
Attributes of innovative companies in diverse innovation typologies

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Abstract: The subject of the study reported in this paper is the exploration of companies' attributes, which discuss the impact of core companies' characteristics towards innovation in diverse innovation typologies, for both incremental and radical innovations. The study of companies in a high technology cluster confirms that innovation drives business performance, and it also outlines, which organisational attributes drive radical innovations. These include attributes associated with product centricity, internationalisation, bottom-up strategies and the degree of centrality in interorganisational networks. The impact of organisational characteristics in different industry sectors is also analysed.

Keywords: innovation; management of innovation; organisational characteristics of innovation; innovation typologies; survey; regression analysis; innovation performance assessment.

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1 Introduction

Innovation is triggered by several influencing factors, and some organisational attributes foster a culture for innovation and success. This analysis investigates diverse characteristics of companies, in order to understand how they might contribute to a successful innovation strategy. These company characteristics include elements of the strategic direction of the business, the awareness towards risks, company renewal, internationalisation, complexity of business model, degree of technology impact, degree of novelty (breakthrough vs. me-too), time to market indication, organisational structure, and the distribution of leadership and power (i.e., top down vs. bottom-up).

Rogers (1995) noted that “much effort has been spent in studying ‘people’ differences in innovativeness...but that relatively little effort has been devoted to analyzing ‘innovation’ differences...” (p.204). It seems that many company characteristics are embedded in the organisational culture, including the organisational set-up and overall strategic approach. Van de Ven et al. (1999) points out that organisational creation is essential to the process of innovation. Certain organisational attributes contribute to the successful utilisation of resources and of new technology to realise innovation success. Schumpeter (1950) highlighted the need for “creative destruction” to ensure survival and growth of businesses and this requires, as prerequisites, factors which include organisational change alongside change in processes, products and new markets.

Thus it appears that the organisation is a critical factor for to realising innovation and it becomes a key challenge for companies. There are many factors (soft and hard factors) that trigger innovation and influence innovation success, ranging from the organisational structure and leadership capacity, to process orientation and the overall approach for implementing company policy (see for example Cooper and Kleinschmidt, 1995, 1996; Lester, 1998; Tang, 1999; Chiesa et al., 1996; Lewrick, 2007).

Yet to the knowledge of the authors there are no studies that combine different organisational attributes to radical and incremental innovations across several typologies conducted in high-technology clusters.

Within this study innovation includes radical and incremental innovations in different typologies, which include organisational change and non-technological characteristics of products, services and processes. This is in line with the OECD and Eurostat (2005, p.46) definition of innovation, which describes innovation “*as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations*”. The purpose of this paper is to expose how various organisational characteristics are associated with these typologies of innovation.

2 Literature review

Amabile (1988) investigated the personal traits which trigger innovation. The personal traits examined were associated with risk, self motivation, creativity, social skills, responsiveness, flexibility, certain cognitive abilities, diverse experience and open-mindedness. Amabile found these traits to be important in explaining innovation, but this only gave a partial explanation. Other explanations lie in organisational factors.

According to Lindgren et al. (2001), traditional organisation forms include attributes from Taylor's scientific management, bureaucracy oriented organisation styles (Weber, 1947), mechanistic systems, goal directed rationalistic organisational systems (Pfeffer, 1982), and a perspective on organisations as closed and stable systems (Thompson, 1967). In contrast, innovative organisations can be described with a different rationality which includes attributes of organic organisations (Burns and Stalker, 1961), emergent, almost random organisations (Pfeffer, 1982), and a perspective on organisations as open and dynamic systems (Burns and Stalker, 1961).

The organisational design theories focus on the structural forms and on the tendency of organisations to put innovation into practice (Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Mintzberg, 1979). Others, like Teece (1998), explored the structural attributes of innovative firms and the effects on process and product innovation. The effects are observed in the competitive advantages which arise from the combination of the physical, social and resource allocation structure. Mainly the knowledge of the company and individuals must be managed, shaped and distributed to influence business and innovation success. The innovation strategy asks for knowledge assets and the combination of knowledge with other core capabilities and assets to create value (Lewrick et al., 2008a). In other works such as that of Argyris and Schon (1978), Nonaka (1994) and Nonaka and Takeuchi (1995), organisations have been analysed by relating innovation to the learning and knowledge creation process. Innovation has been related also to the key organisational structures in order to allow sustained knowledge creation and exploitation. Nonaka and Takeuchi (1995) argue for example that knowledge creation in companies is realised by knowledge conversion: converting existing knowledge into new knowledge, while Argyris and Schon (1978) forwarded loop models to improve managers learning outcomes.

The influence on organisational change and adoption to external influences are considered in studies such as those by Romanelli and Tushman (1994), Child (1997) and Lewrick (2007). The studies from Romanelli and Tushman revealed for example a pattern of discontinuous change in the drivers for activities associated with strategy, structure and power distribution from an investigation of 25 producers in the computer industry. Lewrick (2007) explored the changes in the transformation from a start-up phase towards a more mature phase of business, considering both external factors and internal capabilities in a study conducted within a high technology cluster in Europe. It reveals that the four most important drivers for sustainable growth and innovation success – over the entire business cycle – are the management of knowledge, knowledge acquisition, interorganisational networks exploitation, and the ability to allocate resources for Innovations.

