Complex and open innovation process: representation and analysis of its key networking actors

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Abstract

Open innovation could be perceived as too complex to be systematically managed, according to some industrial experts and academics. Literature on open innovation is dominated by abstract explanations. The objective of this research is to facilitate strategy managers with visualisation and qualitative analysis of complex innovation processes to constantly introduce the required variety of new products. It contributes to the emerging research on mapping representations of open innovation. For that, an analysis framework is created, mapping holistic as-is and should-be views of internal and external networks of key actors who conduct the essential activities towards effectively and sustainably achieve innovation success. Comparison of the as-is and should-be maps highlights areas for potential improvement. Because these key actors form a complex system per-se, these maps are useful to analyse their activities, before detailing managing-decisions about the other actors involved in operational-level innovation processes for specific products. The framework is formed by five elements: New Product Development Phases, Key Actors, Knowledge-Intensive Service Activities, Network Locations and Technology Transfer, identified through interdisciplinary research on Engineering, Business Management, Social Science and Economic Geography. UK-based premium automotive companies (mainly an OEM) have used this approach for better understanding of their open innovation, reporting £7m value-add.

Keywords: Open Innovation, Knowledge Intensive Service Activities, New Product Development Process

1. Introduction

The objective of this research is to enable strategy managers the visualisation and analysis of complex innovation processes to constantly introduce the required variety of new product families. Industrial experts and academics consider some open innovation processes as too complex to be comprehensively delineated and systematically managed. One of the major problems faced by strategy managers is that alignment between the usual but ambitious strategy of innovative companies (constantly offering never seen technology) and their operational-level processes, though vital to success, is often unachievable. For that, the Analysis and Management for Innovation (AMI) framework was created to help strategy managers to conceive the holistic as-is and the should-be views of the key actors that act and interact across functions and across organisations to conduct the activities that are essential to complete the overall open innovation processes of their companies. Because these key actors form a complex system per-se, this AMI framework is useful to map their main activities for innovation, before detailing decisions on the other actors involved in specific operational-level product -family innovation processes.

2. Literature Review

This study aims to contribute with qualitative research to the limited but growing area of mapping representations of open innovation.

2.1 Interdisciplinary approach for innovation

Innovation can be understood as the introduction of a new product, process or service for the first time into a specific market (Dicken et al., 2001). The presented project merges theories and findings from social science, especially economic geography, into traditionally used concepts from engineering and business management. The combination of these disciplines that offer extensive research on innovation can broaden the accuracy of innovation management. According to some experts innovation still remains poorly understood, although numerous studies from diverse disciplines have provided valuable insights to innovation. There is a need for more interdisciplinary research (Beckeikn et al., 2006).

2.2 Abstract concept of open innovation should move to a useful level for firms

The present paper presents research involving concepts such as networks, NPD, actors and KISA, as further explained, in order to facilitate managers to well-define and systematise open innovation practices. There have been many models proposed to analyse innovation such as "product innovation and process innovation; radical innovation and incremental innovation; ...and more recently closed innovation and open innovation" (Lee et al., 2010, p. 291). Indeed, according to many experts, it is the open innovation model which can better define current innovation processes, as new products become more complex, formed by an increasing number of components and targeting a large diversity of markets (Lee et al., 2010; Liu and Chaminade, 2010; Badaway 2010). Because a firm has finite resources, open innovation that a firm conducts through interactions across departments and across organisations, has become crucial to complement, add further value, speed up or enhance its competitive advantages (Gronlund et al., 2010; Lee et al., 2010). There is need for new perspectives explaining how organisations can transform their current models to benefit from open-innovation. Thus, Gronlund et al. (2010) suggest that it is necessary to advance the abstract theory of open innovation to a more concrete and well-defined application level (Badaway 2010). "...there has been a seamless transition between... strategy and the activities undertaken to achieve this strategy..." (Hines et al., 2006, pp. 866 - 867).

2.3 Emerging mapping representations for open innovation

The present study aims to contribute to the emerging area of mapping representations of open innovation, adopting qualitative research to provide a more in-depth understanding of it. The use of qualitative research tools such as interviews enables not only to identify the main patterns of innovation networks, but also to comprehend reasons for their formation and possible improvement. The presented study is based on interviews of key actors daily involved in the analysed open innovation processes. This level of information is necessary for strategy managers. Most recently, studies have been using structured and sophisticated techniques, such as social network analysis (SNA) software, to effectively uncover and map important patterns of innovation, including nodes, ties and technology transfers (Kastelle and Steen, 2010). The generated representations have been reported to be useful for policy decision making (Kastelle and Steen, 2010). Nevertheless, these latest papers have been mostly based on quantitative research (Kastelle and Steen, 2010), which may not "...penetrate the hidden depths of the social relationship that give rise to these..." patterns (Thompson, 2003, p. 56). There is a need for more qualitative research such as the one presented here.

