

TOWARD A DYNAMIC PERSPECTIVE ON EXPLORATIVE AND EXPLOITATIVE INNOVATION ACTIVITIES: A LONGITUDINAL STUDY OF INNOVATION IN THE WIND BLADE INDUSTRY

Matthias de Visser

University of Twente, Capitoool 15, 7521 PL Enschede, The Netherlands

m.devisser@utwente.nl

Innovation requires a combination of explorative and exploitative innovation activities. Previous studies have provided valuable insights in the antecedents of investing in explorative and exploitative activities, the structural governance of exploration and exploitation and the performance implications of engaging in exploration and exploitation. These studies are dominated by cross-sectional research, largely ignoring the evolution of exploration and exploitation over time. Several scholars, however, provide first indications that the allocation of time and resources across exploration and exploitation might change over time. In order to examine the dynamics of explorative and exploitative innovation activities, we conducted an in-depth case study in one particular company in the wind blade industry, applying a novel approach to measure the evolution of the amount of R&D resources allocated to explorative and exploitative activities over a 5 year time period. Our results show that the relative amount of resources and time invested in exploration versus exploitation is not static, but changes over time. The pattern of the evolution of exploration and exploitation at our case company shows phases in which exploration and exploitation activities are well balanced, and phases where one type of innovation dominates innovation activities. Based on additional qualitative data we found first indications of antecedents of the dynamics of exploration and exploitation. Together, our findings provide an interesting starting point for future research on the antecedents, structural governance and performance implications of the evolution of exploration and exploitation over time.

INTRODUCTION

Innovation is seen as crucial for the long-term survival of firms (Schumpeter, 1939; Baumol, 2002). It is increasingly recognized that the innovation process is a multidimensional phenomenon, encompassing processes that focus on the generation of new products and processes (radical innovation) as well as processes that focus on the improvement of existing products and processes (incremental innovation). Innovation therefore requires a combination of explorative and exploitative innovation activities. Explorative activities can be characterized by terms such as search, variation, risk-taking, experimentation, play, flexibility and discovery (March, 1991). Exploitative activities are associated with aspects such as refinement, choice, production, efficiency, selection, implementation and execution (March, 1991).

Previous studies have provided valuable insights in 1) the antecedents of investing in explorative and exploitative activities (Levinthal and March, 1993; Katila and Ahuja, 2001; Gupta et al., 2006). 2) the structural governance of exploration and exploitation (e.g. Gibson and Berkinshaw, 2004; Tushman and O'Reilly, 1996; Jansen et al., 2008), and 3) the performance implications of engaging in exploration and exploitation (Volberda and Lewin, 2003; Jansen et al. 2006). At the same time, these studies are dominated by cross-sectional research, largely ignoring the evolution of exploration and exploitation over time.

Although in-depth studies on dynamics of explorative and exploitative innovation activities are lacking, several scholars provide first indications that, within companies, the allocation of time and resources across exploration and exploitation might change over time. Van de Ven et al. (2000), for instance, emphasize that companies engage in innovation journeys where emphasis might shift over time between different kinds of innovation activities. In a similar vein, modern contingency theory shows that organizations continuously reconfigure their innovation activities to meet changing demands in their internal and external environments (Webb and Pettigrew, 1999; Siggelkow, 2002). Recently, several scholars (i.e. Andriopoulos and Lewis, 2009; Groysberg and Lee, 2009; Raisch et al., 2009) therefore emphasized the need for longitudinal research on exploration and exploitation, which is the main focus of this paper.

In order to examine the dynamics of explorative and exploitative innovation activities, we conducted an in-depth case study in a particular company in the wind blade industry. Whereas existing research (e.g. Lubatkin et al., 2006; Mom et al., 2009) has mainly relied on surveys to measure exploration and exploitation, we apply an alternative approach to measure the evolution of the amount of R&D resources allocated to explorative and exploitative activities over a period of time. In line with Uotila et al. (2003), we applied a word-count method on a database, containing detailed project descriptions of all innovation projects in which the company had engaged during 5 years. Moreover, we were able to link this database to the firm's time-accounting system, allowing to match the hours of each individual employee to specific innovation projects. In this way, we were able to get an exceptionally rich and detailed understanding on how the allocation of time and resources across explorative and exploitative activities evolved over time within this particular company.

