The realities of innovation strategies within the low- and medium-technology industries. Are open and explorative innovation strategies superior than closed and exploitative?

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Abstract

Title: The realities of innovation strategies within the low- and medium-technology industries. Are open and explorative innovation strategies superior than closed and exploitative innovation strategies in the low- and medium-technology industries?

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Level: Master’s thesis, 30hp

Keywords: low- and medium-technology industry, innovation, open innovation, closed innovation, exploitative innovation, explorative innovation, innovation process, knowledge, knowledge based view

Background: Most of the existing literature regarding innovation and innovation strategies focus on high-tech industries. In contrast low- and medium-technology industries are receiving very little attention despite the category is making up the largest part of the manufacturing industries in OECD countries. The phenomenon could be the result of misconceptions regarding innovation process in low- medium-tech industries and existing pre-eminence of linear model of innovation. Investigating the realities of innovation strategies in the low- and medium technology industries would help crystallise the understanding of innovation strategies within low- and medium technology industries uncovering key factors for innovation under the industry category.

Research question: How do organisations under low- and medium-technology industry category innovate and what is the impact the chosen innovation strategy or a combination of innovation strategies have on the organisation?

Purpose: The purpose of this study is to understand which innovation strategies (open, closed, exploitative, explorative or a combination of these strategies) organisations under low- and medium technology industry implement and how such innovation strategies impact the organisation. The aim of the study is to crystallise the understanding in how LMTs innovate, which innovation strategies they select and what influences the selection of innovation strategy.

Method: Abductive research approach is used for the study. Qualitative research method is a primary source of data gathered from 8 organisations operating under low- and medium-technology industry category. The data was gathered via semi-structured interviews with C-level executives and management responsible for innovation initiatives.

Theoretical framework: The literature will present knowledge based view and outline the link between knowledge and open, closed, exploitative and explorative innovation strategies.

Findings & conclusion: Ability to identify relevant knowledge and assimilate it drove innovation within the LMTs assessed. Innovation strategies were selected based on understanding of additional information requirements and market environment in their respective markets. Various combinations of innovation strategies were used at the assessed organisations. Some of the assessed organisations used more open or more closed innovation strategies based on business circumstances. Open innovation strategies enabled fast knowledge accumulation and problem solution discovery. Organisational cultures influence the choice of innovation strategies. Peoples’ knowledge drives performance.
Definitions

C-level executives – board level executives

Close innovation – innovation strategy aiming to develop all intellectual property internally

Complex problem – a solution (a product or process improvement) for a complex problem that has higher value to the organisation in terms of financial return on investment and the development of existing skills and capabilities.

Dynamic environment – changes in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials characterise as dynamic environment (Jansen, et al., 2006). Current products and services may become obsolete because of the dynamic environment requiring new products to be developed (Jansen et al. 2005, Sorensen and Stuart 2000).

Exploitative innovation – Exploitative innovation is incremental innovation that focuses on the modification of existing knowledge for innovation purposes (March, 1991).

Explorative innovation – is a radical type of innovation designed to meet the needs of new customers and markets (Benner & Tushman, 2003). Explorative innovation offers the generation of new designs, ability to create new markets, develop new distribution channels etc. (Abernathy & Clark, 1985).

High-technology (HT) industries according to the OECD definition are industries with high intensity of R&D development e.g. pharmaceuticals, aerospace, computers, office machinery, communication equipment, scientific tools e.g. medical, optical etc. industries fall under HT category.

Innovation activities – product or process innovation initiatives within an organisation that encapsulates innovation processes such as R&D activities.

IUC Halland – an NPO providing innovation support for manufacturing organisations in Halland region in Sweden.

Knowledge mining – search for relevant knowledge

Linear model of innovation emphasises the scientific content of technological knowledge applied in firms. It focuses on formal R&D as a source of information.

Low- and medium-technology (LMT) industries are referred to sometimes as more ‘mature’ and may include the food industry, the paper industry, publishing and print industry, the wood and furniture industry, the manufacture of metal products (foundry industry) as well as manufacture of plastic products and others (Hirsch-Kreinsten, 2008).

OECD countries is an intergovernmental economic organisation with 35 member countries committed to democracy and market economy. OECD member states are high-income economies and are regarded as developed countries.
**Open innovation** is the joint development of knowledge through relationships with external partners, including competitors, suppliers, customers, universities and research institutes (Laursen & Salter, 2006).

Profitable problem – a problem that yields the best return on resources invested and brings value to the organisation.

**R&D model** determines the kind of activities are carried out within an R&D department. R&D departments staffed with industrial scientists are tasked with applied research in scientific or technological fields that may enable future product development. R&D departments staffed with engineers are tasked with directly developing products.

**Return on investment** – is the ratio between the net profit and cost of an investment resulting from an investment of some resource.

**Superior innovation strategy** – a strategy or a combination of strategies that outperform another or a set of innovation strategies.

**Western European** – Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.
### Abbreviations

**CEO** – chief executive officer  
**CI** – closed innovation  
**HT** – high-technology  
**IP** – intellectual property  
**KBV** – knowledge based view  
**LMT** – low- and medium-technology industry  
**OECD** – The Organisation for Economic Co-operation and Development  
**OI** – open innovation  
**PAC** – potential absorptive capacity  
**R&D** – research and development  
**RAC** – realised absorptive capacity  
**ROI** – return on investment  
**WOM** – word of mouth
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1 Introduction

This chapter presents the description of the background related to low- and medium technology industries. Further the key problem that is going to be the focus of this Master’s Thesis.

1.1. Background

Globalisation and technological advancements present organisations with new opportunities and new challenges. The challenges that organisations face threaten the existence of many organisation across a multitude of industries (Drechsler & Natter, 2012). Organisational ability to innovate, respond to changes in the market environment and take a proactive approach to future market trends is becoming increasingly important in markets that are ever more global and competitive (Santamaria, Nieto, & Berge-Gil, 2009). However, due to environmental forces (Lindman, 2002), innovation itself becomes a challenge (Chesbrough & Crowther, 2006) attracting more scholars to study the phenomenon of innovation.

Innovation initiatives in the so called high-technology (HT) industries have attracted the most interest while low- and medium-technology (LMT) industries has received significantly less attention from the academia (Hirsch-Kreinsen, et al., 2005, 2006; Santamaria, Nieto, & Barge-Gil, 2008; von Tunzelmann & Acha, 2005; Robertson & Patel, 2007; Robertson, Smith & Tunzelmann, 2009). Lack of attention regarding innovation in LMT industries could be explained by the configuration of R&D statistics, the pre-eminence of the linear model of innovation (which focuses on formal R&D as a source of innovation), and misunderstanding of innovation process implemented by organisations operating in LMT industries (Hirsch-Kreinsen, et al., 2006).

HT industries are seen as the future of national and global economies (Hirsch-Kreinsen et al., 2005, 2006) discounting the importance of LMT industries, however, undeservedly. Low- and medium-technology industries make up the largest part of manufacturing industries in the OECD countries (Kaloudis, et al., 2005). The predominance of LMT industries is falling at a very slow rate (Kaloudis, et al., 2005). The behaviour of organisations within LMT industries acts as an indicator of the rate of investment in economy (Santamaria, Nieto, & Berge-Gil, 2009). LMT industries play an important role in employment; low- and medium-technology sector employs 60% of all manufacturing sector within EU15, whereas high-technology sector employs 10% (Hirsch-Kreinsen, 2008). Furthermore, LMT industries are also key users of innovation generated in HT industries (Santamaria, Nieto, & Berge-Gil, 2009). Although, HT industries are considered as key drivers for economic growth and productivity, and provide high value-added and well paid employment (Eurostat, 2017), the importance of LMT industries is undeniable.

LMT technology industries utilise different innovation processes and procedures compared to HT industries. Unlike HT industries, LMT industries rely heavily on informal R&D procedures for innovation initiatives (Santamaria, Nieto, & Berge-Gil, 2009). Organisations within LMT industries usually base their innovation processes around internal experimentation rather than latest technical or scientific knowledge (Bender & Laestedius, 2005). Because of the differences between the two industry categories it is important to understand whether innovation literature and the developed innovation strategies based on empirical data from HT industries can be applied, to what extent can the strategies be applied
and what those strategies truly mean for organisations operating in LMT industry sector. Furthermore, it is necessary to eliminate misconceptions and misleading assumptions regarding innovation strategies and processes suggesting that innovation related initiatives within low- and medium-technology industries are inherently homogeneous.