The influence of different organisational characteristics will now be discussed starting with how customer and product centred the company is. Kohli and Jaworski (1990) define market orientation as an *“organisation-wide generation of market intelligence, dissemination of the intelligence across departments and organisation-wide responsiveness to it”*. Slater and Narver (1998) distinguish between being ‘customer-led’ and being ‘market-oriented’. Customer-led businesses *“focus on understanding the expressed desires of the customers...and on developing products and services that satisfy those desires”*. Lewrick et al. (2008b, p.17) identified a positive relation between different facets of customer orientation and innovations: *“a customer centric approach, incorporated in a more operational approach, and customer intelligence related to the*

analytical impact on customer information show a positive impact to innovations". Market-oriented businesses can be characterised as *"committed to understanding both the expressed and the latent needs of their customers...through the processes of acquiring and evaluating market information in a systematic and anticipatory manner"*. Sheth et al. (2000) adds to this by differentiating between market orientation, which considers the mass market, to a customer-centric approach which deals with *"understanding and satisfying needs, wants, and resources of the individual consumers and customers"* as opposite to a product centric approach. Day (1999) highlighted that product-centric companies might become oblivious to the market, however in the case of technology-driven companies there is a possibility that customers will never generate the most valuable innovations. Product centric companies focus on product development and build product lines, while customer-centric companies focus on finding solutions for customers.

To successfully bring ideas to the market requires the ability to take and to manage risk and hence attitude to risk is an important organisational characteristic. This includes the companies' capability to minimise destructive consequences while maximising profit. Harding (1998, p.167) defines risk as *"a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence: how often is a particular potentially harmful event going to occur, [and] what are the consequences of this occurrence?"*. It seems that the meaning of risk has shifted towards a synonym for danger as Graubard (1990, p.v) highlights: *"It is perfectly obvious that the concept 'risk' has taken on wholly new dimensions in recent decades and is today being reflected on in ways that would have been almost inconceivable even a few years ago. The older idea, that risk is essentially a wager, which individuals take in the hope of gaining something significant, substantial, has almost disappeared from common parlance. Risk today is conceived principally as danger..."*

The degree of modernity of a company is thought to increase the potential for innovation. The traditional approach towards innovations refers to a linear process of knowledge production, learning and implementation. This model follows a stream termed by Gibbons et al. (1994) as "mode one" type of knowledge creation. However, this approach lacks in continuous learning and innovation process to cope with growing complexity and rapid change. A more modern perspective includes multiple knowledge sources, partnerships, diversification and learning, management capacity development, and social networks to foster innovativeness (Hall et al., 2004). It might depend on the industry which strategy is more successful, but it can be assumed that companies which operate in dynamic environments are more likely to be forced to apply a more modern perspective towards innovations.

Another characteristic of a company likely to influence on the capability to be innovative is the extent of international orientation of the company. For innovation itself the locational advantage in the capacity to innovate is corresponding to specialised skills, knowledge, institutions, and resources embedded in the innovation system and technological infrastructure. However, the strategy of internationalisation has the advantage of diversity, shared knowledge, collaboration, and access to labour. It seems that innovations can occur everywhere, in any culture or country. Santos et al. (2004, p.33) highlights that *"globalizing the innovation process is an important way to access this great diversity of knowledge"*. Clearly the complexity of markets, products, technologies or the entire organisation has an impact on the innovativeness. The complexity of innovations has two aspects, the market knowledge complexity and the

technology knowledge complexity. The knowledge complexity is associated with innovating products, services and processes supported by the organisational capabilities. Baldrige and Burnham (1975) argued that complex and heterogeneous companies tend to be more innovative than small, simple and homogeneous companies. This is because bigger companies have problems of coordination, control and management which ask for innovative solutions. Also studies of Meyer and Goes (1988) revealed that innovations are more likely when the knowledge complexity increase. A deeper exploration of the technology-drive is explored by Battisti and Stoneman (2003, 2005). They argue that process innovations are more likely considered technological, whereas organisational types of innovations, marketing innovations and/or innovations in services are considered as non-technology based.

The exploration of technology-driven versus non-technology-driven in correlation to different modes of innovation has been analysed in several studies (Hollenstein, 2003; Jensen et al., 2007; Tether and Howells, 2007). Most of these studies reveal that technology-driven companies have higher innovation outputs. This then exposes a further characteristic, that of the degree to which the company is technology driven, which requires investigation. Innovation occurs in various innovation typologies for both radical and incremental innovation, and the strategic direction aims at realising breakthrough or 'me-too' services and products, respective both. Success based on breakthrough innovations becomes critical to the long-term competitive advantage of a company. The risk of failure, and the amount of resources needed, is much lower for 'me-too' innovations in contrast to breakthrough ideas which have high uncertainty about technology viability and market acceptance. Incremental and radical innovations ask for different approaches in managing them (McGrath and MacMillan, 1995), and different capabilities are needed (Lewrick, 2007; Henderson and Clark, 1990). Another attribute of innovation success can be defined as time to market for products and services. The advantage of first to market is associated with a strong image, brand awareness, reputation, and innovation and technology leadership. However, the follower has competitive advantages as well by decreasing the risk, technology failure, and saving resources (Cottrell and Sick, 2002).

The set-up of organisational structures can be divided in hierarchical and flat organisations. Innovators themselves tend to refute the hierarchical structure. Larson and Gobeli (1988) highlight that only 20% of the functionally organised innovating companies are satisfied with this hierarchical structure. In contrast, Calantone et al. (2003) point out that flat, more flexible and adaptive structures tend to outperform functional organised structures. It seems that flat organisations foster self-reliance, problem solving and spur innovativeness. In contrast hierarchical organisations seem to be more restrictive and rule based which cause political behaviours in companies which constrain innovation. These are two types of general strategic development and execution: top-down and bottom-up. The top-down strategy is associated with a deliberate strategy mostly applied when e.g., the market is well known and predictable (sustaining innovations in mature markets). The bottom-up strategy can be linked to a more emergent approach towards the overall corporate strategy. This might be true for new market disruption (e.g., Business model innovation need to change as markets unfold).

Centralised organisations tend to be less innovative than decentralised organisations because of lower employee involvement, commitment and awareness for change. Especially a bottom-up approach towards innovation is hard to realise because lower

level employees are mostly not involved in decision taking or they do not receive feedback on innovation outcomes. Khan and Manopichetwattana, 1989) show that centralisation hampers knowledge and information transfer. In contrast Dewar and Dutton (1986) advance the theory that the centralisation of power is needed to overcome resistance to change, and a result centralisation leads to higher innovativeness.

