Evolution of Shared Cognitive Structures in Entrepreneurial Teams and Opportunity Identification and Exploitation

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Abstract

In the pursuit of opportunity identification and exploitation (Venkataraman, 1997; Shane and Venkataraman, 2000; Eckhardt and Shane, 2003), entrepreneurs develop cognitive structures. Although the classical view in entrepreneurship suggests that these cognitive structures are mainly developed by a single individual, they oftentimes span across the entire entrepreneurial team (e.g., Ensley and Pearce, 2001; Ensley, Pearson, Amazon, 2002; Kamm et al., 1990). West (2007) recently asked "what happens when teams rather individuals make decisions?" and examined collective cognition in entrepreneurial teams. In her own research and/or experience the reader may have encountered ventures where cognition is shared among several team members while in others we can identify a dominant individual that has the most comprehensive insights into the company's current and future opportunities.

This research project identifies the dominance of the cognition of certain individuals within the entrepreneurial team and, more specifically, analyzes the differences in team members' cognitive structures and their contribution to a shared cognition of the entrepreneurial team. Furthermore, this study is interested in the evolution of cognitive structures or, in other words, the learning of entrepreneurial team members over time. Finally, this study examines the relationship between the change in shared cognition in the entrepreneurial teams and the identification and exploitation of opportunities. Hence, this study's research questions are:

- How do shared cognitive structures of entrepreneurial teams evolve over time?
- How do these shared cognitive structures relate to opportunity identification and exploitation?

Literature Review

Shared team cognition has been understood in many different ways. In this paper I would like to understand shared cognition as overlapping causal maps as shown by Laukkanen (1994). More generally, shared mental models are "beliefs that shape inferences, predictions, and decisions about what actions to take" (Cannon-Bowers, Salas, Converse, 1993). In management shared mental models were discussed in form of "dominant logic" (Prahalad and Bettis, 1986; Bettis and Prahalad, 1995) or social cognition (Ginsberg, 1989/1990). Levine, Resnick and Higgins (1993) pointed out that "outside the laboratory and the school, cognition is almost always collaborative" (p. 591). Walsh (1995) argues that "When a group of individuals is brought together, each with their own knowledge structure about a particular information environment, some kind of emergent collective knowledge structure is likely to exist." (p. 291). Although existing entrepreneurship theories oftentimes focus on the "entrepreneur" (Harper, 2008), there is plenty of empirical evidence that entrepreneurial teams are omnipresent. Kamm et al. (2000) mention a number of empirical studies supporting this claim. Cooper and Bruno (1977), for instance, founded that over 80% of high growth companies they surveyed had been founded by a team. Therefore, it seems reasonable to assume in line with Gartner et al. (1994) that "entrepreneurship is more likely to be plural".

In order to better understand shared mental models of entrepreneurial teams, this study draws on insights from the group literature in management (e.g., Miller, Burke, Glick, 1998) and organizational behavior (e.g., Mohammed and Ringseis, 2001). Particularly, Fiol (1994) discusses the tensions between unified thinking and multiple interpretations. In addition, there is evidence of cognitive variance of the team members (Ginsberg, 1990; Prahalad and Bettis, 1986). In the field of entrepreneurship, West (2007) proposes a model where Entrepreneurial Team Collective Cognition (ETCC) is a mediator between the individual-level factors and the decisions and actions of the new venture. West finds an inverted U-shaped relationship between the new venture performance and the degree of differentiation and integration of strategic constructs within the top management team of a venture. The current study builds on the insights gained from a limited number of studies on entrepreneurial teams such as the study by West (2007) and Ensley and Pearse (2000) as well as insights from group research in general (e.g., Miller et al., 1998) for the understanding shared mental models.

Yet, the objective of this paper goes beyond understanding shared mental models of entrepreneurial teams. This paper focuses on the evolution of shared mental models and their impact on opportunity identification and exploitation. In essence, this paper tries to understand collective cognitions of entrepreneurial teams from a dynamic perspective. With the prominent exception of Barr, Stimpert and Huff (1992) very few studies analyze cognitive maps over time. Barr et al. investigated the cognitive maps of two railroad companies over time where only one had satisfactory performance and survived. Although both railroad companies recognized the decline in the rail industry, only the surviving firm changes their mental model of how organizational performance is affected by the changed environment. While Barr et al. (1992)'s paper is extremely important and highly relevant, by design it cannot analyze the divergence among the different members of the management team because it uses letters to shareholders as data source rather than individual interviews as does the current study. In the following, I discuss more about the methodology underlying the current study.

