

On the Development of a Theoretical Framework for New Product Development

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Abstract New Product Development (NPD) is critical for a firm's survival and development. As firms are increasingly challenged by internal deficiencies and paucities of knowledge resources, they need to embrace open innovation strategies. Subsequently, involving suppliers and customers into the process of NPD has been viewed as the most effective means by which internal and external knowledge resources can be optimally leveraged. However, there is a lack of available and reliable mechanisms to facilitate this process. This paper presents a comprehensive theoretical framework developed by harmoniously combining the relevant theoretical fields of Knowledge Management (KM), Open Innovation (OI), Supply Chain Management (SCM) and Product Lifecycle Management (PLM). Additionally, within this framework, Knowledge Audit, Knowledge Calibration and Knowledge Absorption have been employed as valuable tools to manage knowledge loops across the three innovation stages: pre-acquisition, in-acquisition and post-acquisition.

1 INTRODUCTION

1.1 Background

In today's business environment, companies are continually challenged by shorter product lifecycles, faster technological changes, demanding and sophisticated customers and the abiding trends of internationalisation, globalisation and convergence of industries. In response to these changes, increasingly, innovation and NPD has been viewed as critical to a company's success (D'Alene, 1994); (Veliyath et al., 2000). Moreover as competition is shifting from between firms to between supply chains (Christopher, 1992), external actors, such as customers and suppliers are increasingly influencing the process of innovation (Thomke et al., 2002).

As a result, during the last decade, research interests on innovation have been shifted from closed innovation to open innovation where the purposive inflows and outflows of knowledge, as the impetus of accelerating innovation process, can be effectively managed (Chesbrough et al., 2003). Most importantly, due to the paucity or deficiency of internal knowledge assets, firms have to rely on external knowledge to foster innovation and to enhance their performance (Ireland et al., 2002). In this line of rea-

soning, speeding up creative operations will rely on the ability of the firms to co-ordinate, formulate a competitive strategy and compensate for intrinsic deficiencies by optimally leveraging external knowledge resources (Ireland et al., 2002).

According to Drucker (1992), knowledge has become the primary resource for the new economy, where the tangible resources have become secondary. This has been advocated by some researchers who argue that knowledge will become not just as a source of competitive advantage, but as the only source of competitive advantage. (Drucker, 1993); (Nonaka, 1994); (Nonaka and Takeuchi, 1995). It is therefore becoming strategic importance that firms constantly improve their ability to effectively managing knowledge flows, ensure success of NPD and increase competitiveness (Bell, 1999); (Tidd and Hull, 2003); (Karmarkar, 2004); (Schultze and Stabell, 2004); (Chesbrough et al., 2006).

It has been suggested that valuable knowledge could be obtained and exploited through collaboration and cooperation across SC networks and optimally add value for the end customers. Therefore, it becomes imperative for firms to identify valuable knowledge sources within both internal and external environment and foster innovation quicker than the competitors (Darroch, 2005). Recent research has

indicated that the supply chain is becoming the major source of external knowledge, skills, ideas and added value through collaborative efforts across the chain members (CBI, 2005); (Sainsbury, 2007). More specifically, supply chain networks simultaneously influence the present and future (IfM, IBM, 2007). Supply Chain Management (SCM) proponents have argued that the change in the nature of competition is becoming the momentum which shifts the competition from individual firms to supply chains. Furthermore this shift has urged the management practice to re-audit and re-build the value-adding system and forced firms to re-evaluate and re-structure their value chains by adopting a holistic view of the supply chain. In this setup, customers as the “prosumer” (Toffler 1980) together with suppliers have been increasingly considered as the key drivers, co-innovators, co-developers and primary resources to NPD (Thomke and von Hippel; 2002).