Our results show that, within the focal company, gradual shifts from exploration to exploitation and vice versa can be identified. We also found first indications that the tenure of the employees and the turnover of the mother company had a substantial impact on the relative amount of explorative versus exploitative activities over time.

On a theoretical level, this study contributes to the exploration and exploitation literature by showing the inherent dynamic nature of the allocation process across these two kinds of activities. On a methodological level, this study provides an alternative approach to get a more fine-grained understanding of explorative and exploitative innovation activities within firms.

The remainder of this paper is structured in three sections. First, we discuss the innovative methodology that we applied to measure the evolution of exploration and exploitation. Subsequently, we discuss our main results. Finally, we present the main implication of this study and suggest interesting avenues for future research.

METHODOLOGY

This study tracks the evolution of explorative and exploitative innovation activities within a Dutch wind blade technology company from 2003 to 2007. This company was founded in 1999 and has been owned by a mother wind energy company since 2001. The wind energy industry is a very volatile and rapidly changing industry, providing the optimal setting to study the dynamics of exploration and exploitation.

Research design

Our research is based on a two-stage case study. According to Yin (1994), a case study strategy has a distinct advantage to other research strategies such as experiments, surveys, archival analysis, and history when “a how or why question is being asked about a contemporary set of events over which the investigator has little or no control.” The purpose of this study is to look at how different types of innovation activities evolve over time. The nature of our research objective therefore provides a first ground to decide for a case study research approach.

Addressing the research objective also requires examining the dynamics of different processes such as control and coordination. Several scholars (e.g. Yin, 1994; Eisenhardt, 1989b; Pettigrew, 1990; Poole et al., 2000;) argued that a case study approach is especially useful for studying such processes.

Data collection

Data on the evolution of exploration and exploitation were collected in a retrospective way. Retrospective data collection allowed for a more focused process because it reduced the danger of data overload and collecting much unusable data (Leonard-Barton, 1990; Poole, Van de Ven, Dooley, and Holmes, 2000). However, documenting cases in a retrospective way also has its disadvantages. For instance, respondents have the tendency to filter out events that do not fit or that render their story less coherent (Poole et al., 2000). To improve the validity of these retrospective reports and prevent accepting respondent bias, we applied two strategies. First, we triangulated our data, applying two data sources: an interview and documents (Eisenhardt, 1989b; Yin, 1994). Second, we asked the respondent to reflect on concrete events rather than abstract concepts to reduce the risk of cognitive biases and impression management (Miller et al., 1997).

Our study consists of two stages. In the first stage, archival data were gathered and analyzed. Subsequently, results were triangulated with interview data gathered in the second stage.

Archival data, such as project descriptions and time accounting data, were obtained from our case company. These archival data made it possible to construct a quantitative picture of the evolution of exploration and exploitation related innovation activities. The archival data could be juxtaposed to interview data obtained in the

second stage in order to check for systematic biases in retrospective accounts of past innovation strategy in terms of exploration and exploitation (Golden, 1992).

The co-founder of the company was formally interviewed in the second stage. The conversation lasted two hours and was recorded on mp3, yielding 40 pages of interview transcription. The semi-structured interview clarified key events identified from the archival data and provided a more detailed account of how explorative and exploitative innovation activities within the case company evolved over time, and also provided indications of antecedents of key events identified in this evolution.

Analysis

In the first stage the allocation of R&D resources over explorative and exploitative within the company from 2003 to 2007 was reconstructed. We obtained a project description database from the case company, providing project descriptions of all projects that were realized between 2003 and 2007. Projects that were not focused on development of technology and products (e.g. help desk related activities) were removed from the database. In order to measure the amount of resources this firm allocated to exploitative and explorative activities over time, we first labeled the projects either as “explorative activities” or “exploitative activities”. This was done in a manner similar to the method conducted by Uotila et al. (2003), which is based on word-counts of key words. The classification of the projects into explorative and exploitative activities was based on the definition provided by March (1991): “Explorative activities can be characterized by terms such as search, variation, risk-taking, experimentation, play, flexibility and discovery. Exploitative activities can be characterized by aspects such as refinement, choice, production, efficiency, selection, implementation and execution.” We searched for synonyms of the nouns and verbs in thesaurus that is part of current version of Apple’s operating system. Next, we extended the obtained list of words with all possible conjugations of the verbs and adding singular and plural forms. We then searched for these words in the project description database and calculated the scores for “exploration” and “exploitation” for each individual project. Finally we classified each project “explorative” or “exploitative” based on these scores.