Methodology and Research Design

The research is designed as a comparative case study (Yin, 1994; Eisenhardt, 1989/2007) of nine ventures in the German-speaking software market. The Software Industry within the Information Technology Industry is interesting for several reasons: first, the burst of the internet bubble (European Information Technology Observatory, 2004) and the economic downturn 2001/02 (OECD report, 2002/03) hit very hard as the evaluation in this sector in the stock market and the projects done in this field were incomparably well paid. This, of course, led to major change as well as new opportunities in this industry. On the other hand, many potential opportunities through merging with other industries such as the telecommunication industry arose. This potential for horizontal diversification creates intense competition along the value chain. Second, the software industry reaches maturity over the observation period: professionalization, standardization, and industrialization become very relevant in this industry. The above arguments together with the fact that this industry is characterized by little regulation by authorities, few standards and no patents (Liebeskind, 1996) makes it an interesting industry to study entrepreneurial opportunities. In addition, software development such as other high technology industries requires more skills than one individual would be likely to have (Gartner, 1985 based on empirical results from previous studies that showed that 61% of the firms in Palo Alto are teams).

The ventures are located in Munich (Germany) and Zurich/St. Gallen (Switzerland) and are comparable along a number of dimensions such as business, customers, size, structure and development of the company. (Please find more information on details about the ventures in Table 1.) At three different points in time between 2004 and 2006 I had the opportunity to conduct semi-structured interviews with the three most influential individuals in each one of the nine ventures. This lead to a data set of 3x3x9=81 semi-structured interviews each of a length of 90 minutes.

The method for data analysis is cognitive mapping technique (Eden, 1992; Eden and Spender, 1998; Fiol and Huff, 1992; Huff, 1990, Walsh, 1995). More specifically, I use causal mapping technique, “a cognitive map where the relationships are restricted to a may-lead-to, has-implications-for, supports, or cause-effect type of relationship.” (Eden and Ackermann, 1998). The causal maps are analyzed on the individual level and on the collective level. For the collective level, the causal maps are aggregated with the focus on the diversity of explanations that the members of the entrepreneurial team provide. While there are a number of ways to develop collective cognitive maps, this study uses aggregation (Bougon, 1992; Cossette and Audet, 1992; Laukkanen, 1994). As opposed to congregate maps, aggregate maps include dominant causalities and concepts of individuals maps (Bougon, 1992). This is essential for the current study because it preserves the diversity of concepts since concepts that are dominant in individual maps are retained. This is important because these may be potentially very important for the identification of entrepreneurial opportunities. In sum, the cognitive maps will be analyzed on three levels: (1) individual cognitive structures; (2) collective cognitive structures; and (3) collective cognitive structures over time (=collective learning about opportunities). This stepwise analysis enables me to compare the collective or shared cognitive structures over time and its impact on entrepreneurial opportunity identification and exploitation.

Regarding opportunity exploitation, I created an index from the actual opportunities that have been implemented by the company on a scale of 1 through 10. It is important to state that these measures are – as opposed to the shared cognitive maps described above - not cognitive/subjective. These measures are objective and based on a multitude of internal and external documents of each one of the ventures (e.g, internal reports, marketing reports, websites, reports about the company, sales figures, etc.) that were triangulated. In order to be comprehensive, I examined a given venture's opportunity exploitation along five dimensions: Product innovation, service innovation, technology innovation, marketing innovation, and organizational innovation. The opportunity identification is constructed from additional information and interviews with people within the entrepreneurial team and outside of the entrepreneurial team, in order to get a sense of the number of opportunities currently identified. I captured the number of opportunities identified by each company along the same dimensions as the opportunities that were actually exploited by the ventures.