The degree of decentralisation and its effect on innovativeness will be investigated in this study. The business type might differ and can be characterised as business to business or business to customer based on the target buyer of product and services. The degree of centrality in networks provides insights of how the concepts of open innovation and collaboration are applied (see Chesbrough, 2003, 2006). This will be investigated using results derived from a survey of entrepreneurs who are based in the high technology cluster around Munich in Germany. Lewrick (2008b) found that the exchange of knowledge, information and contacts becomes vital for success and innovations. Lengrand and Chatrue (1999) stress the crucial aspects of knowledge which is embodied in networks and communities while social capital becomes a necessity and essential part to understand innovation. The survey results allow further investigation of these findings and to allow identification of the attributes which are associated with success in innovation.

3 Data and methods

3.1 Definition of innovation and innovation measures used

In the context of this study innovation is measured by three categories: counts of incremental, radical and overall innovation. Incremental innovations are the improvements/expansions of existing products, services, processes, technical or administrative conditions. Incremental innovation does not cause a significant departure from status-quo. In contrast, radical innovations in products, services, processes, etc. are breakthroughs that fundamentally change a product or service or process. Overall innovativeness is the total of all innovations put into practice, radical and incremental across all typologies. These categories have been clearly identified by a number of authors such as Tidd et al., 2003; Gatignon et al., 2002; Garcia and Calantone, 2002 and Utterback (1996). To record the number of innovations per annum we used three categories of innovativeness. For incremental and radical innovations low innovativeness was taken as less than five innovations, medium innovation was taken as five to fifteen innovations, and high innovativeness was taken as more than fifteen either incremental or radical innovations per annum. Categorisation of overall innovation was simply the sum of radical and incremental innovations.

3.2 The research instrument and data collection

For data collection a questionnaire was developed and used to obtain the relevant data. The questionnaire derived from the key domains outlined and discussed in the literature review. The aim of questionnaire was to reach a number of participants of innovative companies located in a high technology region around Munich, Germany. Demographic

questions have been added to obtain information related to performance, company age, business sector, core competences, number of employees and the position of the respondent. The questionnaire was pretested on a group of 15 companies with different characteristics (e.g., sector, tenure, employees, etc.). Various modifications were made to the questions in the research instrument as knowledge about constraints increased and as the requirements of a holistic exploration of changes in innovation styles evolved. The original research instruments were prepared in English. To obtain a better response rate and to conquer any language problems identified in the pilot tests, the questionnaires have been translated into German. Discussions in numerous network events of regional business plan competitions helped to establish dialogue with entrepreneurs and enterprisers. This helped not only to understand what, how, and importantly why innovation takes place.

The finalised questionnaire was constructed in html and distributed via e-mail to CEOs of companies located in the high-technology cluster Munich. Two hundred sixteen out of 530 companies completed the questionnaire; data cleaning resulted in a further reduction of 45 responses yielding a response rate of 32%.

The distribution of the sample by level of total innovativeness and business type is displayed in Table 1.

Table 1 Degree of innovation by business sector

Sector	Percentage total innovativeness			
	<i>N</i>	< 10 innovations	10–30 innovations	> 30 innovations
Health industry	32	21.9%	56.3%	21.9%
Knowledge services	31	29.0%	54.8%	16.1%
Manufacturing	43	41.9%	46.5%	11.6%
Traditional services	53	28.3%	54.7%	17.0%
Energy	12	16.7%	50.0%	33.3%

The questionnaire included 13 key questions on different organisational characteristics, scored on a five point Likert scale, to explore comprehensively the influencing factors on innovation (see Lewrick, 2007). The thirteen characteristics are degree of product centricity rather than being customer centric, risk aversion, traditional linear approach to innovation rather than modern open and complex approaches to innovation, degree of international outlook, complexity, non-technology driven, being a 'me-too' rather than breakthrough, being a follower rather than first to market, hierarchy of organisation, bottom up rather than top down strategy, business to customer (B2C) rather than business to business and the degree that the company is in a central position in their interorganisational network. Table 2 provides an explanation of each characteristic.

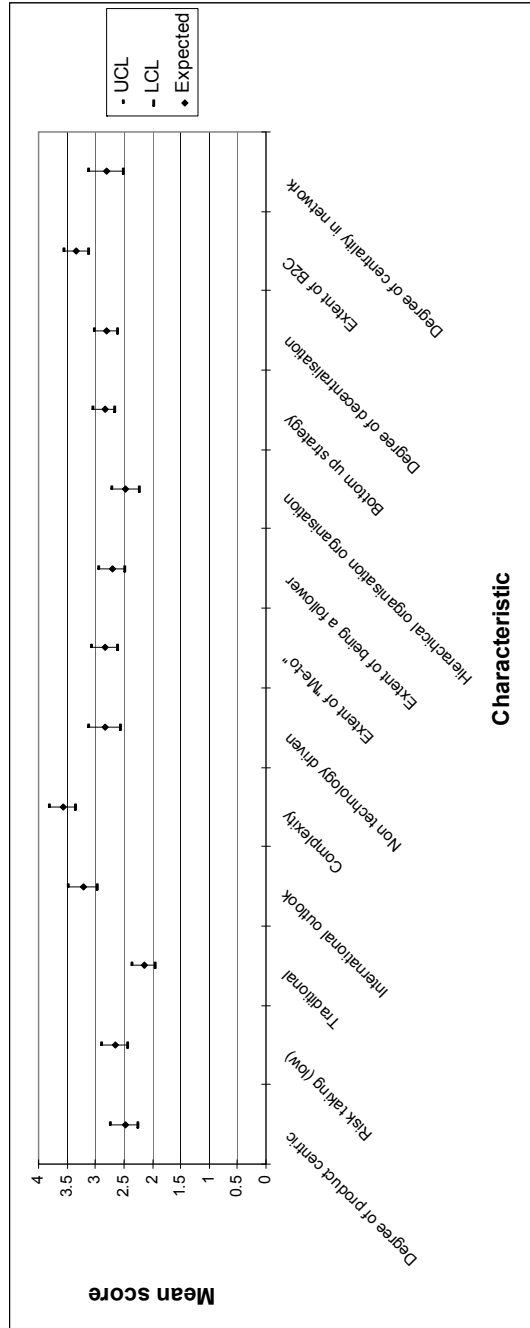
A summary of the mean scores of these characteristics with 95% confidence intervals is presented in Figure 1.