In order to measure the allocation of resources over exploration and exploitation over time, we then matched this database with a time accounting system in which every week of the year all employees entered the hours they spent on each project they were involved in. Finally we were able to calculate the amount of time that was spent on exploitative and explorative projects in every week of the years 2003-2007. By making graphs of the relative amount of resources that were invested in exploration versus exploitation over the period of five years, we identified several key events representing remarkable changes of the balance between both types of innovation activities.

In the second stage we conducted a semi-structured interview with one of the founders of the case company who also was an employee from 2003 till 2007. In the interview we first asked the respondent to describe the history of the company from to present according to his own experience, without instructions about focus on specific events. Subsequently, the key events we selected in our reconstruction of the evolution of exploration and exploitation were discussed and triangulated with the experiences of the respondent in that particular period of time. The respondent related some of the key events of change to factors he referred to earlier in the interview when we were discussing the history of the company. As a result, we are also able to

provide some first indications of antecedents for the key events of change in our reconstruction.

RESULTS

The results of our analysis of project descriptions and time accounting data can be viewed in figure 1. Figure 1 depicts the relative amount of R&D resources spent on explorative innovation activities versus the amount of R&D resources spent on exploitative innovation activities between 2003 and 2007 starting with week 1 in 2003. R&D resources are measured in working hours.

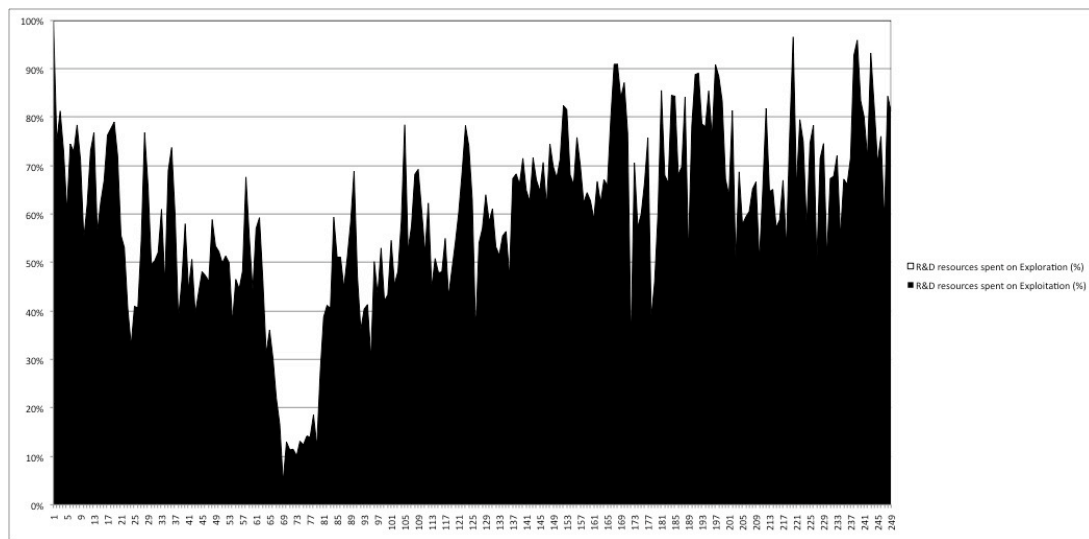


Figure 1: Relative amount of R&D resources spent on exploitative innovation activities versus explorative innovation activities in working hours per week from 2003 to 2007

The results of our analysis show that the amount of resources spent on both types of innovation activities clearly changes over time. Three phases with specific exploration versus exploitation characteristics can be identified.

The first phase begins in week 1 in 2003. In the beginning of that year, innovation is mainly exploitative, representing about 65% of the activities. In the second half of 2003, the amount of working hours invested in explorative innovation activities gradually increases and the investments in both types become almost equal.

In the second phase, starting in week 60 in the second quarter of 2004, exploration radically increases and dominates innovation activities until the fourth quarter of 2004. Only 15% of innovation activities focus on exploitation.