Research Process

For creating the above mentioned maps, I conducted 81 (=3 individuals x 3 time points x 9 ventures) semi-structured interview of 90 minutes length each. In the interviews, I asked a set of questions relative to opportunities that are identified and exploited that are repeated at t1, t2, and t3. In order to be inclusive, the question in each one of these interviews refers to a compilation of the different strategic areas of any business: business model, learning and challenges, strategy and core competencies, customer focus and management, strategic alliances, perception of industry and competition and vision. While the focus of these interviews is intentionally broad in order to leave room for the specific cognitive structures, it is also very systematic in terms of replication over time (i.e., the same set of questions is asked at the three different points in time, interviews span 2 years and are separated by eight months each). These maps are then aggregated into a map representing the overlap and diversity of concepts and causalities. The aggregate map allows for constructs and causalities to "overlap"[1] when they are common elements of the cognitive maps of the individual team members. The aggregate maps were analyzed according to three measures that are used in order to describe the structure of cognitive maps in general: centrality, domain and cluster. These three measures enable me to pinpoint the dominance of certain concepts from different angles and therefore guarantee validity. The coding process for two randomly selected interviews was replicated by two independent researchers that are active in other disciplines. The inter-rater reliability was 87%.

Data Analysis and Results

In the following, I present the insights from the analysis of the individual and the shared cognitive maps over time. I analyzed the individual maps as well as the shared cognitive maps based on the measures mentioned above.

1. Diversity of complexity of shared cognitive map (concepts and causalities)

[1] This "overlap" is represented by the use of colors for the three interviewees in the entrepreneurial teams in Figures 3 and 4.

Researchers have found that complex mental model structure increases both individual and organizational capacity to respond and perform successfully (Ginsberg, 1990; Tuckman, 1964). More specifically, Ginsberg (1994) argues that groups with greater cognitive complexity are more likely to define their competitive environment comprehensively and creatively than homogenous groups. The importance of cognitive complexity on a variety of output variables having been shown in on the individual level (e.g., Bartunek, Gordon, and Weathersby, 1983; Green, 2004) as well as on the organizational level (e.g., Goodwin and Ziegler, 1998), there is reason to believe that it leads to convergent results in the context of entrepreneurial opportunity identification and exploitation. The uncertainty and the ambiguity of the entrepreneurial situation and the fact that processes and routines are usually not yet in place to cope with these challenges, the relationship between cognitive complexity and performance measures to be true. Therefore, I propose:

Proposition 1a: Low complexity of the shared cognitive map is associated with identification and exploitation of more opportunities.
Proposition 1b: High complexity of the shared cognitive map is associated with identification and exploitation of more opportunities.

The data of the nine ventures analyzed in this study clearly showed the above stated relationship. In the following, I refer briefly to the venture with the lowest cognitive complexity and the one with the highest cognitive complexity of shared maps. Delta-Tech has the least complexity of the shared cognitive map. This company also identified and exploited the least number of opportunities (Figure 5 and 6). The interviews at Delta-Tech painted the picture that of the venture being more or less at the mercy of the big players in their industry. The reasons for that could be that the majority of the management team previously worked for a large technology corporation and tried to replicate part of the business, the business processes and general approach in the relatively small company, Delta-Tech. Yet, the team focused very much on the limitations of replicating the model and the limitations of the needs of their customers. One can say Delta-Tech has some “entrepreneurial spirit”, yet reasoned more like an established company and focused on their current customer base rather than exploring new opportunities and new markets in order to expand their business. By contrast, the company with the highest overall average of cognitive complexity of the shared cognitive maps over time, Epsilon-Tech showed a clear vision to expand their current business to reach a very large and different market. The company envisions a business model where they can replicate their business model with exponential growth.

Related to this is the question to what degree are the cognitive maps shared by the members of the entrepreneurial team. Given that cognitive maps consist of concepts and causalities, four theoretical possibilities of overlap present themselves in this context: Concepts and causalities are (not) shared or only concepts vs. only causalities are shared. In the following, I refer to the two dimensions that are most relevant for this study.