The highest scoring characteristics are degree of complexity, extent of business to customers and degree of international outlook. The extent of traditional views to innovation scores the lowest.

Table 2 Explanation of characteristics

<i>Characteristic</i>	<i>Definition</i>
Degree of product centric	The degree of product centric explains the extent of product centric versus customer centric. Product centric companies follow a strategy on product development and build product lines, while customer-centric companies follow a strategy to find solution for customers.
Risk aversion	Risk aversion operates in high risk taking versus low risk taking. The high/low risk aversion indicates the company capability to minimise destructive consequences while maximising profit.
Traditional view	Modern approach versus traditional. The traditional innovation mode refers to linear models, while the modern mode includes loops, multiple stakeholders, networks, learning and utilisation of management capacities.
International outlook	The international outlook differentiates between regional and international. A more regional business approach is characterised by specialised skills, centralised knowledge, institutions and local/regional resources, while the international approach build-up on diversity, shared knowledge, collaboration and access to labour.
Complexity	The degree of complexity distinct between simple versus complex innovations with regard to market knowledge and technology knowledge.
Non technology driven	Non-technology driven refers to technology-driven versus non technology driven. High-end process and product innovations might be considered technological, whereas organisational types of innovations, marketing innovations and/or innovations in services are considered as non-technology based.
Extent of 'me-too'	The extent of me-too refers to breakthrough versus me-too innovations. It provides indication of the companies' objective aiming for incremental or radical innovations.
Extent of follower	The differentiation of first to market vs. follower indicates the innovation strategy. First to market companies are typified as technology and innovation leader, while followers strategy in build on saving resources and decreasing risk of failure.
Hierarchical organisation	Hierarchical organisation versus flat organisation: Hierarchical organisations might be more bureaucratic in fixed structures, while flat organisations are more flexible by working in adaptive structures.
Bottom up strategy	Strategy types top-down versus bottom-up: top-down strategy are applied when the market is well-known and predictable, while bottom-up strategies might be based on an emergent approach towards the overall cooperate strategy.
Degree of decentralisation	The degree of decentralisation range from centralised to decentralised. The centralised organisations focus knowledge and decision taking on a central point, while decentralised organisations tend to share knowledge and general direction but decide more decentralised.
Extent of B2C	The differentiation between business to business versus business to customer indicates customer type.
Degree of centrality in network	The degree of centrality in network gives indication about joint research, manufacturing, sales efforts with other companies.

Figure 1 Mean scores of each characteristic with 95% confidence intervals



4 Results

There is a strong link between innovation and sales increase. This study has given justification to the assumption that innovation drives companies' performance. The frequency of overall innovations grouped by sales cluster is displayed in Table 3.

Table 3 Cross tabulation: sales and number of innovations

<i>Sales level</i>		<i>Total innovativeness overall</i>			<i>Total</i>
		<i>1 = < 10 innovations</i>	<i>2 = 10–30 innovations</i>	<i>3 = > 30 innovations</i>	
Cluster sales	1 = < 14%	21	13	3	37
	2 = 14–30%	4	33	9	46
	3 = > 30%	7	18	8	33
Total		32	64	20	116

Note: 55 companies did not answer the cluster sales question which for this table brought the sample size down to 116.

This confirms the strong association between sales and total innovativeness (this association is significant a $p < 0.001$). For incremental innovation the association with sales and high amounts of innovation is also significant ($p = 0.002$) but for radical innovation no significant association was apparent ($p = 0.142$).

The characteristics are now regressed on the count of the number of innovations and coefficients of the regression models are displayed in Table 4.

It is apparent that all the models only explain part of the number of innovations and a large part will be explained by the nature of the market and the personal characteristics of those engaging in entrepreneurial activity. Nevertheless, some insights are given to the importance of organisational characteristics. The more product centric the company is, the more this is associated with incremental process, product and to some extent technical incremental innovation. For radical innovation, there are significant positive influences on product and administrative typologies (as well as the total radical innovation). Although significant only for radical technical innovation, the category 'risk aversion', as one would expect, seems to have a negative influence on innovation. Having a traditional approach to innovation is a significant positive influence on incremental product, administrative and technical typologies. For radical innovations 'tradition' has a significant positive influence on the typologies of technical and services and slightly so for administrative innovations. 'International outlook' helps to promote the incremental innovations of products and services and the radical innovations of products and slightly for processes. If the company engages in very complex processes, then there is engagement in all incremental innovations. However, for radical innovations it is only for technical and service typologies that complexity emerges as a significant influence. The extent to which a company is non technology driven is significantly positively associated with all typologies except product. For radical innovations there are positive associations with services and technical typologies. Unsurprisingly, having a 'me-too' philosophy has a negative influence on all typologies of innovation, but this is significant only for incremental product and service innovations and for product and administrative radical innovations. For the characteristics of 'being a follower' the only significant relationship is a positive one for incremental service innovations. Although there were no significant relationships for radical innovation, being a follower had negative signs on all the

coefficients. The extent of having a hierarchical organisational structure is only significant (negative) for radical technical innovations, and it seems that the more hierarchical a company is, the less radical technical innovations there will be.