3 Case Study

3.1. Methodology

Qualitative research was conducted to explore in-depth experiences, meanings and perceptions about the innovation process of the OEM (Yin, 2003). It involved a literature review, interviews and meetings; using theoretical sampling. The results are presented as a case study. First, the project tried to identify the customers' requirements. In the presented case, the OEM wanted to satisfy its final customers, delivering "...never seen technology... beyond clients' aspirations..." (author's interviews). For that, the OEM had state-of-the-art product development processes which specify what and when new technology at component level should be implemented to develop the final product in the shortest time possible. Thus, the chief programme engineer (CPE) required that the newly acquired or developed technology would be at Implementation Ready (IR) stage when needed along the Product Development phase. All uncertainties related to R&D were expected to be resolved prior to this phase. As the AMI framework for the OEM was developed up to the Product Development phase, by request of the OEM, it was first identified that the main customer who needed to be satisfied was the chief programme engineer (CPE).

With this information, the project progressed to find out how the OEM attempted to achieve its customers' requirements through its innovation process. The director of the Product Development Operations (PDO)' department, as one of the strategy managers of the innovation process, agreed to be the champion of this project. He introduced the research to the rest of the participants. During the period between September 2005 and June 2006, 27 one-hour recorded and open interviews were carried out with individuals identified, through these same interviews, as some of the most knowledgeable and experienced participants in the innovation process of the OEM. They were also recognised as the ones, who performed the basic KISA of the nine key actors defined in generic AMI framework. Theoretical sampling was used to explore, validate and verify data from interviewees, comparing it until saturation was reached and additional sampling of interviewees no longer provided new information (Strauss and Corbin, 1990). Interviewees were not cased in a standardised one-way mode of communication, such as a multiple-option questionnaire (Yin, 2003; Sayer, 1992). Open interviews allowed the responder to express different circumstances, disclosing specific, substantial and causal agents (Sayer, 1992).

Based on the generic AMI framework, the five elements that shape the 'as-is' (Fig. 1a) and 'should-be' maps (Fig. 1b) of an specific AMI framework for the OEM were created, using cumulative data from these experienced interviewees and the literature review. These five elements are: **1)** [When] NPD phases, along columns, **2)** [Who] Key actors along rows, **3)** [Where] Locations of key actors, defined also along columns, **4)** [What] Essential activities, depicted by circles, and **5)** [How] Technology transfer, delineated by linking lines. The insights of theories and past research that were combined to create each of these five elements are explained in detail in the 'Description of the generic AMI framework' section. For the OEM, the 'as-is' map (Fig. 1a) was formed mainly using data from the interviews, meanwhile the 'should-be' map (Fig. 1b) was built strongly based on information from interviews, theories and past research.

The first three elements of the AMI framework for the OEM are the same for both the 'as-is' and 'should-be' maps (Figs. 2a and 2b), to allow further comparison. Hence, data analysis identified 19 key actors located internally and externally to the OEM that conducted essential activities for innovation, based on the nine mentioned key actors for the basic KISA of the generic AMI framework. The AMI framework for the OEM only pictures nine NPD phases up to the 'Product Development' phase, which are derivatives of the first four out of seven elementary NPD phases identified in generic AMI framework. The locations of the key actors in the innovation process of the OEM were specified also in column one.

The generated AMI framework helped to identify the holistic as-is and the should-be views of the key actors that act and interact across functions and across organisations to conduct the activities (Knowledge Intensive Service Activities –KISA) that were essential to effectively, systematically and sustainably complete each phase of any product -family innovation processes for the OEM. The comparison of the 'as-is' (Fig. 1a) and 'should-be' (Fig.2b) maps highlighted potential improvements in internal and external networks for innovation formed by key actors.

The results of the AMI framework were evaluated and approved by the champion who arranged other two meetings, in which the simple two-sheet AMI framework's maps (Figs. 2a and 2b) supported the dialogue among three strategy managers, PDO director, R&D director and product strategy manager.

3.2. Results

3.2.1 Conception of new ideas (column 2)

Should-be (Fig. 1b): The presented AMI framework helped the analysed firms to visualise specific R&D sources required to develop each technology that needs to be implemented in their products. With similarities to other research (Green and Martinez-Solano 2011), it was found that the 'Conception of new ideas' should come from internal and external R&D units, including suppliers, competitors, customers and universities (see from row 2 to row 7 = R2-7). In the particular case of the OEM, it should mainly come from the interaction between the OEM and its major suppliers and, to a lesser extent, from the customer. Automobile parts suppliers belong to a vast diversity of technology sectors. Nevertheless, economic geography literature has observed that in a MNC, R&D is significantly internalised and centralised in parent companies and in a few internal sites but also in the largest supplying MNCs in each technology sector (OECD, 2006; Dicken, 1998).