2. Number of Shared Concepts and Causalities

Fiol (1994) investigated the new venture development process and found that organizational learning is really about the development of diverse interpretations (Fiol and Lyles,

1985; Huber, 1991). Fiol shows how the team members in the ventures that she analyzed developed unified ways of framing their arguments, while at the same time maintaining diversity through differences in the content of team members' interpretations. Similarly, Clarysee and Moray (2004) relate knowledge diversity to team learning, which, respectively is likely to lead to a greater number of opportunities. For the study of shared cognitive maps, this finding would translate into a high number of shared elements of the maps and a low number of shared elements of the maps. Given that the constituent elements of cognitive maps are concepts and causalities (i.e., links), I assume the following:

Proposition 2: A high number of shared concepts and low number of shared causalities results in the identification and exploitation of a great number of opportunities.

At Epsilon-Tech, for instance, in t1 adaptiveness was the most dominant concept for all three interviewees (Figure 1). The different dominant decision makers recurred to different explanations how adaptiveness serves the company and how it may be reached. Yet, the different causal explanations all support the general concept of adaptiveness to the environment. The reasons provided by the team members are of different nature such as “freedom of the partners”, “clarity of guiding principles”, “performance of strategy process”, or “compatibility of product roadmap”.

Beta-Tech shows the highest number of shared concepts and causality in the sample. In other words, the maps of Beta-Tech are strikingly coherent and integrated; nearly every element in the maps is connected with every other element in the map. Another interesting observation is also that the reasoning pattern at Beta-Tech is very explicit and highly controlled (Reger and Palmer, 1996). I find that Beta-Tech identifies quite a number of opportunities such as developing a new product on a different technological platform and a completely new business model and organizational structure as well as strategic partners. Beta-Tech has a history of ideas anticipating market demand. Oftentimes, this is unfortunately subject to the forces associated with the innovator’s dilemma (Christensen, 2000) and consequently does not result in high returns. Beta-Tech did have some interesting ideas, yet all the members of the team were so familiar with the company that they found a lot of reasons why the opportunities should not be exploited at the specific point in time (the observation period was over two years).

Delta-Tech is a company that had also a substantial overlap of concepts and causalities. Yet, as explained above identified only very few opportunities and these opportunities were very much related to their current business and more reactive moves. When making sense of these results, I suggest that cognitive complexity moderates the relationship between number of shared concepts and causalities leading to the following set of propositions:

Proposition 3a: A high number of shared concepts and causalities results in the identification and exploitation of few opportunities when overall complexity of cognitive maps is low.

Proposition 3b: A high number of shared concepts and causalities results in the identification of a high number of opportunities but the exploitation of only a few opportunities when overall complexity of cognitive maps is high.

Theoretically, there are two more possibilities. The first possibility is that near to no concepts and causalities are shared. This was not the case for any of shared cognitive maps analyzed here. The last alternative would be that only the causalities are shared but not the concepts. Yet, this theoretical possibility is precluded from empirical occurrence since causalities without concept cannot exist in this approach. While we can describe archetypes of causalities, it is not possible to show causalities empirically that are not related to concepts since concepts define to some extent causalities.

4. Change of Shared Cognitive Maps over time

In this section I report my results from the analysis of cognitive maps over time. Only few studies in the field of management investigate the change of cognitive maps over time. Barr et al. (1992) did not look at the overall integration of the map in terms of centrality, domain and cluster. The analysis of integration of cognitive concepts and causalities of the current paper and the comparison with the opportunity identification and exploitation gave a different pattern. Based on the identification of continuity vs. discontinuity of concepts from tn to tn+1, I explored the following set of propositions:

Proposition 4a: The continuity of the concepts in the shared cognitive map (concepts and causalities) is associated with the identification (and hence exploitation) of fewer opportunities.

Proposition 4b: The discontinuity of the concepts in the shared cognitive map (concepts and causalities) is associated with the identification and exploitation of more opportunities.

The development of the shared cognitive maps of Alpha-Tech and Epsilon-Tech are illustrated in Figures 3 and 4 respectively. At each point in time the concepts that were the most prominent in the collective maps at each one of the three points in time between 2004 and 2006 when interviews were done are illustrated. While evolution of the shared cognitive maps at Alpha-Tech continuity is characterized by the highest continuity, the cognitive map at Epsilon-Tech is associated with discontinuity. In other words, out of the nine ventures analyzed here the one venture that showed the least continuity in its shared cognitive maps over time, identified and exploited the greatest number of opportunities. On the other hand, the venture that showed the highest continuity of concepts still identified a number of opportunities but did not exploit them.