Unfortunately, these issues have never been simultaneously discussed, particularly for NPD, and unsurprisingly there are no comprehensive and reliable frameworks to reference. Accordingly, there are a number of gaps that hinder the endeavours of integrating these relevant theoretical fields into a credible and reliable framework. The main gaps are the following:

- Intra-firm KM effort is increasingly becoming an emerging research field wherein the potential value of KM might be optimally explored and exploited. However, tacitness of knowledge together with the intricate technical requirements associated with KM, even in an inter-firm context, is a barrier to the success of intra-firm KM implementation. So the question is how to compensate for intrinsic deficiencies of Knowledge Management Systems and employ the proper KM techniques to facilitate efforts on an intra-firm and open innovation context.
- Open innovation is subject to tremendous pressure emerging from the competitive business environment and complexity of synthesizing external and internal knowledge assets. The shift from closed innovation to open innovation requires firms to do more than just “open the book”. Therefore, the difficulty is how to develop a multidimensional method by which a firm can systematically identify, embed and embody knowledge scattered in the external environment.
- Firms have to network with strategic partners that possess sharable knowledge. Therefore, effective combination of SCM and PLM is vital to achieve the goal of creating knowledge loops in a network context. However, the difficulties might be the feasibility and reliability of embedding knowledge from the

process of managing product lifecycle and effective SCM. Additionally to what extent a firm’s innovation will rely on the knowledge from suppliers and customers and how can evaluate the value of knowledge?

This paper is presented in six sections. The first section introduces the background and states the aims and objectives of the research based on a comprehensive evaluation of identified theoretical gaps. Section two gives a brief explanation of the adopted research approach followed by a literature review. The fourth section presents and discusses the foundations of the theoretical framework that is presented in more detail in section five. Finally the sixth section briefly discusses the preliminary theoretical framework followed by concluding remarks.

1.2 Aims of Research

A prerequisite to this state of affairs is to design a comprehensive and creditable system by harmoniously combining relevant theoretical fields to bridge the gaps. In doing so, this paper aims to present a preliminary theory-based framework which can facilitate the process of managing knowledge loops for NPD and outline a novel approach for innovation within increasingly competitive environment. It mainly employs Knowledge Audit, Knowledge Calibration and Knowledge Absorption techniques to control knowledge loop across three collaborative innovation phases, pre-acquisition, in-acquisition and post-acquisition.

2 METHODOLOGY

Adoption of the methodology (See Figure 1) is shaped by the research aims. In order to design a theory-based framework, gaps specification has been positioned as the prerequisite of formulating the basic research aims. It is followed by a relevant literature review that highlights not only the main building blocks of the framework but also uncovers distinct characteristics. These characteristics, if explored and developed effectively, provide one approach to bridging the theoretical gaps.

3 LITERATURE REVIEW

3.1 Knowledge Management

Increasingly, innovating firms have to improve their

abilities to meet the never-ending requirements, from demanding customers and fierce competition, by effectively managing internal and/or external valuable knowledge resources.

KM is a kind of strategy which delivers the right knowledge to the right persons at the right time (APQC). And KM efforts can be understood, no longer merely as an option but rather as a core issue that has to be thoroughly dealt with for firms to surpass the global competition (Singh, 2007). Effective KM implementation for innovation can be solely realized by aligning with the overall business strategy not only within internal environment, but also across the external supply chain (Mudge, 1999); (Okunoye and Kartsen, 2002); (Dan Holtshouse, 2011).

As a process (OECD, 2003), KM can improve the learning abilities and increase effectiveness and efficiency of organizational performance by systematically coordinating processes of knowledge internalization, externalization, socialization and combination (Mockler et al., 1992); (Nonaka, 1994). This viewpoint about KM has been advocated by Davenport et al., (2003) who place the attention on the process of “knowledge import” and “knowledge export”. The underlying principle is to “export” imported knowledge to the rest of firm for the purpose of solving problems or encouraging innovation. Meanwhile, the resource-based view of firms has shown that relationships between buyers and sellers are the most important intangible resources than technical and organizational capital (Penrose 1959); (Darroch, 2005).