As-is (Fig. 1a): Although most interviewees (mainly key decision-makers) agreed that it is imperative to visualise and understand the sources of new ideas for the automobile, the applied state-of-the-art management processes used by the analysed firms ignored, or partially consider this phase (R2-7). As a consequence, the technology that could have been ready on time is not because the main internal and external R&D sources were not formally identified and acknowledged. The following subsection explains how knowledge networks are formed to absorb most of the information on new technologies in the market.

3.2.2 Capturing information on new technologies (column 3)

Should-be (Fig. 1b): The aim is that the rich generation of ideas about new technologies in the market is captured by those in charge of identifying, developing and deploying technology in the vehicle. Interviewees identified that the responsible groups for that were the following functional departments: R&D (see row 2 = R2), development engineering (R6), and manufacturing (R7), which are classified in this project as 'internal technology experts'.

As-is (Fig. 1a): Instead, the AMI highlights that a reduced number of actors, the 'strategy team' (R14-17), in charge of developing the 'vehicle strategy' of the OEM were all looking for and capturing information on new technologies, from similar sources, independently of each other and so duplicating their efforts and redundantly using their limited resources. Moreover, they were all heavily reliant on databases (see links from R14-17 to R4) when making decisions about what technologies should be selected for each product, mainly because it would be extremely difficult for each single individual to obtain direct information from the thousands of 'internal technology experts' (R&D (R2), development engineering (R6) and manufacturing engineers (R7)) within the company.

Also, the AMI framework has shown that unfortunately these 'internal technology experts' - who have to work daily identifying, developing and deploying new technology into the vehicle - are not encouraged enough by the company to develop a more complete vision of the road mapping technology in their own areas. Interviewees said that they are sometimes narrowly focused on only three or four suppliers (R2) to access information about new technologies. It was observed that some 'internal technology experts' managed to successfully develop internal and external knowledge networks (e.g. Communities of Practice) (Wenger, 1998), to introduce new technologies.

3.2.3 Documenting new technology development and transfer information to the product strategy team (column 4)

Should-be (Fig. 1b): Interviewees advised that the 'internal technology experts' who work in a common technology area should periodically discuss, agree and document (e.g. by using technology roadmaps - TRMs) how they all perceive the long-term technology development in their areas (see links between R3, R6 and R7) with contribution from their suppliers (R2). They should also have a formal, periodical and systematic way (e.g. TRMs) of transferring their captured knowledge about new technologies to the 'strategy team' (Line R6-R17) (Cooper, 2001). The 'strategy team' should only coordinate and support these 'internal technology experts' in documenting their knowledge about new technologies (R17). Interviewees mentioned several benefits for the 'strategy team', including:

- focusing their limited resources on developing the vehicle strategy (Ohno, 1988)
- documentation of valuable knowledge on new technologies from 'internal technology experts' (e.g. detailed TRMs)
- having enough time to consider recommendations from 'internal technology experts'
- closing the gap between 'internal technology experts' and the 'strategy team' (Hines et al., 2006)
- Gaining marketing feedback about the desirability of new technologies early during the process (Ohno, 1988)

As-is (Fig. 1a): 'Internal technology experts' work quite independently of each other when developing technologies and do not communicate with each other enough. Also, they do not communicate systematically with the strategy team (see link from R3 to R15), and so, their knowledge on new technologies is often lost. R&D experts communicated informally with the strategy team, which tried to forecast technology development in each sector (R14-17).

3.2.4 Long-term and short term product strategy (mainly columns 5 and 7)

Should-be (Fig. 1b): Subsequently, the product strategy involves the evolution of a new idea into a marketable product. As in previous research (Green and Martinez-Solano, 2011), it was observed that the strategy team and the parent company's development advice team are the main actors that should work with departments such as manufacturing, management and marketing but also with finance, purchasing and HR (R18-20) in order to create the product strategy, visualising its potential market and constraints on resources (OECD, 2006). Past economic geography studies have suggested that Development Advice mostly comes from the MNC's parent company (R8) (Dicken, 1998). In this phase, these vehicle strategists (R14-17) can define what products will be placed as leaders or followers in the automotive market niche in the short and long term. The adequate visualisation and development of previous knowledge networks is vital for the successful accomplishment of this phase (Zanfei, 2000). The product strategy team of the company should be able to select the best (commodity level) technologies that could be included in each product from a given document (such as TRMs) from the 'internal technology experts' (see linking line in R17 from C4 to C7) (Howells, 1996). This could happen after a formal, periodical and systematic two-way communication between the 'internal technology experts' and the 'strategy team' (see links from R6 to R17 in C6 and C8). As a result, the selected technologies could be feasible and cover the firm's strategy for each specific product.