Table 4 Regression models of the degree of innovation

Variable	Incremental innovation					Radical innovation					Total innovation		
	Process	Product	Services	Administration	Total	Process	Product	Services	Administration	Technical		Total	
(Constant)	-0.100	2.449***	1.352***	0.556	1.743***	1.104***	0.763*	0.201	1.082**	0.046	1.689***	0.529	1.030***
Degree of product centric	0.154**	0.185***	-0.101	0.066	0.134*	0.006	0.034	0.175***	-0.074	0.211***	0.229***	0.098**	0.065
Risk aversion	0.021	-0.057	-0.019	0.028	-0.102	-0.054	0.024	-0.004	0.010	0.063	-0.145**	-0.006	-0.062
Traditional	0.125	0.181**	0.058	0.150*	0.252**	0.163**	0.023	0.066	0.176**	0.171*	0.299***	0.132	0.223***
International outlook	0.082	0.120**	0.115**	-0.066	0.008	0.000	0.090*	0.180***	0.069	0.019	-0.035	0.071	0.010
Complexity	0.224***	0.034	0.199***	0.209***	0.258***	0.144***	0.016	0.133**	0.001	0.020	0.165***	0.029	0.118***
Non technology driven	0.160**	-0.031	0.119**	0.148***	0.153**	-0.002	0.074	0.090	0.145***	0.044	-0.147***	0.025	0.042
Extent of 'me-to'	-0.051	-0.245**	-0.285**	-0.171	-0.138	-0.129	0.012	-0.265**	-0.074	-0.210*	-0.151	-0.152	-0.207**
Extent of follower	0.056	-0.064	0.295***	0.061	0.069	0.053	-0.135	0.003	-0.046	-0.123	-0.078	-0.039*	0.043
Hierarchical organisation	-0.054	-0.025	0.049	-0.076	-0.008	-0.018	-0.030	-0.022	-0.052	0.074	-0.185**	-0.050	-0.048
Bottom up strategy	0.104	-0.001	0.213***	0.162***	-0.026	0.097**	0.088	0.158**	0.196***	0.166**	0.002	0.137***	0.103**
Degree of decentralisation	-0.043	-0.046	-0.015	-0.079	-0.032	-0.006	0.010	0.088	-0.085	0.026	0.091	0.036	-0.014
Extent of B2C	-0.018	-0.034	-0.041	0.005	-0.101	-0.030	0.055	0.094	-0.080	0.067	0.096	0.086*	0.013
Degree of centrality in network	0.087*	-0.097**	0.006	0.080**	0.039	0.049	0.107***	-0.011	0.131***	0.141***	-0.033	0.047	0.026
Adjusted R ²	11.9%	19.3%	13.1%	14.8%	25.5%	12.3%	7.6%	21.4%	13.6%	20.3%	28.9%	14.7%	14.6%

Notes: ***significant at the 1% level
 **significant at the 5% level
 *significant at the 10% level

The bottom-up way by which strategy is formed significantly helps to drive incremental service and administrative innovations and radical product, service and administrative innovations. The 'degree of decentralisation' is not significantly associated with any of the typologies; although interestingly the signs of the coefficients are negative for all incremental innovations and positive for most of the radical innovations. The degree to which the company is characterised as business to customer rather than business to business is not significant for any of the innovation typologies.

Finally, the more a company is at the centre of its interorganisational network, the more radical innovations are likely to occur for the typologies of process, service and administration. For incremental innovation 'interorganisational centrality' makes innovation in the administrative typology significantly more likely to occur, but significantly less likely for the typology of product innovation.

These characteristics vary between different business sectors. This is made clear from Table 5, which presents the results from the one way analysis of variance significant variation is indicated by P values less than 5%.

Table 5 Variation in characteristic scores by business sector

<i>Characteristic</i>	<i>Mean score by business sector</i>					<i>P</i>
	<i>Health industry</i>	<i>Knowledge services</i>	<i>Manufacturing industry</i>	<i>Traditional services</i>	<i>Energy industry</i>	
Sample size	32	31	43	53	12	
Degree of product centric	3.09	2.61	2.53	1.75	2.33	< 0.1%
Risk aversion	2.91	2.35	2.79	2.85	2.42	30.7%
Traditional	2.34	2.32	2.21	1.70	2.08	2.9%
International outlook	3.63	3.77	3.12	2.85	2.42	0.4%
Complexity	3.63	3.71	3.21	3.26	3.08	28.5%
Non technology driven	2.47	2.10	2.40	3.47	1.92	< 0.1%
Extent of 'me-too'	2.91	2.65	2.70	2.49	2.25	42.3%
Extent of follower	2.63	2.65	2.53	2.40	2.17	70.8%
Hierarchical organisation	2.25	2.74	2.58	1.79	2.08	0.5%
Bottom up strategy	2.91	2.94	2.74	2.79	2.83	94.1%
Degree of decentralisation	3.00	2.55	2.88	2.60	2.25	21.2%
Extent of B2C	2.78	3.19	3.49	3.34	2.33	2.0%
Degree of centrality in network	2.83	2.74	2.66	2.76	3.99	1.9%

From Table 5 it is apparent that the health industry focuses more on products, while traditional services focus more on customers. Other sectors tend to have equal focus between customers and products. In terms of traditional approaches to innovation, oddly it is traditional services which score significantly lower. In terms of being driven by technology the energy sector has significantly more focus on technology while traditional

services are driven significantly by non technology drivers. Traditional services also are significantly less hierarchically structured. The health, manufacturing and traditional services sector are significantly orientated towards business to customer while energy sector focuses more on business to business. Finally, in regard to degree of centrality in networks, companies in the energy sector are significantly more centralised in their interorganisational networks than the companies in the other sectors.