1.2. Problem discussion

Innovation has become a cornerstone of organisational development and existence (Birkinshaw, et al., 2011). Schumpeter (1939) defined innovation as ‘doing things differently in the realm of innovation.’ From a business perspective innovation concerns change related to products that an organisation produces or the processes designed to produce the products (Tidd et al., 2005). The scale or the degree of innovation is determined by the vastitude of knowledge required for different degree of innovation and vice versa (Enzing et al., 2011). Incremental innovation projects aiming to adapt, refine current products require lesser amount of new knowledge in comparison to radical innovation projects aiming to produce entirely new products production processes, or enter new markets (Benner & Tushman, 2003).

Innovation strategy takes into consideration various variables, such as resources available, internal capabilities, market trends, market stability, the forces within the business environment such as competitive forces etc. Innovation strategy directs the processes and the outputs of innovation projects within an organisation. The uniqueness or the perceived superiority of production outputs in comparison to competition creates competitive advantage (Kessler et al., 2000). Because of dynamic market environment innovation based on only scientific models is no longer sufficient (Rothwell, 1992). Innovation requires the participation of actors from inside and outside the firm which demands for higher level of integration (Teece et al., 1997). Innovation strategy, therefore, encapsulates accumulation and development of knowledge, assessment of external and internal business environments, understanding of business network and the role and the potential of the network in the innovation process.

Rothwell (1992) suggested that innovation models evolved from “First Generation innovation model”, which is a linear innovation model where innovation is science driven, to the “Fifth Generation innovation model” where interaction, cooperation and accumulation phenomenon involving actors from within and outside of the organisation requiring high level of integration of intra- and inter-firm levels (Teece et al., 1997). Rothwell’s (1992) “Fifth Generation Innovation model” requires the ability to integrate and combine external with internal knowledge. Hence, the management of organisational openness for innovation, identification of relevant knowledge and its accumulation have become key elements of an organisation instrumenting and directing innovation projects and their scale.

The way organisations innovate is changing (Birkinshaw et al., 2011). Innovation has a broader meaning relating to fundamental change in the value chain, business model, pricing plan, routes to the market, management routines, research focus etc., which indicates that innovation initiatives have become more complex demanding greater amount of knowledge needed to implement innovations. In order to tackle the challenges a number of scholars suggest a simultaneous use of open and closed innovation strategies (Botero, Vihavainen, & Karhu, 2009), some scholars propose implementing combination of open and exploitative innovation (Vrande, Jong, Vanhaverbeke & Rochemont, 2009).
It is presumed that because of the nature of low- and medium-technology (LMT) industries organisations operating under LMT industry category are primarily concerned with innovations related to the improvement of production efficiencies (Heidenreich, 2009). Further assumptions state that improvement of production efficiencies does not require the use of open innovation models (Heidenreich, 2009) suggesting that LMTs only participate in closed innovation initiatives. Such assumptions have already been challenged. Vanhaverbeke (2006) and van de Meer (2007) analysed organisations in mature industries in the Dutch market. Their findings indicated that the use of inbound open innovation was diffused but the adoption of outbound open innovation had serious barriers. A question, however, still remains whether open innovation paradigm and explorative innovation can be applied in the LMT industries (Drechsler & Natter, 2012). As increasingly dynamic market environment impacts high-technology industries (the suppliers of technology to LMT industries) (Chen, 2016) and the clients of LMT organisations (Hirsch-Kreinsen, 2008) forcing them to advance their innovations, it is unlikely that LMTs are not impacted in a similar manner demanding for more drastic innovation methods.

Many academic articles have been written about the benefits of open innovation and the advantage that explorative innovation has over exploitative innovation model, however, very limited research has been done analysing the applications and impact open, close, explorative and exploitative innovation or a combination of them in LMT industries (see appendix: A1- research gap, p. 78). The aim of the study is to increase the understanding in how LMTs innovate, which innovation strategies they select and what influences the selection of innovation strategy. The findings should help crystallise the understanding of innovation strategies in the LMT industry sector.

1.3. Purpose of the study

The purpose of this study is to understand which innovation strategies (open, closed, exploitative, explorative or a combination of these strategies) organisations under low- and medium technology industry category implement and how such innovation strategies impact the organisation. With the information of qualitative interviews and scientific literature, this study helps to understand how LMTs innovate, which innovation strategies they select and what influences the selection of innovation strategy. To be precise, this information is gathered in an “innovation strategy circle” which is developed by the authors of this study. The “innovation strategy circle” provides an overview of what it truly means for LMTs to implement particular innovation strategies.

1.4. Research question

The research question and sub question as listed below should be the main problem area, answer the purpose and aim of this thesis:

How organisations under low- and medium-technology industry category innovate and what is the impact of the chosen innovation strategy or a combination of innovation strategies on the organisation?
2 Theoretical framework

In this chapter, relevant literature for this Master’s Thesis is being analysed in order to provide a foundation for further empirical investigation. This analysis is structured in three main parts: knowledge based view, organisational openness, scale of innovation. The organisational openness and scale of innovation consist of the innovation strategies such as open, closed, explorative and exploitative. The literature provides various definitions and explanations of innovation types. The subsequent theory of the knowledge based view provides a greater understanding of the role of knowledge in an organisation and how knowledge and requirements for specific knowledge impacts innovation strategy choices.

Figure 1: The influence of knowledge

The graph explains the rationale behind the chosen theories and literature on knowledge and innovation strategies. The knowledge of decision makers instruments the choice of innovation strategies which influences organisational performance. Employee knowledge affects their performance which impacts the implementation of strategic choices. Our observation suggests just a few of many ways knowledge influences innovation strategies and innovation strategy implementation.
2.1. Knowledge based view

The subchapter ‘Knowledge based view’ (KBV) is structured in the parts management, structure and process. This part combines knowledge theory with innovation strategies and underlines their interdependence.

Accumulation of data since the 80s gave birth to knowledge-based, post-industrial economy, frequently referred to as the ‘new economy’ (Choo & Bontis, 2002). The role of knowledge in the business environment became of significant importance and could be compared to that of land in pre-industrial agrarian economy (Quinn, 1992; Drucker, 1993). Knowledge Based View (KBV) theory of a firm emanated from Resource Based View of the firm. The latter was used to explain how a firm manages its competitive advantage through the deployment of firm resources and capabilities while developing firm’s resource base for the future (de Stefano et al., 2016), whereas KBV emphasises the importance of knowledge.

According to Grant (1995, p.18) knowledge is:

1. “Knowledge is the key productive resource of the firm in terms of contribution to value added and strategic significance.”
2. “Knowledge comprises information, technology, knowhow, and skills. A critical distinction is between explicit knowledge that be articulated and therefore communicated, and tacit knowledge that is "personal" (Polanyi, 1962; cited in Grant, 1995) and more difficult to communicate.”
3. “Knowledge is acquired by individuals, and in the case of tacit knowledge is stored by individuals.”
4. “Because of the cognitive and time limitations of human beings, individuals must specialize in their acquisition of knowledge: increased depth of knowledge can normally only be attained through sacrificing breadth of knowledge.”
5. “Production (the creation of value through the transformation of inputs into output typically requires the application of knowledge.”

The assumptions that knowledge is the primary source of value and critical input in production are fundamental parts of KBV of the firm theory (de Castro et al., 2011). KBV of the firm theory extends beyond traditional concerns of strategic management and addresses other areas of the theory of the firm such as organisational structure, the role of the management, the allocation of the decision making, decision making rights, the theory of innovation etc. (Galende, 2006). Knowledge based approach investigates how organisations generate, acquire, integrate and transfer knowledge (Suarez, Perez, & Almeida, 2001).

KBV emphasises two core objectives for firms: (1) generate new knowledge and (2) apply the new knowledge (Chou, 2005). KBV advocates that the process of knowledge creation, integration, transfer and application have greater benefits than knowledge itself (Chou, 2005). The value of knowledge can only be realised when the knowledge is utilised and outputs related to that knowledge are produced.

2.1.1. Management

From KBV perspective the firm can be described by the range of knowledge that it integrates (de Castro et al., 2011). The capacity of knowledge utilisation within a firm can identified by matching the firms’ product and knowledge domains (Grant, 1995), therefore, it can be said that efficient knowledge utilisation is present where “knowledge domain of the
firm matches exactly the knowledge requirements of the product domain (p. 19)” without any knowledge underutilisation (Grant, 1995). Within contemporary organisations knowledge management is an essential activity to the success of the organisation (Chou, 2005).

Knowledge management strategies enable organisations to leverage information for achieving the desired business results. Human productivity is knowledge dependent (Subramaniam & Youndt, 2005). Knowledge production requires a structured approach (Escribano et al., 2009), in other words organisational design impacts how individuals and departments interact to each other. Chrysler, American Express, Shell’s deep sea exploration and many other organisations depends on the internal ability to leverage the knowledge of many individual specialists to generate new solutions (Grant, 1996).

