factor model might not be universally completed. To further extend the proposed KNG model, more case studies in different emerging economic regions are suggested in future research. Moreover, a quantitative research method can be employed to examine the relationship among all these KSFs and the impact of each factor to the collaborative innovation result It will also be worth to perform similar empirical studies in a number of other industries to be able to compare the results.

Acknowledgment

The authors would like to thank all the stakeholders that participated in the study and in particular those of whom from Sasol that were interviewed. They provided valuable insight and without their help this research would have not been possible.

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