The association between business sector and innovation was investigated using an analysis of contingency tables to determine if the variation in characteristics reported in Table 5 might correlate with different levels of innovation in each typology. In carrying out this analysis the companies in the energy sector were dropped from the analysis as the numbers in the sample were too small to permit reliable analysis. Although there is no significant association between total incremental innovations and business sector, there are some significant associations within the different typologies: for example, there are significantly more incremental process and product innovations than expected in the health sector, and fewer than expected in traditional services. In the health industry there is more focus on product, greater risk aversion, more international outlook and complexity, less centralisation and more business to business orientation than in traditional services. For incremental administrative innovation, more appear in traditional services and fewer in manufacturing than what could be expected. This might be explained by companies being more product orientated and technology driven, and are more hierarchically organised than companies who provide traditional services. Considering the number of technical incremental innovations, a significantly higher number is observed in the health sector, and significantly fewer in manufacturing than expected. Again this might be explained from Table 4, reporting that companies in the health sector tend to be more product centric, have greater international outlook and face greater complexity than those in manufacturing. However, those companies in manufacturing tend to have greater focus on business to customer and to be less hierarchically organised than those in health. No significant association was observed for incremental service innovations.

For radical innovations no significant association between business sector and the number of innovations were found at the 5% level for any of the typologies.

We also investigated how the characteristics varied with size of the company as measured by number of employees. Significant differences at a P level of less than 5% were found only for the variables degree of international orientation, complexity, non technology driven, and hierarchical organisation. There was a significant, though small, positive correlation between number of employees and degree of product centric, international orientation, complexity, the extent to which the company is driven by technology and the extent to which the company is hierarchically organised. The Pearson correlations were 0.216, 0.323, 0.320, 0.298 and 0.341 respectively.

5 Conclusions

The exploration of company characteristics revealed that different organisational attributes have influence on various innovation typologies for both incremental and radical innovations. The results contribute to the field of innovation management and they should be seen as supplement to studies aiming to identify innovation capabilities or people differences in innovativeness. It seems that some organisational characteristics

have stronger impact on incremental process innovation, like the degree of product centrality or high complexity of knowledge and technology, while a high centrality in networks drive more radical process innovations. The international outlook contributes to both incremental and radical product innovations. Incremental and radical service innovations are more likely to happen in organisations which appear to be not technology-driven. The study also reveals insights into administrative innovations which are mainly triggered by a bottom-up strategy for both radical and incremental innovations. Incremental and radical innovations associated to technical features correlate with advanced complexity of knowledge and technology. However, the impact of the different attributes differs in industries.

This study does have some limitations firstly the attributes of the individual entrepreneur/manager are ignored clearly individual motivation and aptitudes are important determinants of innovation success and there might well be different entrepreneurial profiles that work best in different organisational forms. The whole interaction between the entrepreneur and the organisation has not been included in this study. Secondly it has been assumed that the organisational attribute are measurable and that they vary in a linear way. More in depth study is needed to investigate the validity of the organisational measures, but the study does allow general trends to be detected. Also one has reservations about the degree to which results can be generalised from the High Technology Cluster of Munich which has a tradition of focussed innovation.

Nevertheless, from the study some general recommendations can be formulated to help companies to understand the impact of different characteristics and their influence on different innovation typologies for both incremental and radical innovations. Companies following a customer centric approach have advantages in streamlining core processes and increase the impact of administrative operations. Especially processes with customer interfaces have the potential to gather important information for ideas and innovations. A more product centric approach might have high impact on new product development but it seems that the probability for market success is lower than for companies following a more customer centric approach. Companies with a high risk aversion are less likely to be able to realise radical innovations in general. A careful evaluation of ideas and alignment resources is needed, but without allowing the risk of failure no innovation success can be realised. Following a non-traditional approach towards innovations has a positive impact on radical innovations. Companies focusing on a more traditional approach towards innovation need to widen their perspective and accept that innovation goes beyond strong R&D. The influence of the market, customers, diverse teams, and the active management of organisational-wide knowledge becomes key for success. This should include the replacement of linear innovation models by open innovation models with various loops and interfaces to critical knowledge and information. An international outlook tends to influence positively both incremental and radical innovations. It seems that more diverse teams, market access and active observation of mega trends in different regions have a positive influence on the innovativeness. To increase innovation success companies might consider first expanding their innovation network internationally, and consider expansion to new markets at a later stage. However, increasing complexity in growing companies results in more incremental innovations than radical innovations. For radical innovations companies should perhaps consider creating smaller entities or separate companies for realising breakthrough ideas. This allows operating in simple structures with faster decision taking. A general 'me-too' strategy of companies allows easy and fast access to markets but it is not supportive for

any type of innovations. Companies must create a unique selling proposition in products and services to provide advanced and attractive offerings to their customers. Active trend scouting, market investigation and customer focus help to capture new ideas. Customer intelligence and market knowledge are necessary assets but even more important is to secure the capabilities to transform knowledge into products, services, and processes. In contrast to following a 'first-to-market' strategy, companies operating as 'follower' have a lower potential for radical innovations. The 'follower' seems to operate in processes and strategic direction which are not built to create breakthrough ideas. When it comes to the organisational structure it seems that the set-up has impact to put ideas into practices. Companies with many hierarchical layers lack in the ability to decide on innovation direction and strategy. In many cases companies with flat organisations are quicker in deciding about strategic direction. To create innovativeness it is important for companies to implement a culture which includes both 'bottom-up' and 'top-down' to get the highest impact on innovativeness. Last but not least companies are better off focusing on allowing open innovations. This proves the studies of Chesbroughs (2003), which show that ideas becoming better by letting them flow out of the company in order to combine different knowledge and views to develop them. Ideas will return to the company as new offerings or business models

To succeed it becomes crucial to companies to put themselves in a central position in an innovation or business networks. Centrality in a network has positive impacts on radical innovations in all typologies. The findings validate some outcomes from earlier studies on innovation attributes in various aspects. For example the positive impacts of customer orientation (Lukas and Ferrel, 2000; Lewrick et al., 2008b) or the positive impact from inter-organisational networks increasing innovativeness (Baum et al., 2000; Shan et al., 1994 Stuart, 2000). The influence on decentralisation on innovation and knowledge reported by Khan and Manopichetwattana (1989) is for example not supported in this study. In comparison to previous works, it includes more innovation typologies: processes, product, services, administration, and technical. Most research has focused on a single sector, R&D project or typology, e.g., product innovations. The effect of organisational variables on innovation is not clear and there is a great deal of discrepancy amongst researchers as to the nature of the effects.