In the third phase, starting week 85, exploitative innovation activities gradually increase. There are many weeks where exploitation peaks at around 90% of efforts made in R&D at the wind blade technology company. Exploitative innovation activities have gradually become the core of innovation.

In order to understand the evolution of the amount of explorative and exploitative activities at the case company, we will now illustrate each phase based on quotes of one of the founders of the case company we interviewed.

Gradual increase of exploration

At the beginning of the first phase we identified, it was two years ago that the company was taken over by its mother company. Research and development was mainly focused on incremental changes of the products that the company delivered before the take-over: “We had to implement our existing technologies in the manufacturing facilities of our mother company in India.” At that time manpower was also available to discover new technologies: “There was a healthy balance between attention paid to support what was going on in the field, and to innovation.” “We could afford to play around and discover new technologies. We were not too busy with support related activities at that time.”

Domination of exploration

In the second phase, completely new blades had to be designed for a new wind turbine with higher MW capacity, including new technologies and production methods. These designs were highly different from the products the company developed before: “We had to design a whole new generation of wind blades and tackle some important issues or previous models suffered from.” Engineering personnel mainly consisted of ambitious engineers who were involved in the company from the start.

Gradual increase of exploitation

After explorative activities peaked, exploitative activities gradually increased. Revenues of the mother company radically raised and there was high pressure for fast scale-up and small modifications of existing blade designs: “Turnover of the mother company radically increased and the pressure to deliver blades that fitted turbines with higher capacity fast, was severe.” Because many redesigns were done in a rush, the amount of time that had to be invested in support activities dramatically increased: “The company has been put in a hold by day-to-day activities and support.”

In these years, more and more of the original engineers left the company, most of them because there was few room for real innovations: “At a certain moment one is drowned in the volume of day-to-day support related activities. The talented people then leave as a result, they don’t buy that.” The company consequently experienced difficulty with improving quality procedures and support: “In the early years few attention was paid to documentation and because our people who had most experience left, it got more and more difficult to recover.”

In the current situation the company has nearly to no resources left to invest in exploration: “We are mainly busy with product support and trouble shooting.” “People who visit us all react the same: the club is numb, everyone sits behind their desks. Where’s the spirit, the real debate; what is really going on here? Everyone is just writing procedures.”

DISCUSSION AND CONCLUSION

Toward a dynamic perspective on exploration and exploitation

With this longitudinal study we contribute to theory by providing a dynamic perspective on the evolution of explorative and exploitative activities. We reconstructed how the allocation of time and resources across explorative and exploitative activities of a wind blade technology company evolved over a period of

five years. Our results show that the relative amount of exploration versus exploitation is not static, but changes over time. The pattern of the evolution of exploration and exploitation at our case company shows phases in which exploration and exploitation activities are well balanced, and phases where one type of innovation dominates innovation activities. At the same time, within these phases, many ups and downs of exploration occur; the relative amount of exploration versus exploitation is dynamic and continuously changes.

Furthermore, based on an interview we found indications of antecedents of the dynamics of exploration and exploitation. Over the years, mean tenure has decreased and turnover of the mother company has increased. The success of the mother company led the wind blade company to scale-up existing products so fast, that engineers had to spend almost all of their time to updating procedures and repairing problems in the field. As a result the most experienced and talented engineers left the company, leaving young inexperienced engineers alone with day-to-day support and repair tasks without the ability to dive into new technologies for future products. These factors, increase of turnover and decrease of mean tenure of personnel, might explain that over the years, exploitation has become more dominant.

Further research

Because of this indication that innovation strategy can evolve over time, we will continue this research and investigate the drivers and performance implications of the shifts between exploration and exploitation. What causes these changes and how are they managed in terms of structural and control mechanisms? What are the performance implications of changes of the relative amount of exploration versus exploitation, within and between the phases we identified? Based on the indications we found for antecedents of the evolution of exploration and exploitation, we want to link our reconstruction to data about company turnover and mean tenure of personnel. In order to investigate performance implications of exploration and exploitation dynamics, we want to link financial data to our reconstruction of the amounts of time and resources spent on exploration and exploitation. Furthermore we will continue to do similar analyses in other companies to investigate other evolutions of exploration and exploitation, their antecedents and performance implications over time.