From the strategy literature perspective the key role of a manager is to accumulate valuable knowledge or capabilities and protect them (Wernerfelt 1984). Therefore, management is responsible for developing and advancing organisational capacity through knowledge and new capability development (Nickerson & Zenger, 2004). However, it is not feasible for management to decide the kind of knowledge is required. Instead the management must identify valuable problems that would lead to identification of knowledge required to resolve those problems (Nickerson & Zenger, 2004). The objective while choosing a problem is to ensure that a high-value solution is discovered. Management needs to choose a problem with the best return on invested (ROI). The objective of identifying the problem that yields the best ROI is achieved through application of organisational mechanisms that govern search (Nickerson & Zenger, 2004).

Existing knowledge is required in to generate new knowledge (Subramaniam & Youndt, 2005). Without possessing specific knowledge related to a problem area that organisation is attempting to resolve it is challenging to develop an understanding of what additional information is needed. New knowledge generation often requires the involvement of different knowledge domains from different business areas as knowledge acquisition requires greater specialisation than its application (Grant, 1996). Production of new knowledge requires coordination of individual specialists possessing different kinds of knowledge (Escribano et al., 2009). Knowledge creation cannot be separated from knowledge application if knowledge is specific to a particular production team (Grant, 1996), therefore, the involvement of key individuals throughout the innovation process starting with knowledge generation to implementation is necessary.

Higher level management within the organisation need to know what kind of knowledge individuals within the organisation possess. Without the knowledge of what information is available the knowledge will not be transferred and utilised (Easterby-Smith & Lyles, 2011, p.384-391). Ability to transfer firm specific knowledge within the organisation is positively associated with higher levels of performance. According to Spender (1996), specific knowledge and the process of integrating relevant knowledge is difficult to imitate. Internal knowledge transfer internally sets the foundation for innovation and efficiency (Davenport & Prusak, 1998; cited in Suarez, Perez & Almeida, 2001). Grant (1995) proposed a primary knowledge mechanism comprising of two parts: (1) direction and (2) routine. Direction encapsulates established rules, guidelines and directives developed for other organisation members in order to integrate knowledge. Under direction tacit knowledge is codified into explicit knowledge. Organisational routines ensure interaction among specialists within organisation which allows knowledge integration (Grant, 1995). Such mechanism permits knowledge integration without extensive communication (Grant, 1995).


2.3.2. Structure

The knowledge heterogeneity is described as different kind of knowledge, know-hows and expertise which is located at an organisation and is available to the organization through its network partners. This knowledge from partners can influence the direction of R&D activities and, therefore affect the end product/result (Rindfleisch & Moorman, 2001) or as well further increase tolerance towards external knowledge and application of external technology (Spencer, 2003). An organization can gather heterogeneous knowledge and broaden its understanding by accessing various technology and knowledge areas from different partners (Wu & Shanley, 2009). Knowledge accumulation and dissemination requires structure (Kirschbaum, 2005) and certain pre-existing factors (Yilmaz et al, 2005).

Organisation require specific internal organisational structure in order to facilitate information and knowledge transfer (Hansen and Nohria, 2004) inside of an organisation and from outside-in, facilitating innovation. The internal reorganisation can be implemented in the following ways:

1. Facilitating low power distance cultures within an organisation (Yilmaz et al, 2005).
2. Facilitating organisational structures such as independent business units or cross-functional teams (Kirschbaum, 2005; Huston & Sakkab, 2006).
3. Establishing organisational roles such as champions or gatekeepers.
4. Facilitate knowledge management systems (Thierauf, 1999).

Power distance is an extent to which individuals within organisations understand that power in their organisational environment is distributed unequally (Hofstede, 2001; cited in Richardson & Smith, 2007). Organisations with high power distance normally contain hierarchical organisation structures where the power and decision making is located at the top of the organisation (Javidan et al., 2006). Employees at high power distance organisations expect direction from their leaders (Richardson, 2007). A high degree of power distance creates an environment with less employee participation (Newman & Nollen, 1996), increased reliance on rules and procedures and a high level of subordination (Van Oudenhover, 2001).

High power distance organisational cultures imply that organisational members complete their tasks and once they are complete they await for more instructions from the top. Such working approach creates a mind-set that is primarily focused on completing tasks in accordance to the required standards meaning that activities outside of the scope of the task could potentially improve efficiency are ignored (Yilmaz et al., 2001). This organisational setting creates an environment for innovation that only finds place at the top of the organisation. The key challenge becomes gathering the relevant data and transferring to the top of the organisational hierarchy for decision making. Employees focusing primarily on task completion may not identify new information as essential for supporting decision making and hence relevant information is unlikely be shared with the higher levels in the hierarchy to support strategic decisions (Yilmaz et al., 2001).

Higher level decisions are often made using lower level knowledge (Grant, 1996). For example, organisational decisions are made at the board level, however, the knowledge required to support those decisions rests at the sales department or other departments. Very often because of the immobile nature of the knowledge generated at the lower level of the organisational hierarchy, the decisions made at the top level of the organisational hierarchies
are impoverished because of the absence of key knowledge (Haak-Saheem & Darwish, 2014). According to de Vries (2006), willingness to share knowledge is also influenced by job satisfaction, performance beliefs, team members’ extraversion and employee agreeableness among other things.

Employees of organisations with low power distance are assumed to be more comfortable with voicing their opinion, take more ownership of their task performance and are more critical about their or the tasks that their peers are performing (Richardson, 2007). This indicates that employee feedback and knowledge share is greater than in high power distance (John, 2001). Within high power distance organisational cultures knowledge acquisition through exploration and generative learning (questioning long-held assumptions) is impeded, diffusion of knowledge within an organisation is limited (Slater & Narver, 1995). Therefore, high power distance organisational cultures limit organisational learning (Yilmaz et al, 2005). Organisations with low power distance are more innovative than high power distance organisational cultures (Shane, 1993). According to Shane (1992) within low power distance culture, management has a better overview of the skills and knowledge possessed by the employees within the organisation leading to a better utilisation of available resources.

A knowledge management system may provide the platform for management at the top to improve information and knowledge accumulation to support strategic decision making. A knowledge management system provides information which is essential for the development of competitive advantage of the organization, provided that organisational roles are established to synthesise the data. The knowledge management system contains different kinds of information including sales data, trends analysis and reports, historic and current data. This data allows decision makers to gain access to and understand, analyse patterns and trends quicker (Thierauf, 1991). Establishing organisational roles for knowledge could ease information flow outside of knowledge management systems. Champions are employees or consultants which help with the transition from closed to open innovation (Chesbrough & Crowther, 2006). Gatekeepers are responsible for the interface of the organisations internal and external environment (Tushman, 1977). Reward systems and incentives are also an effective way to incentivise knowledge accumulation and transfer (Chesbrough, 2003).

Organisational cultures and structures impact the ability and the capacity of organisational learning that may lead to the generation of new innovative solutions developed by an organisation creating a competitive advantage over competition. Knowledge management systems could potentially ease information flow in hierarchical organisational structures (Thierauf, 1991), however, organisational mind-set and the culture may have a stronger impact on organisational learning (Yilmaz et al., 2001) and innovation within organisations.

2.3.3. Processes

According to Suarez, Perez, & Almeida (2001) the availability of resources and capabilities does not guarantee success. It is the distinctive resources that a firm controls or carries out certain activities better than the competitor that guarantee success and contributes to defending the organisation in dynamic market environments.

Absorptive capacity has been identified as an important dynamic capability. Zahra & George (2002) provided a greater understanding in absorptive capacity suggesting that absorptive capacity is a multidimensional construct that affects different capabilities and routines at different times. Furthermore, Zahra and George (2002) introduced two subsets of
absorptive capacity: potential (receptiveness to external knowledge) and realised (capacity to leverage absorbed knowledge). Similarly, Arora and Gambardella (1994) emphasised the importance of being able to assess and exploit external knowledge.

Figure 2: Knowledge absorpt ion process

PAC allows organisations to assess external knowledge and identify the knowledge that is necessary for innovation (Zahra & George, 2002). RAC is concerned about absorbing and exploiting the knowledge to produce goods (Zahra & George, 2002). Absorptive capacity has four dimensions’ acquisition, assimilation, transformation and exploitation each allowing to explain how absorptive capacity can influence innovation process (Zahra & George, 2002):

- **Acquisition** – capability to find and identify relevant external information
- **Assimilation** – routines and processes for analysis and interpretation
- **Transformation** – ability to modify and adapt the information and combine it with existing knowledge
- **Exploitation** – ability to transform the knowledge into competitive advantage

Through the process outlined by Zahra & George (2002) knowledge is converted into tangible products. Organisational routines and processes need to be developed in order to acquire, assimilate, transform and exploit knowledge (Srivarhana & Pawloski, 2007). Cohen and Levinthal (2000) found that the level of absorptive capacity determines organisational performance with high absorptive capacity firms performing better than the ones with low absorptive capacity. Absorptive capacity also helps sustain competitive advantage. Competitive advantage is a condition that puts a business in a favourable position in comparison to their business competitors. Ability to merge internal and external information contributes towards competitive advantage (Rigby & Zook, 2002). Therefore, it is necessary for an organisation to be able to understand the value of external information, and assimilate the information in R&D projects (Kostopoulos, Papalexandris, Papchoroni & Ioannou, 2011). R&D activities vary in their contribution (Prahalad and Hamel, 1990). How this internal and
external knowledge is organised is vital for the success of the R&D processes (Kessler et al., 2001).