The continuity of all central concepts at Alpha-Tech is evidenced by the continued line in the graph in Figure 3. This continuity of the concepts is striking when compared to the remaining firms in the sample (See Figure 4 and explanation below on Epsilon-Tech). Alpha-Tech's cognitive maps show extremely consistent argumentation over time. That Alpha Tech's discourse centers on 'software engineering' pushes aside arguments such as cost, administrative, organizational issues or other issues that may be relevant at a given point in time.

The most dominant concepts at Epsilon-Tech clearly change (indicated by the single data points in Figure 4). At t2 the most relevant shared concept at Epsilon-Tech is a financial goal, i.e. "100 million dollar growth in three years" and at t3 the most dominant shared concept is "profit" with acquisitions and more precisely an acquisition capability being the main driver for profits.

Yet, the pattern in the shared cognitive maps supporting the changing most dominant constructs remains, i.e. high number of shared constructs with high diversity in causalities.

Reflection on Results and Contribution

The objective of this study consisted in analyzing the emergence of team mental models or cognitive structures and their impact on opportunity identification and exploitation. The findings are summarized in the model in Figure 7. While the total overlap between concepts and domains is negatively related to opportunity identification and exploitation, the partial overlap of concepts only but not causalities is positively related to opportunity identification and exploitation. Discontinuity of concepts contained in the shared cognitive map over time is also positively related to opportunity identification and exploitation. This research also identified the overall cognitive complexity of the collective map as a moderator in this relationship.
There may be trade-offs between these variables that have not yet been fully explored in this study. It would be interesting to understand, for instance, whether a discontinuity of concepts (that could be generated through external consultants and/or industry outsiders) could mitigate the negative effect of limited cognitive complexity or exceeding overlap at a map at one point in time. Conceivably, an intervention in some companies that share too much of their knowledge in order to generate creative "follow-up opportunities" could be valid basis for generating new ideas, yet the complexity of the maps need to be increased through outsider input resulting in a discontinuity. In sum, the model invites researchers to a rigorous large sample test of the variables in this model and entrepreneurial teams to reflect on their current practices and mental models and how they fit this model.

By enhancing our understanding of collective entrepreneurial cognition, this project addresses a new and relevant but underexplored research area in the field of entrepreneurship (e.g., Dutta and Thornhill, 2008). In addition, this research provides insights on the change in cognition and hence can advance our understanding of the entrepreneurial learning process (e.g., Eckhard and Shane, 2003). Specifically, this study developed a set of propositions that go beyond the static analysis of entrepreneurial team cognitions.

Limitations and Future Research

Like most research this study has a number of limitations. Given that the context of this study is the German-speaking software industry, the results are limited in their generalizability. The trade-off between in-depth analysis versus large scale analysis, was resolved in favor of in depth analysis. Furthermore, the research is clearly set in an exploratory research paradigm and does not attempt to test the propositions. Further research could test the propositions developed by this research in different cultural context and in different industries. An additional analysis of the strategizing process and how it moderates the propositions presented here (e.g., differences in the process such as between automatic and controlled processing Reger and Palmer, 1996) appears also be very promising. In addition, I hope this study encourages more researchers to investigate more the collective entrepreneurial cognition. Beyond that, I see great potential in the analyses of collective cognitions over time.

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Appendix

Table 1: Characteristics of the Ventures in the Sample

Firm	Origin	Country	Industry focus	Focus on function within firm	Ratio (project/product)	Number of members of dominant coalition	Management fluctuation	Prior experience of members of dominant coalition
Alpha-Tech	ETH	CH (US, H)	banking dominant, but others	security	100	5	low (founder-CTO left)	mainly technology /business
Beta-Tech	Technology Corporation	GER	none	none	100	3 (+2)	very low (one of the founders left)	mixed: technology/business /philosophy
Gamma-Tech	Bain Consulting	CH	none	webdesign	70	8	very high	business (management) technology (founders)
Delta-Tech	Technology Corporation	GER	universities, governnmental	information management	20	3	very low	business/technology
Epsilon-Tech	McKinsey	GER	construction	project management	200	7	low	business/(technology, construction industry)
Zeta-Tech	Business School	CH	none	HR processes	20	4	low (CTO left)	business (management has not technology experience)
Eta	Technological University Munich	GER	none	security	70	3	very low	mainly technology; management
Theta	Design Organization/ Business School	CH	none	marketing	120	7	medium	mainly management, design, technology
Iota	ETH	CH	financial dominant but others	security	80	11	low	mostly technology; also business