KM can be seen as an effective coordinating mechanism which ultimately enables the resource to be converted into capabilities (Nelson and Winter, 1982); (Darroch, 2005). Earl (2001) suggests that KM can be regarded as central to product and process innovation or improvement, executive decision-making and organizational adaptation and renewal. In term of innovation, the KM perspective of NPD is about how to seek optimal ways of controlling the valuable knowledge assets. In essence, this process is an effort of utilizing these mechanisms to coordinate the conversion process, namely from the embedded knowledge to embodied knowledge (Madhavan et al., 1998). Most importantly, in order to innovate, firms need to create an inventory of knowledge assets and make it more visible, accessible, sharable and measurable (Jarrar 2002); (Skyme and Amidon, 1997). Furthermore, the firms can benefit from successful KM implementation by enhancing their competitive advantage, customer focus, employee relations and development, innovation, and lower costs (Skyrme and Arnindon, 1997); (Dykeman, 1998).

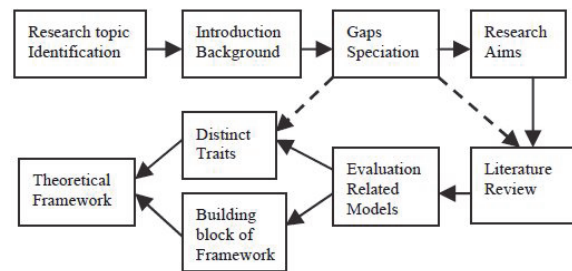


Figure 1: Research methodology.

3.2 Innovation

Today’s business environment is fiercely competitive. Globalization, ever fast changing technologies and increasingly demanding customers are constantly pushing the performance bar upward. Becoming an innovator is the only way to be a winner. Unsurprisingly, successful firms have to innovate at the global frontier and shift the technology frontier better than their rivals (Porter and Stern, 2001). A survey conducted by Product Development and Management Association (PDMA) has shown that successful new products contributed 50% to 60% of sales in most companies (Hustad, 1996). Additionally, success of NPD will help the firms to siege new opportunities and actually propel the firms into new business fields wherein they can gain first-mover advantages or surpass the competitors in term of responsiveness or innovativeness.

According to CBI (Confederation of British Industry) (2005), innovation is considered as being ‘the successful exploitation of new ideas’ across industrial networks that collaborate in a SC context to stimulate the creation of these ideas. Meanwhile this process will rely on the decision to exploit and develop the power of effective KM implementation which can support innovation and creativity (IFM and IBM, 2007). Consequently, firms become much more prepared to innovate and perform successfully to meet the requirements from the customer and market faster and better than the competitors.

DTI (2007) also concluded that there is a need to take a broader view of the innovatory process and to tap into a network environment, because that individual actor is seldom capable to innovate independently. Networks through establishment of “weak and strong ties” (Granovette, 1973) and bridging of “structural holes” (Burt, 1992) can greatly enhance the processes of knowledge creation. This viewpoint has been advocated by Antoni who states that the knowledge needed for innovation is often a product of the confrontation and combination of different fields of knowledge from heterogeneous resources

(Antonio, 2009). Therefore, it has become a strategic attractive option to acquire knowledge from external sources to compensate for scarcity of internal resources (Freeman, 1987). In a similar vein, open innovation (Chesbrough, 2003), as an emerging innovation strategy, has been regarded as the essential element to revitalize in-house innovation or closed innovation and to accelerate the innovation process (Schebrough, 2003); (Tether, 2002); (Coombs et al., 2003); (Howells et al., 2003). Gassmann et al., (2004) present three archetypes of the open innovation process:

- Outside-in: integrating external knowledge, customers and suppliers;
- Inside- out: bring ideas to market;
- Coupled processes: couple outside-in and inside-out process and work in alliances in a complementary manner;

3.3 Supply Chain Management

Basically, SCM covers all business processes between vertically linked entities within three dimensions, action, relationship and process (Bowerox et al., 1999); (Cooper et al., 1997); (Lambert et al., 1998); (Bask and Juga, 2001); (Persson, 2002).