The key findings and management implications for sustaining innovativeness over the business cycle can be summarised as follows.

- a Various attributes in growing companies trigger different innovation typologies and degrees of novelty. Successful companies link their business strategy and organisational set-up to the desired outcomes.
- b Radical product innovations are supported by attributes associated with international outlook, higher complexity, and a business culture allowing employees to participate actively in the idea und innovation process.
- c Successful companies searching for new ties and utilising interorganisational networks which results mainly in radical process and service innovation.

Further investigations are needed to explore more deeply the impact of companies' characteristics to the various innovations typologies for both incremental and radical innovations. In particular there is a need to investigate the interaction between the entrepreneur and the organisational typologies. Also further worked using more

qualitative research approaches is required to develop and better understand the measures of the organisational attributes.

References

- Amabile, T.M. (1988) 'A model of creativity and innovation in organizations', *Research in Organizational Behavior*, Vol. 10, pp.123–167.
- Argyris, C. and Schon, D. (1978) *Organizational Learning: A Theory of Action Perspective*, Addison-Wesley, Reading, MA.
- Baldrige, J. and Burnham, R. (1975) 'Organisational innovation: individual, organisational, and environmental impacts', *Administrative Science Quarterly*, Vol. 20, No. 2, pp.165–176.
- Battisti, G. and Stoneman, P. (2003) 'Inter- and intra-firm effects in the diffusion of new process technology', *Research Policy*, Vol. 32, No. 9, pp.1641–1655.
- Battisti, G. and Stoneman, P. (2005) 'The intra-firm diffusion of new process technologies', *International Journal of Industrial Organization*, Vol. 23, No. 1–2, pp.1–22.
- Baum, J., Calabrese, T. and Silverman, B. (2000) 'Don't go it alone: alliance network composition and start-ups' performance in Canadian biotechnology', *Strategic Management Journal*, Vol. 21, pp.267–294.
- Burns, T. and Stalker, G. (1961) *The Management of Innovation*, Tavistock, London.
- Calantone, R., Garcia, R. and Droge, C. (2003) 'The effect of environment turbulence on new product development strategy planning', *Journal of Product Innovation Management*, Vol. 20, pp.90–103.
- Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston.
- Chesbrough, H. (2006) *Open Business Models: How to Thrive in the New Innovation Landscape*, Harvard Business School Press, Boston.
- Chiesa, V., Coughlan, P. and Voss, C. (1996) 'Development of a technical innovation audit', *Journal of Product Innovation Management*, Vol. 13, pp.105–136.
- Child, J. (1997) 'Strategic choice in the analysis of action, structure, organizations and environment: retrospect and prospect', *Organization Studies*, Vol. 18, No. 1, pp.43–76.
- Cooper, R. and Kleinschmidt, E. (1995) 'Benchmarking the firm's critical success factors in new product development', *Journal of Product Innovation Management*, Vol. 12, pp.374–391.
- Cooper, R. and Kleinschmidt, E. (1996) 'Winning businesses in product development: the critical success factors', *Research Technology Management*, July–August, pp.18–29.
- Cottrell, T. and Sick, G. (2002) 'Real options and follower strategies: the loss of real option value to first-mover advantage', *The Engineering Economist*, Vol. 47, No. 3, pp.232–263.
- Day, G. (1999) 'Misconceptions about market orientation', *Journal of Market Focused Management*, Vol. 4, pp.5–16.
- Dewar, R. and Dutton, J. (1986) 'The adoption of radical and incremental innovations: an empirical analysis', *Management Science*, Vol. 32 pp.1422–1433.
- Garcia, R. and Calantone, R. (2002) 'A critical look at technological innovation typology and innovation terminology: a literature review', *The Journal of Product Innovation Management*, Vol. 19, pp.110–132.
- Gatignon, H., Tushman, M., Smith, W. and Anderson, P. (2002) 'A structural approach to assessing innovation: construct development of innovation locus, type, and characteristics', *Management Science*, Vol. 48, No. 9, pp.1103–1122.
- Gibbons, M., Limoges, H., Nowotny, S., Schwartzman, P. and Trow, M. (1994) *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, UK Sage, London.
- Graubard, S. (1990) 'Preface to the issue "risk"', *Daedalus*, Vol. 119, No. 4, pp.v–vi.