Figure 1: Cognitive Map for Epsilon-Tech at t1

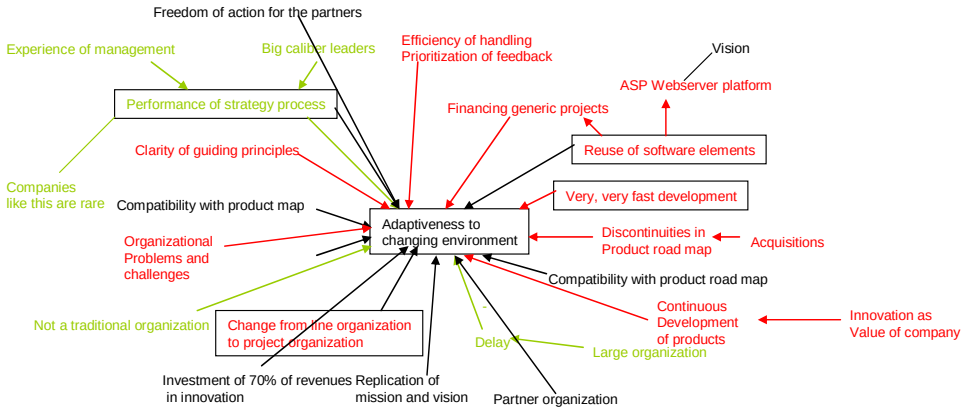

Figure 2: Cognitive map for Beta-Tech at t1

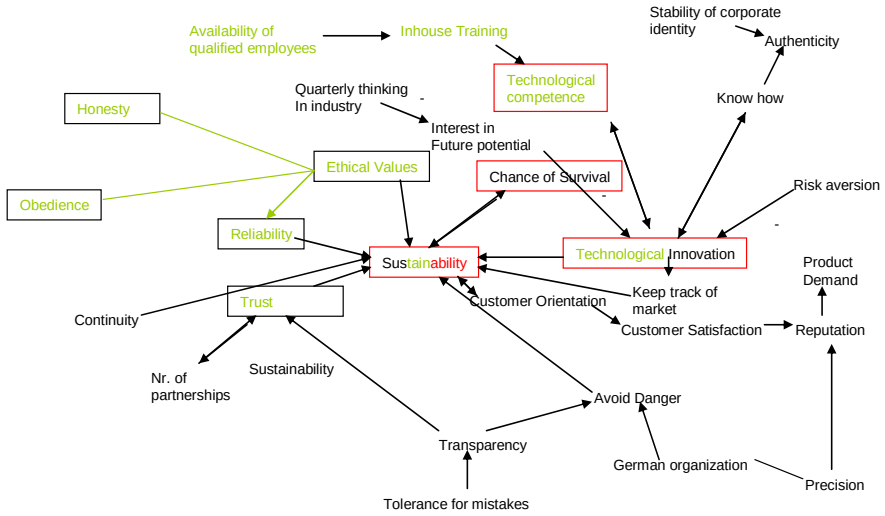

Figure 3: Evolution of dominant concepts at Alpha-Tech

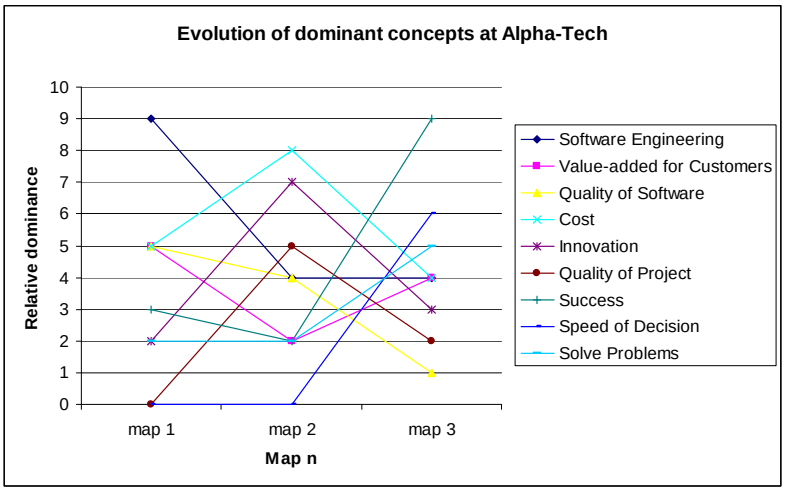

Figure 4: Evolution of dominant concepts at Epsilon-Tech