The Council of Supply Chain Management Professionals (2006) concluded that SCM “encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all logistics management activities. In essence, supply chain management integrates supply and demand management within and across companies.” SC as a value chain can offer the opportunities to simultaneously improve the individual firm’s performance and increase the possibilities to achieve common goals or “growing the pie” (Harwick, 1997). Meanwhile, it provides firms with a way to optimally leverage its core competences and unique skills and strategically outsourcing non-core activities to external networks (Cox, 1999); (Laseter, 1998); (Quinn, 2000).

The relation-oriented definition (Aitken, 1998) of SCM suggests that relationships; cooperation and mutuality are vital in improving effectiveness and efficiency and overall performance. Consequently, appropriate relationships with channel members are not only the antecedent of successful “outsourced activities” but also the consequence of fruitful collaboration. Therefore, it is core to improve the abilities and create a mechanism by which the intricate relationship can be enforced (Drucker, 1998); (Bowersox, 1999).

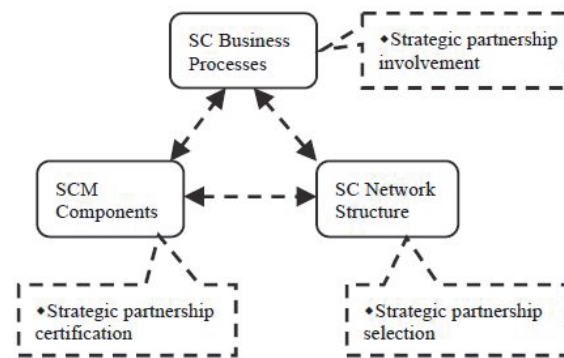


Figure 2: SCM Framework (adapted from (Lambert et al, 2000); (Cooper et al, 1997)).

SCM presents the effective integration of key business processes that add value to end-customer, from upstream suppliers, manufacturers, distributors and retailers (Richard and Wisner, 2005). So it can be seen as an approach to coordinating functions and processes and responding the requirements of customers through effective management of information and knowledge across the network (Nancy et al. 2003). Cooper et al. (1997) state that the SCM encompasses three closely inter-related elements: the SC network structure, the SC business processes, and the SCM components (see Figure2). This framework provides the basic principles of creating strategic supply chain configuration considering all exogenous and endogenous variables related to NPD and strategically, operationally and technologically create long-term stable relationships (Hult et al., 2004). Basically strategic supply chain relies on three aspects: strategic partnership selection, strategic partnership certification and strategic partnership involvement (Burt and Soukup, 1985); (Swink, 1999); (Shin et al., 2000).

Based on the extant literature, it is widely accepted that the suppliers’ innovative capabilities are the major determinants for collaboration. Meanwhile, Burton (1988) argues that suppliers accounted for approximately 30% of the quality problems and 80% of product lead-time problems. Recently, most of research focuses on the timing of supplier’s involvement. Petersen et al., (2005) state that early supplier integration is an important coordinating mechanism for decision making that links product design, process design and supply chain design together. The main derived benefits have been classified as the following by a number of researchers (Handfield et al., 1999); (Ragatz et al., 2002):

- Early identification of technical problems;
- Fewer engineering change orders or prototypes;
- Better utilization of internal resources;

- Access to new or supplementary product and process technologies;
- Reduced technical and financial risk;
- Improved product features
- Shorter time to market

3.4 Customer Knowledge Management

It is worth noting that the failure rate of NPD is high, with some researchers estimating it to be between 40-75% (Stevens and Burley, 2003). According to Mansfield (1981) and Zirger (1990), the lack of a fit between new product attributes and customer requirements is a major cause of the failures. Essentially, tacit nature of knowledge (Polanyi, 1966), stickiness of knowledge (Von Hippel and Tyre 1996) and “knowledge that is located, embedded and invested in practice” (Bourdieu, 1977), (Lave, 1988) have been viewed as the main barriers which hinder processes of knowledge creation. Ironically, if companies fail to continually innovate, they die (Chesbrough, 2003). Within such background, Customer Knowledge Management (CKM) has been regarded as the key prerequisite for NPD (Chesbrough, 2003). Paquette (2006) presents a depiction of customer knowledge flows shown in Figure 3.