- Hall, A., Yoganand, R., Rajeswari, R., Prasad, G., Naik, G. and Clark, N. (2004) 'Introduction', *Innovations in Innovations, Reflections on Partnership, Institutions and Learning*, CPHP, ICRISTA and NCAP, India.
- Harding, R. (Ed.) (1998) *Environmental Decision-Making: the Roles of Scientists, Engineers and the Public*, The Federation Press, Sydney.
- Henderson, R.M. and Clark, K.B. (1990) 'Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms', *Administrative Science Quarterly*, Vol. 35, pp.9–30.
- Hollenstein, H. (2003) 'Innovation modes in the Swiss service sector: a cluster analysis based on firm-level data', *Research Policy*, Vol. 32, pp.845–886.
- Jensen, M., Johnson, B., Lorenz, E. and Lundvall, B. (2007) 'Forms of knowledge and modes of innovations', *Research Policy*.
- Khan, A. and Manopichetwattana, V. (1989) 'Innovative and non-innovative small firms: types and characteristics', *Management Science*, Vol. 35, No. 5, pp.13–44.
- Kohli, A. and Jaworski, B. (1990) 'Market orientation: the construct, research propositions, and managerial implications', *Journal of Marketing*, Vol. 54, No. 2, pp.1–18.
- Larson, E. and Gobeli, D. (1988) 'Organizing for product development projects', *Journal of Product Innovation Management*, Vol. 5, pp.180–190.
- Lawrence, P. and Lorsch, J. (1967) 'Differentiation and integration in complex organizations', *Administrative Science Quarterly*, Vol. 12, pp.1–47.
- Lengrand, L. and Chatrie, I. (1999) 'Industrial aspects of the information society: business networks and the knowledge-driven economy', An empirical study carried out in Europe and Canada, A study commissioned by the Enterprise Directorate-General.
- Lester, D. (1998) 'Critical success factors for new product development', *Research Technology Management*, January–February, pp.36–43.
- Lewrick, M. (2007) *Changes in Innovation Styles: Comprehensive Study of the Changes in Innovation Styles to Identify the Causes and Effects of Different Influencing Factors and Capabilities to Create a General Innovation Pattern*, Napier University Press, Edinburgh.
- Lewrick, M., Raeside, R., Peisl, T. and Omar, M. (2008a) *Knowledge and Innovation: the Impact of Knowledge Infrastructure, Knowledge Enhancement and Knowledge Acquisition on Innovativeness*, Napier University Press, Edinburgh, RP035/2008.
- Lewrick, M., Raeside, R., Peisl, T. and Omar, M. (2008b) *The Influence of Customers and Competitors on the Market Orientation on Start-up and Mature Companies*, Napier University Press, Edinburgh, RP033/2008.
- Lindgren, R., Stenmark, D., Bergquist, M. and Ljungberg, J. (2001) 'Rethinking competence systems for innovative organizations', *The 9th European Conference on Information Systems*, Bled, Slovenia, June 2001, pp.776–786.
- Lukas, B. and Ferrel, O. (2000) 'The effect of market orientation on product innovation', *Journal of the Academy of Marketing Science*, Vol. 28, pp.239–247.
- McGrath, R. and MacMillan, I. (1995) 'Discovery driven planning', *Harvard Business Review*, July–August.
- Meyer, A. and Goes, J. (1988) 'Organizational assimilation of innovations: a multilevel contextual analysis', *Academy of Management Journal*, Vol. 31, pp.897–923.
- Mintzberg, H. (1979) *The Structuring of Organization*, Prentice Hall, Englewood Cliffs, NJ.
- Nonaka, I. (1994) 'A dynamic theory of organizational knowledge creation', *Organization Science*, Vol. 5, pp.14–37.
- Nonaka, I. and Takeuchi, H. (1995) *The Knowledge Creating Company*, Oxford University Press, New York.
- OECD and Eurostat (2005) 'Oslo manual: the measurement of scientific and technological activities', *Guidelines for Collecting and Interpreting Innovation Data*, 3rd edition, OECD and Eurostat Publication, Paris.

- Pfeffer, J. (1982) *Organizations and Organization Theory*, Pitman Publishing, Marshfield.
- Rogers, E. (1995) *Diffusion of Innovations*, The Free Press, New York.
- Romanelli, E. and Tushman, M. (1994) 'Organizational transformation as punctuated equilibrium: an empirical test', *The Academy of Management Journal*, Vol. 37, No. 5, pp.1141–1166.
- Santos, J., Doz, Y. and Williamson, P. (2004) 'Is your innovation process global?', *MIT Sloan Management Review*, Vol. 24, No. 4, pp.31–37.
- Schumpeter, J. (1950) 'The process of creative destruction', in J. Schumpeter (Ed.): *Capitalism, Socialism and Democracy*, 3rd ed., Allen and Unwin, London.
- Shan, W., Walker, G. and Kugut, B. (1994) 'Interfirm cooperation and startup innovation in the biotechnology industry', *Strategic Management Journal*, Vol. 15, pp.387–394.
- Sheth, J., Sisodia, R. and Sharma, A. (2000) 'The antecedents and consequences of customer-centric marketing', *Journal of the Academy of Marketing Science*, Vol. 28, No. 1, pp.55–66.
- Slater, S. and Narver, J. (1998) 'Customer-led and market-oriented: let's not confuse the two', *Strategic Management Journal*, Vol. 19, No. 10, pp.1001–1006.
- Stuart, T. (2000) 'Interorganisational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry', *Strategic Management Journal*, Vol. 21, pp.791–811.
- Tang, H. (1999) 'An inventory of organizational innovativeness', *Technovation*, Vol. 19, pp.41–51.
- Teece, D. (1998) 'Design issues for innovative firms: bureaucracy, incentives and industrial structure', in A.D. Chandler Jr., P. Hagstrom and O. Solvell (Eds.): *The Dynamic Firm*, Oxford University Press, Oxford.
- Tether, B. and Howells, J. (2007) *Changing Understanding of Innovation in Services: From Technology Adoption to Complex Complementary Changes in Technologies, Skills and Organisations*, Report for the DTI, CRIC and Manchester Business School, University of Manchester.
- Thompson, J. (1967) *Organizations in Action*, McGraw-Hill, New York.
- Tidd, J., Bessant, J. and Pavitt, K. (2003) *Managing Innovation*, John Wiley and Sons, Chichester.
- Utterback, J. (1996) *Mastering the Dynamics of Innovation*, Harvard Business School Press, Boston, MA.
- Van de Ven, A., Polley, D., Garud, S. and Venkataraman, S. (1999) *The Innovation Journey*, Oxford Univ. Press, New York.
- Weber, M. (1947) *The Theory of Social and Economic Organization*, The Free Press, New York.