2.1. Organisational openness

In the following, open and closed innovation strategies will be discussed and subsequently compared in a table.

Open and closed innovation strategies carry both advantages and disadvantages that may have a positive and/or a negative impact on organisational performance and competitive advantage. Open approach to innovation may significantly reduce the costs of innovation activities and speed up innovation process through partnerships and collaboration (Cantista & Tylecote, 2008), however, may strip an organisation of their competitive advantage if sensitive information leaks exposing organisational secrets. Closed innovation may help protect organisational intellectual property (IP) (Drechsler & Natter, 2012), however, may also hinder an opportunity to identify new profitable ideas outside of the knowledge and capability scope held within an organisation.

2.1.1. Open innovation

Technological change in firm’s core market increases a firm’s degree of openness (Drechsler & Natter, 2012). Dynamic business environment forces organisations to look for new solutions to the challenges that emanate from such environment (Carrillo & Franza, 2006; Chesborough, 2003; Gridnley & Teece, 1997; Lichtenhaler, 2005). In a dynamic environment, many organisations are unlikely to have full range of knowledge requirements necessary to introduce new product in a timely and cost-effective manner.

Dynamic business environment throws new challenges at organisations across a multitude of industries changing the rules and requirements for innovation initiatives demanding for a more collaborative approach (Botero, Vihavainen, & Karhu, 2009). Only internally generated knowledge is no longer sufficient to achieve stable organisational performance in dynamic market environments. Under such circumstances innovation strategies promoting knowledge sync in-and-out of organisation such as open innovation model become an attractive innovation strategy option. Open innovation model was developed by Chesbrough after analysing innovation process of several companies (Botero, Vihavainen, & Karhu, 2009).

Open innovation in principle is a model of distributed innovation that leverages inflows and outflows of information accelerating accumulation of knowledge required for innovation initiatives (Botero, Vihavainen, & Karhu, 2009). As innovation management paradigm, open innovation is comprised of two dimensions: (i) outbound open innovation aiming to exploit technical knowledge commercially via established relationships with other organisations by sharing internally developed technologies and knowledge for profit and (ii) inbound open innovation which aims to establish relationships with external organisations in order to improve internal innovation performance by accessing their technical and scientific competences (Chiaroni, Chiesa, & Frattini, 2010). Lichenhalter et al., (2013) proposed a more holistic view of the open innovation dimensions by introducing four types of open innovation cultures: technology isolationists, sponges, fountains and brokers.
Lichenhalter’s et al. (2013) four open innovation cultures provide a better insight on how knowledge and technology was generated in the open innovation environment which provides an advanced understanding of organisational attitudes and objectives for open innovation.

Within an organisation open innovation initiatives may be pursued in multiple ways: (i) organisational form of acquisition or exploitation and consequent time horizon, (ii) number of partners such as traditional supply chain relationships to collaborations with universities, competitors, service companies, or firms operating in other industries (Chiesa & Manzini, 1998), (iii) exploitation of external sources during the stages of the innovation process (Gassman, 2006).

Empirical research shows that the implementation of open innovation requires extensive networks of inter-organisational relationships (Chiaroni et al., 2010). Network that lays foundation for innovation has two main characteristics: (1) search breadth which is a number of external search channels or sources that organisations rely on, and (2) search depth which indicates the extent to which organisations utilise internally the resources from different external sources or search channels (Chiaroni et al., 2010). By controlling both of the characteristics firms can implement inbound open innovation. Network, especially the one where managers in charge of R&D engage in, allow organisations to access valuable external technologies and information. Open outbound innovation mechanism should be designed with intellectual property in mind, ensuring its protection (Chesbrough & Crowther, 2006).

Supply chain network is important for increasing innovation and R&D effectiveness (Cantista & Tylecote, 2008). Organisations have many partners within their supply chain, however, the ability to understand how to operate in chain-like structures determines the success of innovation initiatives (Tottie & Lager, 1995). Supplier-customer relationship is critical to innovation initiatives as depending on the relationship the supplier can get the required input from the customer in the development project (Leifer, 2000) and allows the supplier to better understand the customer’s needs which aids in developing new ideas.
Theoretical framework

(Biemans, 1991) and reducing risks (Gemuender et al., 1992). Furthermore, developing a network of competencies ensures an organisation is keeping pace with latest technologies and knowledge that help identify and take advantage of new opportunities (Chiesa et al., 2004).

Opening up innovation may lead to advanced innovation strategies through acquisition of new technology or knowledge that previously was not available (Cassiman & Veugelers, 2006) allowing to reduce financial and labour time required for the implementation of a particular innovation. Although open innovation is beneficial in many ways organisations within certain industries utilise innovation strategies contrary to open (Cohen, Nelson, & Walsh, 2000). Decision to maintain a level of ‘closedness’ are normally influenced by several factors including fears of losing intellectual property (IP) (Chesbrough & Crowther, 2006) and inability to identify valuable and appropriate partners to work with (Drechsler & Natter, 2012).

2.1.2. Closed innovation

Unlike open innovation, in the closed innovation model information for innovation is generated internally within an organisation, even if it causes additional costs or inflexibility (Lindman, 2002). Lindman’s (2002) research indicated that closed innovation strategies for innovation initiatives can be sufficient and provide stability under certain conditions:

1. Being able to make changes to the core product, to extend the scope of application of core technology at low costs. Furthermore, being able to identify new market opportunities and enter those markets with existing products where competition is low.

2. When a firm possess large accumulative knowledge base around a mature technology and is able to extend the scope of application of the technology in a way that specifically reflects customers’ needs. Innovation initiative is based around the search of new product applications which is done internally. Under these circumstances present technology scope directs the future product development efforts.

3. Under circumstances where an organisation producing specialised product highly depends on very few customers. As only the firm understands highly specialised product and customer needs, the product is strictly made in-house.

4. When product technology itself defines the application scope. Only related application areas outside the core business can be targeted. As a result, minimal changes are made during product development efforts. If cooperation between the client and the supplier exists, it only takes place in the area of practical engineering.

Research by Drechsler & Natter (2012) uncovered two major reasons why firms within various industries continued following closed innovation model. First, firms with knowledge gaps were not open to innovation because they did not have the expertise to assess innovation opportunities nor the capabilities needed to internalise external knowledge. The organisation was either unattractive to potential collaborators due to lack of expertise or the organisation itself was not able to identify potential collaborators (Drechsler & Natter, 2012). The second reason for remaining closed was organisations fears over loss or intellectual property and competitive advantage (ibid.). During periods of high competitive threats, fear
over loss of intellectual property, firms tend to reduce their level of openness (ibid). To sustain competitive advantage and overcome competitive threats organisations aim to introduce new products (Carillo & Franzia, 2006). Although competition fosters innovation (Fuentesaz, Gomez, & Polo, 2003; Kimberly & Evanisko, 1981), the environment presents higher risks related to IP which signals for organisations to reduce the degree of cooperation. Chiaroni et al., (2010) findings indicated that closed innovation model was also implemented in organisations where customers had relatively low demand for product innovation and weak competition. The findings also uncovered that R&D was carried out in a very unstructured way in organisations that implemented closed innovation model (Chiaroni et al., 2010).

Organisations that implemented closed innovation strategies lacked long-term planning (Lindman, 2002). Instead of using specific and predefined innovation strategies, these organisations relied on (1) management experience and knowledge focusing on responding to changes in external circumstances (ibid.); (2) plans produced at the top management level; (3) taking into consideration only the learnings from previous innovation efforts (ibid.).

In the following, a table with a summary of open and closed innovation is given in order to emphasise on the main differences. This confrontation consists of the organisation’s internal perception and objectives concerning their innovation strategy.