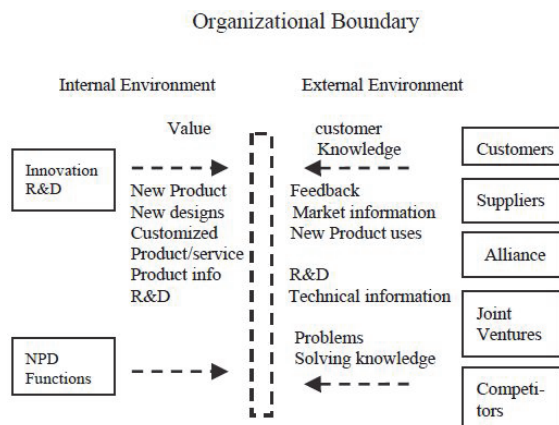


Figure 3: summary of Customer Knowledge (Paquette, 2006).

Traditionally, a NPD project (see Figure 4) needs to effectively coordinate R&D and marketing to identify potential opportunities and formulate sound means to make it happen. In essence, the combination can be regarded as the process to leverage complementary knowledge resources. Increasingly, success of NPD projects requires companies to develop competence by creating an external knowledge sharing ecosystem which can not only ensure the success of NPD, but also it is hard to simulate (Charlie and Re-

bentisch, 2003). In doing so, many companies have shifted their attention from customer relationship management (CRM) and data mining strategies to CKM and recently from exploration of knowledge about customer to knowledge from customer (Berson et al., 2003); (Davenport et al., 2001). This is because that customer has moved from passive recipients of NPD in 1970s and early 80s towards demanding to play a more active role in the 21st century (Prahalad and Ramaswamy, 2000). In one word, customer has moved out from audience onto the stage. Customer knowledge, as one of the most important knowledge bases for an organization, can be broadly defined as a combination of external consumer knowledge and supply chain knowledge etc (Bennet and Gabriel, 1999); (Paquette, 2006). Accordingly, CKM refers to processes of involving customer into innovative activities or improvement of performance by sharing valuable knowledge within the network environment. This process actually increases the firms' competitive advantage by encouraging learning process or customer learning wherein two-way exchange of knowledge can benefit the both parties (Stewart, 1997). However this process is considered to be relatively passive and even tacit for most of researchers and practitioners. Probably, the challenge here is to create mechanism to manage the relationships (Davenport et al, 2001). Among the numerous researchers, Leonard and Rayport (1997) developed an “empathic design”, which is an observation-oriented research method, to involve the customer into the process of innovation by exploring the tacit knowledge through observation of their daily routine. Similarly, Von Hippel (1986) argues that “lead user” is a source of novel product concept which plays vital roles to compensate for the deficiencies of potential user experience in the real world. According to Gibbert et al., (2002), there are five styles of CKM:

- prosumerism stems from the expression “prosumer” (Toffler, 1980) and indicates that customers can play the key roles as co-innovators, as in Bosch and Mercedes-Benz, Quicken, IKEA practice (Gibbert et al, 2002).
- Team-Based Co-Learning focuses on embedding customer knowledge into a platform which can facilitate the process of embodying the shared knowledge into new product or service. In this setup, Amazon.com and Toyota have been regarded as the most typical examples.
- Mutual Innovation was, initially, identified by Von Hippel (1988) who found out that end-users play decisive role of innovation. According to Gibbert et al, (2002), Rider Logistics have been developed from a trucking company to logistic solution providers

through mutual innovation with its customers.

- Communities of Creation are different from traditional communities of practice and reflected in the mutual interaction of groups of customer knowledge in order to achieve the common goal of knowledge creation (Sawhney and Prandelli, 2000). Examples are “beta” created by Microsoft and Netscape; “Antenna shops” from Sony and Panasonic.
- Joint Intellectual Property is the most intense form of cooperation between companies and their customers by sharing ownership of NPD (Gibbert et. al, 2002). For example, Skandia Insurance and Kooperativa Forbundet.