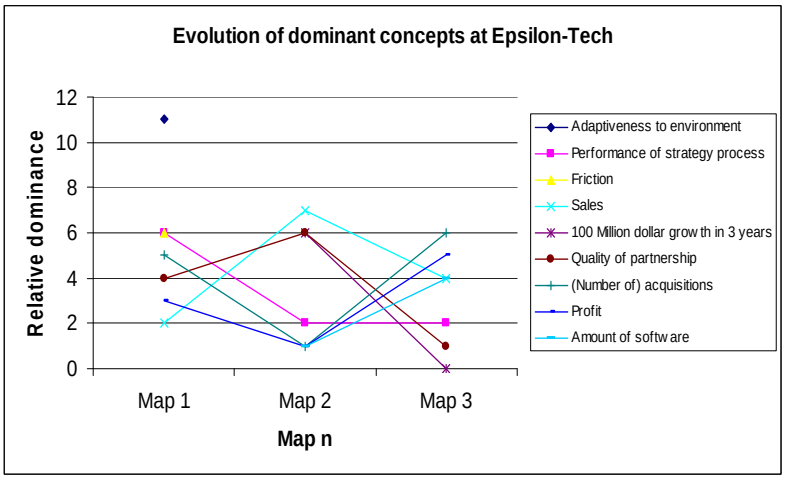

Figure 5: Opportunity Identification along five dimensions for the nine ventures

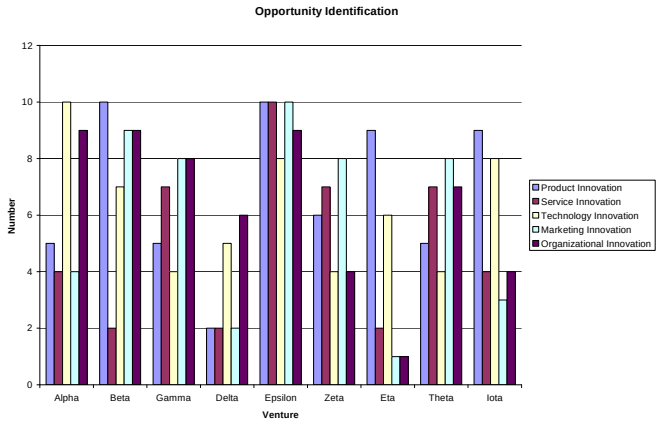

Figure 6: Opportunity exploitation along five dimensions for the nine ventures

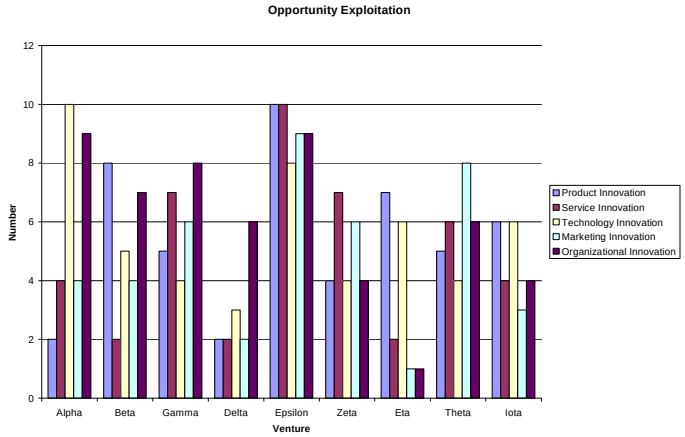

Figure 7: Model