<table>
<thead>
<tr>
<th>Open innovation</th>
<th>Closed innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “Not all of the smart people work for us”, therefore, it is essential to find relevant individuals outside of the organisation and tap into their knowledge and expertise (Botero, Vihavainen &amp; Karhu, 2009)</td>
<td>- The smart people work internally (Botero, Vihavainen &amp; Karhu, 2009)</td>
</tr>
<tr>
<td>- External R&amp;D add significant value and compliments internal R&amp;D initiatives (Botero, Vihavainen &amp; Karhu, 2009)</td>
<td>- R&amp;D should be done internally from discovery, development to distribution (Botero, Vihavainen &amp; Karhu, 2009)</td>
</tr>
<tr>
<td>- Research does not have to be originated internally to benefit from it (Botero, Vihavainen &amp; Karhu, 2009)</td>
<td>- Being the first one to discover new products will allow to profit from the first movers advantage in the market (Botero, Vihavainen &amp; Karhu, 2009)</td>
</tr>
<tr>
<td>- Building a solid business model is more important than getting to market first (Botero, Vihavainen &amp; Karhu, 2009)</td>
<td>- It is essential to be the first ones to commercialise an invention to achieve organisational performance objectives (Botero, Vihavainen &amp; Karhu, 2009)</td>
</tr>
</tbody>
</table>
- The use of internal and external ideas will help achieve goals in a more efficient manner (Botero, Vihavainen & Karhu, 2009)
- Generating the most and the best ideas internally will help outperform competition (Botero, Vihavainen & Karhu, 2009)

- Intellectual property should be a source of profit and, therefore, should be shared for fees; purchase of external IP should implement whenever it advances our own IP (Botero, Vihavainen & Karhu, 2009)
- IP should be carefully controlled so the competition could not profit from it (Botero, Vihavainen & Karhu, 2009)

- High need for collaboration with external organisations for innovation purposes (Elmquist, et al., 2009)
- Network involvement in innovation process is limited (Elmquist, et al., 2009)

(Source: Botero, Vihavainen & Karhu, 2009)

2.2. Scale of innovation

The chapter ‘Scale of innovation is structured’ in the parts exploitative innovation and explorative innovation which are compared at the end of this section.

External environmental factors impact the effectiveness of innovation types (Zahra, 1996; Zahra and Bogner, 1996; Jansen, et al., 2006). Competitiveness in the market and market dynamics affect the choice of innovation type (exploitative or explorative) and performance (Levinthal & March, 1993). Environmental dynamism is the degree of environmental instability and the rate of change of the environment (Dess & Beard, 1984) whereas environmental competitiveness is the extent of competitive intensity within the business environment (Matusik & Hill, 1998) which is often associated with pressures for higher efficiency and lower prices (Matusik & Hill, 1998). Organisations that pursue exploratory innovation in more dynamic environments increase their financial performance by developing new products, services and entering new markets (Jansen, et al., 2006), which eliminates the threat of obsolescence of knowledge and other capabilities. According to the findings by Jansen et al., (2006) the use of exploitative innovation has a negative effect on financial performance under the same market conditions. Both of the innovation types are knowledge intensive activities (Jansen, Bosch & Volberda; 2005).

2.2.1. Exploitative innovation

Exploitative innovation is incremental innovation that focuses on the modification of existing knowledge (March, 1991). The main objectives for exploitative innovation are refinement, efficiency, implementation, execution (Park & Kim, 2015), improvement of established designs, expansion of existing products and services or the increase of productivity in existing distribution channels (Abernathy & Clark, 1895). The key purpose of exploitative innovation is to strengthen current technologies and capabilities to satisfy the needs of existing customers and markets (Jansen, Van Den Bosch, & Volberda, 2006). Therefore, key activities related to exploitative innovation are to refine and extend existing knowledge (Benner & Tuschman, 2003). Because of the nature of exploitative innovation, continuous exploitative innovation is less complex to implement, requiring standardised routines and processes for new knowledge and capability generation (March, 1991) through
organisational learning via single-loop learning, low level learning, first-level learning and so on (Kim & Park, 2015).

As exploitative innovation only requires the advancement of existing knowledge, the implementation of exploitative innovation initiatives do not require a substantial amount of time to develop (March, 1991). Furthermore, exploitative innovation provides stability and reduces organisational uncertainty (Jansen et al, 2006). Through application of exploitative innovation organisations can improve operational efficiencies through cost reduction and product improvement which in return increases firm reliability and accountability in the eyes of the existing customers and markets (Hannan & Freeman, 1984). Overall exploitative innovation generates less uncertainty, however, it also limits the scope of newness (Gopalakrishnan & Damanpour, 1994).

Although organisations achieve good performance via the implementation of exploitative innovation, in an event where business environment becomes highly unpredictable, hyper competitive (increasingly dynamic) excessive use of exploitative innovation may become a ‘self-destructive trap’ in a long-term perspective (March, 1991) which manifest in a form of lack of knowledge and capabilities to respond environmental threats. Furthermore, within industries that are in decline some organisations continue pursuing exploitative innovation by improving and extending existing products (Leonard-Baron, 1992) in a most likely attempt to win over market share from the competition. Organisations pursuing this strategy may find themselves trapped in an endless existing product innovation cycle (Levinthal & March, 1993) potentially decreasing margins (Jansen, et al., 2006). Therefore, the ability to learn new cognitive frameworks, discovering new niches (Lant & Mezias, 1992) becomes an essential part of organisational operations allowing to identify future threats (Kim & Park, 2015) identify solutions to ensure the survival of the organisation, and perhaps pave the way for exploratory innovation which may become a necessity to generate profits during long periods of competitive rivalry (Levinthal & March, 1993).

2.2.2. Explorative innovation

Explorative innovation is a radical type of innovation designed to meet the needs of new customers and markets (Benner & Tushman, 2003). Explorative innovation offers the generation of new designs, ability to create new markets, develop new distribution channels etc. (Abernathy & Clark, 1985). Exploratory innovation makes existing knowledge and established routines redundant (March, 1991) or requires departure from existing knowledge (Brenner & Tushman, 2002) for existing knowledge may no longer be sufficient to address or identify potential challenges and opportunities. Disruptive innovation is very important as it brings to markets new products along with different value proposition introducing cheaper, easier to use and simpler products (Park & Kim, 2015).

Explorative innovation requires a wide scope of search in order generate knowledge and potential solutions to resolve new challenges in markets that have not previously been served (Katila & Ahuja, 2002). It demands for extensive search, variation, risk taking, experimentation and discovery of new solutions or new opportunities (Park & Kim, 2015). It is particularly required when an organisation attempts to enter new emerging markets or serve the needs of new customers through development of new technologies or capabilities (Benner & Tushman, 2003). Because of the nature and the requirements of new knowledge and capabilities explorative innovation is implemented on a much larger magnitude and requires more time for its delivery (March, 1991). The standard operating procedures that had
been previously established to cater for exploitative innovation do not have the capacity to generate multiple interpretations of available information and various problem solutions (Keck & Tushman, 1993). Intensive organisational learning becomes one of the central requirements to implement explorative innovation. Such learning may take place through different or a combination of learning processes and models such as meta-level learning, double-loop learning, automatic cognitive processing (Park & Kim, 2015) to name a few. Benner and Tushman (2003) suggested that organisation seeking to implement exploratory innovation should look outside existing knowledge structure.

Explorative innovation may be resource demanding, requiring large financial investments to develop new knowledge and capabilities to achieve the set objectives (Jansen et al., 2006). Within high competitive environment large financial investments required to implement explorative innovation may not be readily available meaning that organisation may look for financing elsewhere.

Numerous authors in the area of innovation argued that organisations need to be ambidextrous (Gibson & Birkinshaw, 2004; He and Wong, 2004) and implement both types of innovation simultaneously (Benner and Tushman, 2003), however, more needs to be understood on how explorative and exploitative innovation may be implemented simultaneously (Jansen et al., 2006) as both of these types of innovation demand for different procedures to gather, integrate, amend and apply new knowledge.

Typical challenges companies face when trying to combine explorative and exploitative innovation are the following: resource distribution problems, influence of dominant designs and the dominance of exploitation learning (Giller et al., 2010). Furthermore, research studies usually apply exploitation management tools on exploration projects. Those tools are based on cost-quality-delay principles and therefore do not match exploration projects. experts refer to the more fitting innovation-field management tools for research concerning explorative innovation (Giller et al., 2010).

A relative imbalance of those two innovation strategies can lead to a negative sales development. Their findings showed that bi-manual organisational design should be practiced. Furthermore, concrete practical managerial recommendations have been created as follows. Senior managers need to be aware of how to distribute resources between innovation types. This goes in line with creating new metrics to rank resource distribution and benchmark the performance of innovation.