3.5 Product Lifecycle Management

Recently, the interest about CKM has been positioned as an effective Product Lifecycle Management (PLM) approach (Ameri et al, 2005). According to Stark (2005), PLM is “the activity of managing a company’s products all the way across their lifecycle (from cradle to grave) in the most effective way”. In essence, PLM is the starting point of the innovative process which consists of continual knowledge identification and knowledge acquisition from customers or market. Therefore, effectiveness of PLM will dramatically influence further processes of knowledge creation and ultimate success of NPD projects. In this line of reasoning, gathering information and knowledge from the customer and market will be the key start of efforts to synthesize knowledge loops for successful NPD. Particularly In term of managing knowledge across the product lifecycle, it might require different approaches within the different stages from product introduction, growth, maturity (saturation), and decline to retirement (Ameri et al., 2005). Basically, there are a number of issues which need to be addressed:

- Vital shift: from customer survey to customer involvement;
- Listening to voices about the product and then to the customer;
- Gaining as much as invaluable (information) knowledge from reverse logistics;
- Managing the firm (or supply chain) as a whole rather than separate functions;
- Standardizing the process of management and information analysis;
- Accurate evaluation of possibilities of potential risks and advanced planning activities;
- Increasing the reliable and feasible decision-making;
- Calibrating strategy based on valuable feedback

and seizing new opportunities;

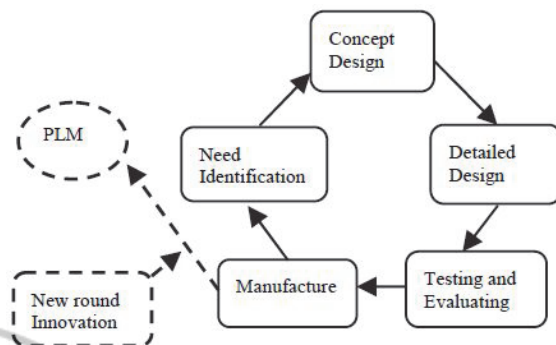


Figure 4: Product introduction process (adapted from Marshall, 2000).

4 FOUNDATIONS OF THEORETICAL FRAMEWORK

Just as discussed above, this paper aims to expand NPD into SC context. Accordingly, it is vital to structure the framework based on effective combination of SCM and KM. Inspired by the strategic supply chain model (Lambert et al., 2000); (Cooper et al., 1997), this theoretical framework is constructed into three phases, pre-acquisition, in-acquisition and post-acquisition. Moreover, in order to embrace open innovation strategy (Gassmann et al., 2004); (Schebrough, 2003), the framework especially focuses on two aspects: firstly analyzing internal and external knowledge assets regarding to internal availability and external complementary credibility (and **sharability**). This process is extraordinarily linked with Knowledge (Management) Audit Approach (Leibowitz, 1999) and has to be conducted within the pre-acquisition phase. Secondly, as a process of transferring embedded knowledge to embodied knowledge (Madhavan et al., 1998), innovation is subject to coordination of the two actions. In its essence, Knowledge embedding can be matched with Knowledge Calibration (Pillai and Goldsmith, 2006) and ultimate knowledge embodying will be closely linked with Knowledge Absorption and absorptive capability (Cohen and Levinthal, 1990). Subsequently, as key drivers of innovation, these two KM techniques can be utilized to facilitate the process of knowledge embedding and knowledge embodying across two phases: in-acquisition and post-acquisition. In fact, this framework might compensate for the deficiencies of existing Open Innovation studies and expand the related research into broader context.