Our managerial contribution lies in the application of insight into innovation balance over time as a monitoring tool. Our particular case company plans to invest more resources into explorative activities. By monitoring the relative amount of exploration versus exploitation with the method we applied, the company can check whether plans are met.

REFERENCES

- Andriopoulos, C., M. Lewis., 2009. Exploitation-exploration tensions and organizational ambidexterity: Managing paradoxes of innovation. *Organization Science* 20(4) 696–717.
- Baumol, W.J., 2002. In: *The Free-Market Innovation Machine*. Princeton University Press, Princeton.
- Eisenhardt, K.M., 1989b. Building theories from case study research. *Academy of Management Review* 14, 532-550.

- Gibson, C. B., & Birkinshaw, J., 2004. The antecedents, consequences and mediating role of organizational ambidexterity. *Academy of Management Journal* 47, 209-226.
- Golden, B.R., 1992. The Past Is the Past - Or Is It? The Use of Retrospective Accounts as Indicators of past Strategy. *The Academy of Management Journal* 35(4) 848-860.
- Groysberg, B., Lee, L.E., 2009. Hiring stars and their colleagues: Exploration and exploitation in professional service firms. *Organization Science* 20(4) 740-758.
- Gupta, A.K., Smith, K.G., Shalley, C.E., 2006. The interplay between exploration and exploitation. *Academy of Management Journal* 4, 693-706.
- Jansen, J.J.P., George, G., van den Bosch, F.A.J., Volberda, H.W., 2008. Senior team attributes and organizational ambidexterity: The moderating role of transformational leadership. *Journal of Management Studies* 45(5) 982-1007.
- Katila, R., Ahuja, G., 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45 1183-1194.
- Leonard-Barton, D., 1990. A dual methodology for case studies: synergistic use of a longitudinal single site with replicated multiple studies. *Organization Science*, 1 248-266.
- Levinthal, D.A., March, J.G., 1993. The myopia of learning. *Strategic Management Journal* 14, 95-112.
- Lubatkin, M.H., Simsek, Z., Ling, Y., Veiga, J.F., 2006. Ambidexterity and performance in small- to medium-sized firms: The pivotal role of top management team behavioral integration. *Journal of Management* 32(5) 646-672.
- March, J.G., 1991. Exploration and exploitation in organizational learning. *Organization Science* 2, 71-88.
- Miller, C.C., Cardinal, L.B., Glick, W.H., 1997. Retrospective Reports in Organizational Research: A Reexamination of Recent Evidence. *The Academy of Management Journal*, 40(1) 189-204
- Mom, T.J.M., van den Bosch, F.A.J., Volberda, H.W., 2009. Understanding variation in managers' ambidexterity: Investigating direct and interaction effects of formal structural and personal coordination mechanisms. *Organization Science* 20(4) 812-828.
- Pettigrew, A.M., 1990. Longitudinal field research on change: theory and practice, *Organization Science* 1, 267-292.
- Poole, M.S., Van De Ven, A.H., Dooley, K., Holmes, M.E., 2000. *Organizational change and innovation processes: theory and methods for research*. Oxford: Oxford

University Press.

Raisch, S., Birkinshaw, J., Probst, G., Tushman, M.L., 2009. Organizational Ambidexterity: Balancing Exploitation and Exploration for Sustained Performance, *Organization Science* 20(4) 685-695.

Schumpeter, J.A., 1939. In: *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. McGraw-Hill, New York.

Siggelkow, N., 2002. Evolution toward fit. *Admin. Sci. Quart.* 47(1) 125–159.

Tushman, M.L., O'Reilly, C.A., 1996. Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review* 38, 8-30.

Uotila, J., Maula, M., Keil, T., Zahra, S.A., 2003. Exploration, Exploitation and Financial Performance: Analysis of S&P 500 Corporations. *Strategic Management Journal* 30, 221-231

Volberda, H., Lewin, A., 2003. Co-evolutionary dynamics within and between firms: From evolution to coevolution. *Journal of Management Studies* 40, 2111-2136.

Van de Ven, A., Angle, H. Poole, M., 2000. *Research on the Management of Innovation: The Minnesota Studies*. Oxford University Press.

Webb, D., Pettigrew, A., 1999. The temporal development of strategy: Patterns in the U.K. insurance industry. *Organization Science* 10, 601-621.

Yin, R.K., 1994. *Case study research: designs and methods*. London: Sage.