A framework of how metrics under evaluation could look like, can be seen in the following eight measurement points. Those points are objectives on which the focus was in the researched technological industries over a time period of three years. In this list, the first four points are rather vital for explorative innovation, whereas the last four points are essential for exploitative innovation (He & Wong, 2004):

- Introduce new generation of products (explorative)
- Extend product range (explorative)
- Open up new markets (explorative)
- Enter new technology fields (explorative)
- Improve existing product quality (exploitative)
- Improve production flexibility (exploitative)
- Reduce production cost (exploitative)
In practice, exploitative and explorative innovation ambidexterity requires the management of imbalances between exploitative and explorative innovation on a regular basis. For example, to establish capabilities out of adverse areas in order to create competitive advantages (He & Wong, 2004).

In the following, a table with an overview of explorative and exploitative innovation is given in order to emphasise on the main differences. This confrontation consists of the organisation’s internal perception and objectives concerning their innovation strategy.

**Table 2: Explorative innovation and exploitative innovation**

<table>
<thead>
<tr>
<th>Explorative innovation</th>
<th>Exploitative innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Radical innovation (Zhou &amp; Wu, 2009).</td>
<td>- Incremental innovation (March, 1991)</td>
</tr>
<tr>
<td>- Focus on developing completely new products or entering new markets (Aloini &amp; Martini, 2013).</td>
<td>- Focus for improving current products for current customers (Zhou &amp; Wu, 2009)</td>
</tr>
<tr>
<td>- Current knowledge is made redundant because of the nature of innovation (Greve, 2007).</td>
<td>- High reliance on current knowledge and capabilities and refinement of them (March, 1991)</td>
</tr>
<tr>
<td>- Substantial amount of new knowledge and capabilities is required (Karamanos, 2012)</td>
<td>- New knowledge updating/extending current knowledge and capabilities for the purpose of extending current product capabilities (Zhou &amp; Wu, 2009)</td>
</tr>
<tr>
<td>- The involvement of individuals from outside of the organisation with new knowledge and capabilities is essential (Benner &amp; Tushman, 2003)</td>
<td>- The involvement of individuals from outside of the organisation is beneficial but not essential (Benner &amp; Tushman, 2003)</td>
</tr>
<tr>
<td>- Organisational learning requirements: Double-loop learning, meta-level learning, deviation-amplifying adaption, automatic cognitive processing and second-order learning (Park &amp; Kim, 2013)</td>
<td>- Organisational learning requirements: Single-loop, low-level learning, deviation-reducing adaption, conscious cognitive processing, and first-order learning (Park &amp; Kim, 2013)</td>
</tr>
</tbody>
</table>

(Source: own construct.)
2.3. Analysis method

In the analysis method, the way of analysing and structuring the empirical data is being described.

Analysis model presents the flow and the key aspects considered within this Master’s thesis project. The process is composed of three parts: existing theory, theoretical development and findings. By analysing existing theory and literature on innovation strategies we have developed an ‘Innovation mechanism’ which comprises of knowledge, managements control, scale of innovations, innovation openness and network. Within the Analysis and discussions part only 5.1. Knowledge, 5.2. Openness and 5.3. Scale of innovation will be explicitly discussed as the Master’s Thesis concerns innovation strategies such as open, closed, exploitative and explorative. The listed strategies rely heavily on knowledge. Management control and network will be reappearing themes throughout the discussion.

Figure 4: Analysis model

The arrows within the box show how the ‘Innovation mechanism’ parts interrelate. By combing the literature on areas research areas listed in the ‘Existing literature’ section we will draw conclusion allowing to answer the research question.
Based on theoretical literature (see Figure 4) “Innovation strategy circle” (Figure 5), was developed enabling the authors to visually position the assessed organisations to provide a visual depiction of key differences and similarities among the assessed organisations helping the authors draw conclusions with regards to what it truly means for LMTs to implement a particular combination of innovation strategies.

The “Innovation strategy circle” is developed using literature on open, closed, exploitative and explorative innovation. Innovation cultures (Lichenhalter et al., 2013) and open innovation dimensiona (Chiaroni, Chiesa, & Frattini, 2010) were used to understand the direction of knowledge and technology absorption. After empirical data analysis, the authors decided to add an additional innovation culture called “followers”. In our thesis “followers” are the organisations that mainly rely on client information for innovation projects. Isolationists use their own internal and internal expertise and knowledge that they generated. Sponges are searching for external knowledge, market trends and data for innovation purposes. Fountains transfer their technological knowledge through licencing to other companies without the use of external knowledge. Brokers operate in an open collaboration with their partners and therefore implement innovation quicker than they would do it alone (Lichenhalter et al., 2013).

The innovation strategy circle is used as a framework to structure and classify the found empirical data. In the analysis, the innovation strategy circle will be filled with empirical information.
In this chapter, the scientific approach is being described in order to provide an understanding of the emergence of this master’s thesis. This thesis is based on critical rationalism and written accordingly. All findings are results of the deduction of the authors of this thesis and the authors which were cited. The goal of this documents is to answer the research question (Berger, 2010, p. 10-15). This chapter is structured in three parts, the description of the research process, trustworthiness and research ethics.

In the figure 6 below, the “research onion” from Saunders et al. (2012, p. 126-160) is presented. This provides a structure of the methodological choices of this thesis. Subsequently, each layer of the “research onion” will be discussed chapter wise.

Figure 6: Research onion

(Source: Saunders et al., 2012; modified by the authors of this thesis)

3.1. Research approach

According to literature, there are three basic types of scientific, logical reasoning: deduction, induction and abduction (Aliseda, 2006, p. 56).

Deduction: Theory → Empiricism
Induction: Theory ← Empiricism
Abduction: Theory ↔ Empiricism

The inductive approach researches first the empirical data such as observations and findings and then concludes to the theory. This means that theory is the outcome of research.
However, the demarcation is not always defined strictly and approaches can overlap, especially when additional empirical data is gathered in a second round (Bryman & Bell, 2015, p.25). Inductive approach to the research could not be used for the study as the authors needed to develop a better understanding in the area of innovation strategies in order to identify and collect the key data to fulfil the purpose of the study.

To collect the literature in advance and afterwards conduct interviews as in deductive approaches, shows the advantage of asking specific questions in complex areas. This provides a start in the subject matter and helps the authors to create an analytical framework in advance. With the information from scientific literature and case studies, main variables, components, themes and issues are being identified for the future framework. This is used to create an explanatory framework and direct the analysis of the empirical data (Saunders et al., 2009, p. 489-495). In the process of writing this master thesis and collecting empirical data, the authors noticed that they need to develop their theoretical framework further since not all of the gathered empirical information could be explained with the current literature findings.

The authors decided to undertake an abductive approach. This approach offers assumptions of the subject matter which need to be validated empirically. It further allowed the authors to get an in-depth insight into the subject of this thesis and therefore ask the right questions when conducting the interviews. However, the researched theory has no claim to completeness or verity. Observations are being explained and might be disproved when additional information is available. Since the borderlines between abduction and induction are narrow, the definition of abduction fits best the research model of this thesis. Additional theoretical and empirical information is collected on a regular basis during the entire process of writing (Aliseda, 2006, p. 56). The authors of the paper understood that new empirical data may uncover facts relevant to the study that had not been previously considered, therefore, requiring the authors to conduct additional research in order to support the findings or the assumptions made during data analysis. As a result, abductive approach to research was chosen for the study.

3.2. Research strategy

The authors of this thesis conducted an exploratory empirical research study. Exploratory studies allow to ask open questions and explore processes and get information about the topic of interest (Saunders et al., 2012, p.171). The way of undertaking the exploratory research which the authors choose is interviewing relevant employees of the organisations that were selected for the study. Therefore, the authors have strategically selected relevant individuals to be interviewed at organisations that were used for the study. As the research question is “How do organisations under low- and medium-technology industry category innovate and what is the impact the chosen innovation strategy or a combination of innovation strategies has on the organisation?” and the purpose of the study is “to investigate which innovation strategies (open, closed, exploitative, explorative or a combination of these strategies) organisations under low- and medium technology industry implement and how such innovation strategies impact the organisation” exploratory research was an appropriate choice for the study. Another reason for choosing exploratory research for the study was the assumptions that the direction of the study might be influenced by the acquisition of new data, exploratory research is flexible and can change if needed during the process (Saunders et al., 2012, p.171). As the subject of innovation in LMTs is industry and company specific, the authors considered experts as individuals holding roles related to innovation management within the firm and board level executives. The flexible nature of
exploratory research gave the authors of this study the possibility to adapt if new directions was required.