5 PRELIMINARY THEORETICAL FRAMEWORK

Based on the literature review, a preliminary theory-based ACA (Audit, Calibration and Absorption) framework (See Figure 5) is formalized as following:

5.1 Pre-acquisition and Knowledge Audit

Audit Approach is a critical part of a KM framework and an effective first step of internal KM efforts (Leibowitz, 1999). Effectiveness of Knowledge Audit is a determinant which directly affects the decision making about “can I do it” (Knowledge Management Audit) and further activities related to managing knowledge resources. Essentially, it can provide an outline by systematically investigating and evaluating the “health” of a firm’s knowledge and ability and readiness of further KM implementation. Most importantly, it encourages two fundamental and philosophical conversions; from we do not know what we know to know what we don’t know and from know what we don’t know to know how to know. The main objectives of Knowledge Audit or knowledge management audit in the pre-acquisition phase are:

- What we know and what we don’t know (knowledge and abilities gaps identification)
- Who knows and can we cooperate (partnership selection)
- How to make it happen (knowledge loop creation)
- Are we ready to embrace activities of KM? (ability audit)
- To formulate an innovative strategy (outside-in, inside-out or coupled model);
- To analyze data or information from customers and market;
- To locate and evaluate the valuable external knowledge assets and select strategic partnerships (for example: suppliers, customers);
- To create and disseminate strategic goals through mutual collaboration and cooperation;

5.2 In-acquisition and Knowledge Calibration

According to Pillai and Goldsmith (2006), knowledge calibration is a measure of the degree of agreement between knowledge accuracy and confidence within the knowledge acquiring and embedding processes. Meanwhile, capability to calibrate knowledge acts as a facilitator or valuable catalyst which can support

firms to make judgement about strategic partners in term of abilities, characteristics, potential development and criteria of meaningful interaction. The main objectives in this phase constitute the requirement for the following actions:

- Building up trustworthy relationships;
- Enhancing mutuality;
- Addressing shared goals and consistently improving routine activities;
- Harmoniously integrate and optimally utilize IT-based hard infrastructure and people-based soft mechanisms;
- Improving leaning awareness and abilities;
- Cooperative Chain Culture Creation (C4);

5.3 Post-acquisition and Knowledge Absorption

Employing KM techniques will aim to facilitate not only sharing of knowledge between providers and receivers but also embodiment or absorption the acquired knowledge into the new products or services. Accordingly, there are numerous factors that will affect the success of knowledge absorption, but amongst them, absorptive capability and the learning processes are the decisive determinants (Cohen and Levinthal, 1990); (Helfat et al., 2007). Absorptive capability is the ability to use prior knowledge to recognize the value of new knowledge and to assimilate and apply it to create new knowledge and capabilities (Cohen and Levinthal, 1990). The learning processes are the mechanisms and key impetus that effectively compensate for the firms’ ability deficiencies (Helfat et al., 2007). The key issues of this phase should be addressed as following:

- Continuously improve the strategic partnership;
- Evolve from knowing firm to learning firm(encouraging individual creative activities; indirectly or directly customer involvement etc);
- Migrate from learning from partners to learning with partners (acting with suppliers as a whole by joint activities and optimally uses knowledge to reduce uncertainties);
- Embody technology knowledge and market knowledge into NPD and plan product introduction (integrating related factors, such as distributors, retailers, inventory and marketing etc);