As is (Fig. 1a): At the time of the presented analysis, it was considered that there was not an effective link between the 'Conception of new ideas' (C2) and the 'Product strategy' phases (C5, C7). Sometimes, it was not possible to deploy some technologies selected by the 'strategy team' mostly from databases (R4), because these technologies were not feasible for the company, or they were accessed too late during the product development programme.

3.2.5 Long-term and short-term technology development (mainly columns 6 and 8)

Should be (Fig. 1b): The maps of the AMI framework shows that if proper knowledge networks have been developed previously with the most convenient internal and external R&D sources (as explained above), the desired technology could be identified, acquired or developed on time, and then deployed in the final product when required at the product development phase (see triangle links between R3, R6 and R7 in C3-4, C6, C8, C10) (Hanninen and Kauranen, 2006). It is recommended that 'internal technology experts' (R&D (R3), development engineering (R6), and manufacturing engineers (R7)) from the same technology area should communicate formally and periodically with each other, from the very moment that they are capturing information about new technology through its development and until they have to deploy it within the vehicle programmes. These experts should discuss and agree together as a single team what technologies are feasible to develop in the long and short-term. It can be seen in the mapping of the AMI framework that the internal R&D department would be expected to lead the long-term technology development (see R3 in C6), working with other internal and external R&D centres, for example, the parent company (R4 in C6), suppliers (R2 in C6), R&D universities, and others (R5 in C6) (Lin and Chen, 2006). The short-term technology development would be mainly led by the technology development engineers (see R6 in C8) (and suppliers (R2 in C8)), with moderate participation by the R&D team (R3 in C8) (Hildreth and Kimble, 2004). Finally, technology development and manufacturing engineers would lead the deployment of the technology in the 'product development' phase. In this phase, the R&D team's participation should be minimal, only supporting the other teams in the case of unforeseen changes.

As-is (Fig. 1a): However, the mapping of the AMI framework shows - as interviewees explained - that R&D, technology development and manufacturing groups in the same technical area do not communicate with each other enough (see no links between R3, R6, R7 in C2-C9). Thus, the R&D team is sometimes communicated with too late during the process, so that either its developed technologies are unfeasible for the company or that there are not enough resources to deploy them. As a result, R&D may waste considerable resources in developing technologies that will not be deployed. Also, sometimes, the R&D team does not have time to carry out long-term technology development (see R3 in C6); instead, this team has to spend its precious time deploying technologies into the programmes (see R3 in C10).

4. Conclusions

The AMI framework development is a step in-between that could be conducted to help develop the link of establishing sustainable innovation strategy and managing operational-level processes. It enables key actors to commit their valuable knowledge and experiences to the 'memory of the organisation', storing and communicating their value-add practices that encourage innovation. As innovation is not static, the AMI tool also facilitates the regular analysis and systematisation of these practices, that otherwise may be considered ad hoc occurrences and lost. Because the AMI framework development is based on qualitative research, it can provide not only a mapping representation of vital patterns, but also a realistic explanation and proposed improvement of these patterns (Thompson, 2003). In this way, the present study contributes with qualitative research to the limited but growing research area on graphical representation of complex open innovation processes. Further research in this area is recommended combining more qualitative and quantitative research methods (e.g. using software programmes) to enhance the benefits of these findings on policy making.

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4. Figures

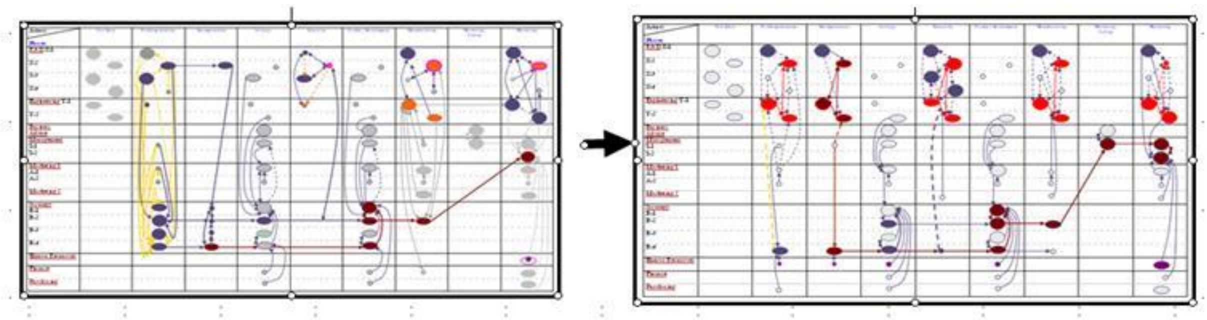

Fig. 1. (a & b) 'As-is' and 'Should-be' map