3.2.1. Case selection

Case selection is a vital factor of the success of an academic research and cases need to be chosen carefully in accordance to answer the research question (Oehlrich, 2014, p.115-123). Therefore, the organisations presented and analysed in this study are in accordance with the area of investigation. Therefore, the authors of this thesis have created the following selection criteria for the analysed companies: the companies have to be manufacturing organisations that operate under low- and medium-technology industry category, are currently active and not facing bankruptcy, are based in Western European. According to Heidenreich (2009) and the European Community Innovation Survey (CIS, 2014) low- and medium technology manufacturers in Western European countries show similarities in fields such as processes, organisational and marketing innovations and internal innovation capabilities. In order to gain a general overview of LMTs the authors decided to take a broad range of potential respondents in terms of their size, markets operated in (domestic or international), various industries. The objective was to capture potential differences among these organisations and finds similarities – independent variables influencing the choice of innovation strategies.

3.3. Research method

The question of the fitting research method, quantitative or qualitative, depends on the studied subject. Quantitative data is mostly used to collect numeric data and answers the research question within a defined framework. Qualitative data creates not numeric data but individual declarations (Saunders et al., 2009, p. 413-433). As this thesis undertakes exploratory research with the purpose to analyse how innovation strategies are implemented by LMTs, qualitative research was a more befitting research method for this study. The authors decided to conduct semi-structured interviews (see appendix A2 – interview guide, p. 83) in order to be able to analyse the topic of innovation from various perspectives and providing the authors with rich data potentially uncovering additional information enriching the study findings.

3.4. Data collection

The data collection and availability of data is crucial for the success of a research (Collis & Hussey, 2003). In a scientific research, it is vital to regard the research topic from various perspectives and sources (Myers, 2013). In order analyse the research topic scientifically, a review of current literature and an empirical investigation is undertaken and explained in the subsequent chapters.

3.4.1. Literature review

The basis of this thesis consists of a review of current academic literature which focuses on the chosen topic of innovation and variations of innovation. The authors identified relevant literature allowing the authors to develop a greater understanding in the topic of innovation which enabled the authors to assess empirical data with a greater precision and objectivity. The literature areas that were relevant for the study were “knowledge based view”, “organisational openness” and “scale of innovation” also known as type of innovation referring to exploitative and explorative innovation. All sources are cited accordingly in order
to provide traceability tractability. The literature is researched in academic online journals and university’s library. This theory provides a basis and guidance for the empirical data. According to Saunders et al. (2012, p.66-75) there are two main objectives for reviewing literature. The first objective is that the authors need to develop the idea of the research topic further and define it. The second objective is that the authors critically review the literature. As a result the authors were able to show awareness of studies which have been undertaken, their limitations and highlight the contribution of the study which will be undertaken.

The authors conducted online search to investigate whether similar articles with a similar purpose had been written. The authors found 30 articles on LMT innovation, however, none of them explicitly focused on open, closed, exploitative or explorative innovation for LMTs (see appendix: A1- research gap, p. 78).

3.4.2. Empirical data

Two ways of gathering empirical data have been conducted. First, semi-structured interviews were held with the organisations. Second, online research was conducted in order to compare the information gathered from the interviewed organisations against external sources. This approach allowed the authors of the paper to verify statements made by the respondents and potentially identify additional information needed from the interview respondents.

The empirical data was gathered by the authors in order to contribute to the literature on innovation within LMTs. The choice of data collection and analysis methods may impact the accuracy of the results (Myers, 2013). Qualitative, semi-structured interviews allowed the authors to capture a wider range of information than initially planned for. It was one of the authors objectives to enable the author to discover relevant information for the study that may have not been considered before gathering the data. Furthermore, semi-structured interviews allowed to collect richer data for the study (Saunders et al., 2012, p.248, p. 544-577).

The interviewed individuals held various positions in the organisations. Some of the interviewed personnel included C-level executives, heads of departments, and individual holding roles related to innovation management and execution. The authors of this study communicated the purpose of this study and the business areas that the authors would like to discuss with the respondents. The positions of the interviewed individuals are provided in Table 3 below.

<table>
<thead>
<tr>
<th>Company</th>
<th>Industry</th>
<th>Headquarter Location</th>
<th>Position</th>
<th>Tenure</th>
<th>Data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Foil and laminates for packaging printers</td>
<td>United Kingdom</td>
<td>CEO</td>
<td>3 years</td>
<td>Telephone</td>
</tr>
<tr>
<td></td>
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<td>VP Technology and Product</td>
<td>7 years</td>
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<td>B</td>
<td>Windows</td>
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<td>Junior CEO (collaboration in 1 year (6 years))</td>
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The majority of interviews were conducted face-to-face. Face-to-face interviews have the advantage of reading gestures and mimics of the respondent. The authors of this study considered face-to-face as the most beneficial type of interview and, therefore, implemented face-to-face semi-structured interviews whenever the circumstances allowed. Two of the eight interviews were conducted via the telephone. According to Holbrook (2003), interviews via the telephone may be easier to arrange. The shortcoming of telephone interviews is no visibility of the person, therefore, the respondent’s body language cannot be registered and interpreted. The authors of this study were aware of the drawbacks of interviews via the telephone and paid specific attention to the respondents’ tone of voice and expressions in order to compensate for the absence of visual information.

The companies which were analysed range in employee number from 24 up to 50,000 worldwide (See Table 3: overview conducted interviews, for differences among the cases). The headquarters of the companies are located in Western Europe: Austria, Great Britain, Switzerland and Sweden. Some of the assessed organisations serve both domestic and international markets. The authors of the study wanted to assess innovation strategies of LMTs operating under different settings in order to gain a general overview and a deeper understanding of various factors impacting strategic innovation choices. One of the most important requirements for the organisations assessed was the location of headquarters within Western European countries. According to Heidenreich (2009) and the European Community Innovation Survey (CIS, 2014) LMTs within Western European countries face similar environmental pressures.

All interviews were conducted with a guideline which has been developed by the authors of this thesis in accordance to the literature findings. This interview guideline consists of nine main research themes. The nine interview themes are listed and explanations why the themes were selected are provided below.

- **Innovation process**: this topic aims for understanding innovation from idea generation to implementation. Accordingly, ideas, research, plan, prototype and the launch of the product is investigated.
- **R&D**: the type of R&D (scientific or engineering), the number of individuals involved and their responsibilities, and the involvement of other network parties in the R&D process were investigated.
- **Network**: the involvement of network partners in the exchange of information, and collaborative projects with an objective to innovate.
- **Organizational learning**: this topic investigates the knowledge management and transfer across an organization.
- **Organizational structure**: this point asks about the structure of the workforce of the organization and presence of organisational hierarchies.
• **Organizational culture**: leadership style, general attitude and collaborations inside the organization are being researched.

• **Marketing**: this topic deals with marketing initiatives. Marketing activities indicated the situation in respondents’ respective markets and reasons for specific marketing activities.

• **Growth and organizational development**: the aim is to analyse historical data and possible changes in the innovation strategy.

• **Past experiences and challenges regarding innovation**: the authors want to know what the main development challenges and problems internal or external have been so far. This information was requested to provide an understanding how the selected organisations responded to challenges faced and what strategies were used to eliminate the challenges.

The authors attempted to contact the relevant people using social media platforms such as LinkedIn. The authors also used contact details provided on relevant company’s website. However, strategies mentioned previously showed below average results as response time was lengthy and success rate was low. The authors also utilised their personal network to get in touch with relevant personnel working at the organisation of interest for the study. Utilising personal network contacts proved to produce the best results.

The primary data collected was complimented with online research and was called “Supplementary research”. The reason for including online research was to compare with and verify the information provided by the individuals interviewed. The data collected through the interviews appeared to be consistent with the data collected from the online sources. In one of the cases the online information source managed by the responding organisation, slightly exaggerated business network involvement in the innovation processes. The online research findings were added to the empirical data section and placed in the sections for corresponding case studies under subheading “observation of external appearance.”

### 3.5. Data analysis

The data gathered was structured in accordance to the interview guide (see appendix A2 – interview guide, p. 83). The interview guide was based on the learnings from innovation literature research. The authors of the paper built a table of case summary providing key differences between the companies assessed in order to show the key differences between the organisations assessed, that the reader might consider important. First, the authors implemented a within-case analysis and afterwards a cross-case analysis of the gathered empirical data. The within-case analysis provides detailed primary data allowing the author to gain a better overview of each case. The authors chose the cross-case analysis as it allows to identify key similarities and differences among the cases analysed (Ayres et al., 2003).

### 3.6. Credibility

Therefore, the following measures were taken in consideration to avoid misunderstandings or personal biases. First, data about the organization was gathered directly from relevant personnel of each organisation. Second, during the interview the interviewers would verbally summarise the information provided by the respondents and ask for verification. Third, the authors conducted additional online research to verify the consistency of the information provided by the interview respondents. The interviews were recorded by using a notepad and a pen for note taking and using an audio recorder for further analysis.
The authors discussed the data to ensure all relevant information was extracted from the interviews and supplementary online research.