6 CLUCLUDING REMARKS

This framework focuses on systematically synthesi-

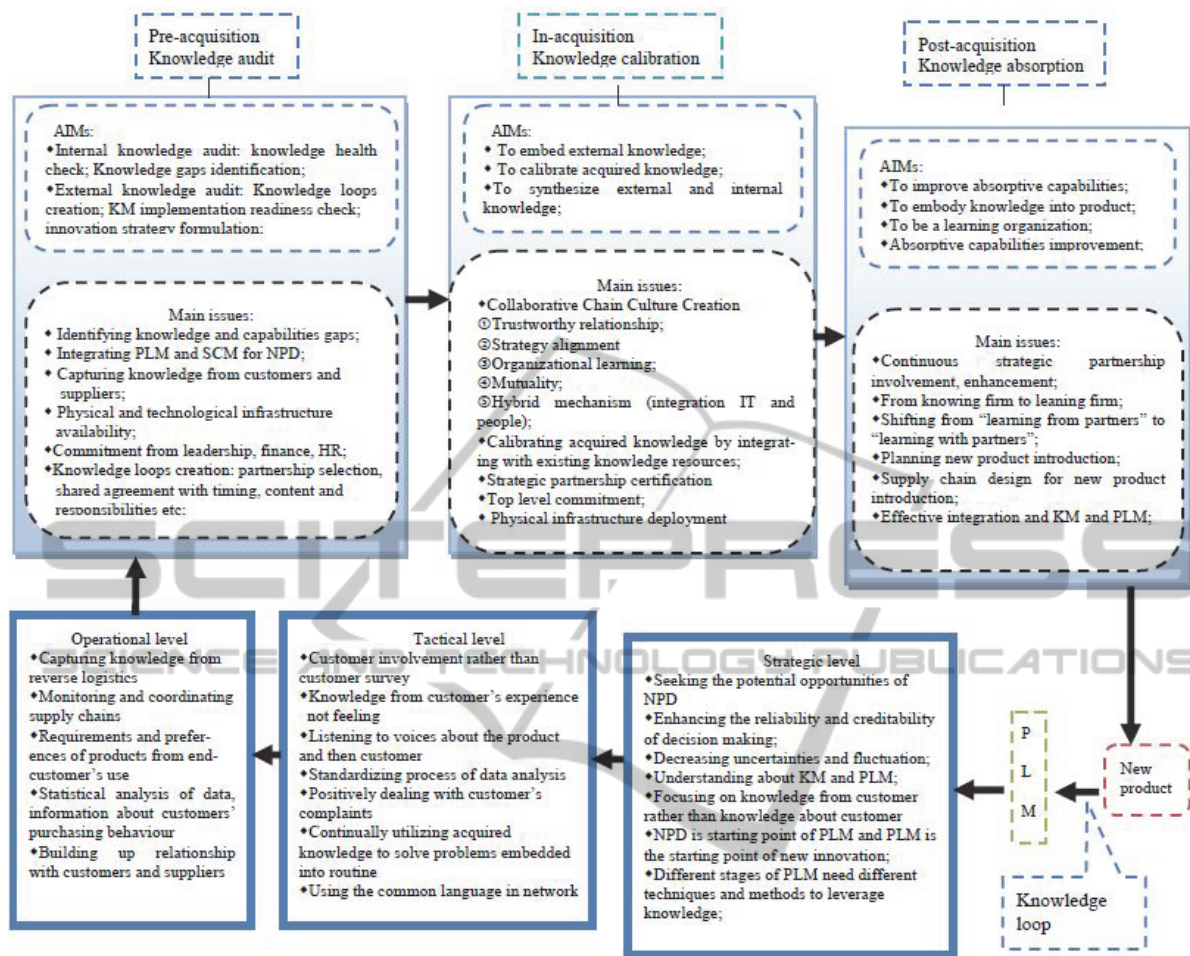


Figure: 5 Preliminary ACA framework.

zing relevant theoretical fields and expanding NPD into supply chain context by adopting OI strategy. More specifically, it has accurately captured the nature of existing knowledge management system and the core of NPD to design a three-phase knowledge creation framework. It logically integrates three KM techniques into the process of innovation and synchronizes with SCM. In essence, by referencing this framework, researchers and practitioners can easily manage NPD projects in terms of optimally leveraging knowledge resources, accurately self-positioning, detecting and employing solutions to solve the potential problems. And as a result, the firm can achieve the goals of shortening "time to the market", obtaining first mover advantages and satisfying the end customer requirements.

As part of a wider research project, this paper mainly focuses on presenting a theoretical framework which can be considered as a reference model for further research. This framework integrates a number

of theoretical concepts and utilizes existing approaches to facilitate effective use of knowledge management techniques in the NPD process. At this stage, the proposed framework needs to be evaluated from a practical point of view. In this sense, a process of validation will be undertaken to verify and improve the creditability and feasibility of this framework.

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