3.6. Reliability

Reliability defines if the data collection practices and analytical processes would output unitary findings if reproduced on other occasions or by other researchers (Saunders et al., 2012). Inconsistencies can occur from either respondent or researcher misapprehension. The misapprehension can be deliberate or undeliberate on both sides. Examples for respondent misapprehension can be inappropriate interview settings where the respondent cannot or does not want to answer freely. Misapprehension from researcher point of view can be that the researcher is tiered or not prepared enough to understand the answers of the respondent and therefore interprets them differently (Saunders et al., 2012, p.192). Respondents are more likely to answer questions freely if the “subjective human experience” is positive. Therefore, the researchers aimed for a professional and positive relationship with the respondents (Krefting, 1991).

The authors of this study ensured collaboration and openness of the respondents with the following steps. The authors emailed details about the study focus, the information required and the potential outcomes of the study to the respondents. Each time before the interview was arranged, the interview guide was shared with the respondents in advance and time was given for the respondents to prepare for the interview. The interviews were conducted in an environment that the interviewed individuals felt most comfortable. In the case of this study, 6 out of 8 face-to-face interviews were conducted at the headquarters of the organisations being assessed. The authors decided that the most suitable location choice for face-to-face interviews would be the headquarters of the selected companies. Before starting the interview, the interviewers verbally introduced the study, the purpose of the study, the aims of the study and where and how the findings would be used. The interviewed individuals were asked for permission to audio record the interviews. Finally, both parties agreed that the data gathered would be anonymised and the ‘original’ data containing details about each respondent would not be shared publically. These actions according to Saunders et al. (2012, p. 190-196) and Krefting (1991) would help establish trust allowing the interviewed organisations to speak openly.

3.7. Validity

Three types of validity are identified by Saunders et al. Saunders et al. (2012, p.188-202). Those types are construct validity, internal validity and external validity. Construct validity examines if the research measures what it planned to measure and is being applied at quantitative researches. Internal validity is given when two variables, such as theoretical data and empirical data, are in a causal relationship. The authors of this study assured internal validity by basing the interview guideline on theory from the literature review and by conducting an abductive research approach where theory and empirics stand in constant consultation with each other (Saunders et al., 2012, p. 193 & Aliseda, 2006, p. 56). External validity assures that the study’s research findings can be generalised. This means that the study’s outcome is a representative sample of the researched population (Bryman & Bell, 2015, p.51). To provide a general applicable research, the authors of this study examine a broad range of representatives of LMT companies in Europe. The generalisation was developed by analysing the theories of innovation strategies and knowledge and generating new concepts and theory out of that information. In the following step, the authors used the
empirical data to validate the developed theories. Finally, the theory and the empirical data was merged in order to create new findings about the innovation strategies of LMTs. It can be concluded that the findings of this study are not related to a specific company but in fact are related to the general innovation strategies of LMTs. The interviewed companies have their headquarters in different Western European countries. In semi-structured interviews, validity can be improved by providing clear questions, verify meanings and explore responses at any time (Saunders et al., 2012, p.384). For the authors of this thesis, the previously mentioned characteristics were given and made use of at all conducted interviews.

The authors of this study ensured to formulate questions appropriately in order to ensure the most a valid answer was retrieved. According to McDaniel et al (1994) interview validity is higher when the person conducting the interviews uses situational, job related questions, therefore, the questions asked were situational, asking the respondent to describe particular situations, rather than asking questions leading to “yes” or “no” responses. The interview was structured in a way that would allow the respondent to sustain a track of thought and also enable the interviewed to obtain verification during the interview through a form of related questions of which the answers would signify the consistency in the story and responses provided by the respondents. The personnel to be interviewed was chosen based on a criterion of which the main criteria was ability to obtain a holistic overview of the entire organisational or innovation initiatives, therefore, the relevant personnel that the authors contacted were individuals holding CEO, board level positions or department heads responsible for innovation. If the respondent was not a CEO or the head of the department the third option to qualify for the right interview candidate was an individual with technical knowledge, individual involved in innovation process on a continuous basis. The interviewer also tried to capture the respondent’s mood and feelings towards the organisation and future plans to determine whether negative emotions towards the organisation interviewed were present. According to Saunders et al. (2012, p.192) negative feelings of dissatisfaction with the company or other factors within the working environment may impact the reliability of the answers provided.

3.8. Criticism of the sources

The challenge when collecting the data was to find fitting organizations which are willing to be interviewed by the authors. When the authors used their network to approach correspondences, they payed specific attention not to allow the authors to select the individuals to be interviewed, but instead chose the befitting person themselves based on the authors’ information requirements. The authors managed to find organizations which fulfil the needed requirements of the research purpose of this study and which represent a diverse mixture of dimensions. Those dimensions are various divisions in LMT, organisation size in terms of employees or turnover and customer areas.

The organisations analysed required anonymity due to competition concerns or other reasons which they did not elaborate. This can have the disadvantage that the collected data is not reconstruct able and retraceable. There is a certain risk that based on organisation specific facts and figures, some organisations can potentially be recognised. As a countermeasure, the authors transformed the data in the most generalising way possible. However, the advantages of anonymising the organisations predominate. An anonymous description provides neutral understanding of the company and allows no biases of the reader when the organization is already known. Further, some organizations might be more willing to hand out information
and can talk more freely if they can stay anonymous. The gathered data is being shared with the organizations and their permission is being required.

3.9. Research ethics

The authors of this thesis were especially careful when it comes to appropriate level of information transfer and respect towards the interviewed organizations. The study was conducted, so no interviewee would feel mistreated or offended. The permission for digital audio recording was asked for in advance and could be stopped at any point. The original data which has been collected is only available to the authors of this study but on request can be shared with the company, supervisors or examiners.
4 Empirical findings

The following empirical data section is split in these sections: the interview data, observation organisation appearance and findings summary. In “interview data”, the findings from the eight conducted personal interviews are listed and structured. The “observation of external appearance” adds the information which was acquired through online sources. Finally, at the end of this chapter, a “findings summary” of all the presented data above is provided in a table. Due to confidentiality concerns references and the names of the organisations are not provided.

4.1. Company A

Background

Company A manufactures and produces foils, laminates and holographic materials which are used on packaging and other printed materials to enhance marketing impact. The organisation operates in Europe, America and Asia. A specific number employees worldwide is not disclosed; however, company’s LinkedIn profile indicates between 501 and 1,000 employees.

Innovation process

Product innovation takes place on a reactive basis. The type of product innovation projects that Company A gets involved in highly depends on client demands and product requirements. Decisions with regards to product innovation take place at the board level where return on investment (ROI) is assessed. Product innovation projects that are believed to yield the best ROI are approved and those products enter the research and developments (R&D) stage at one of R&D facilities specialising in a particular product area. Once the product is developed, it is then produced by an outsourced producer. The finished goods are then sent to the packaging or media printer where the product fed into the print machines. In the past the organisation attempted to develop new products on their own, however, unsuccessfully. The organisation did not have the capability to understand future market trends and future client needs, therefore, the products developed were not in demand.

Another focus for innovation is improving efficiencies and managing resources. For these type of innovation projects the organisation occasionally consults other subsidiaries owned by the parent company. The other subsidiaries operate in different industries to Company A, however, where possible the organisation is trying to leverage the knowledge regarding process innovation from other subsidiaries.

R&D

Research & development project are determined based on considerations of ROI and resource availability. Projects that are considered to meet the criteria for entering the R&D stage are selected. The costs of R&D are shared between the client and the producer (Company A). Company A is also involved in long-term projects with their clients developing more complex product.
Network

Company A collaborates with other subsidiaries, however, this collaboration is consultative where organisations can learn from each other by sharing their experiences relating to process innovation within their organisations.

Client organisations are very important for Company A and primarily drive product innovation and process innovation initiatives.

The level of collaboration between Company A and the supplier organisations is very low. Companies within their network are raw material suppliers and equipment suppliers. Very often the supplier organisations that produce the foils or laminates have no knowledge of what the product would be used for. Company A only shares the information that is required to produce the goods. According to Company A, fear of losing intellectual property (IP) determined their decision to limit the information shared with external partners.

Organisational structure

The organisation is quite hierarchical. Decisions are made at the top of the organisation and passed down to lower levels of organisational authority for implementation. Information regarding sales orders and client feedback and information regarding process deficiencies is shared upwards within the organisation for potential consideration.

Organisational culture

The average age within the organisation is 45 years. The organisation tries to always use internal resources when possible. The organisation is very client focused. Not only does the organisation try to understand potential client needs through close collaboration but also by assessing industry reports and trends found in well-known industry publications specialising in the packaging industry.

Marketing

Company A attends industry exhibitions where they generate most of their leads. Company A also gets approached by potential clients because of word-of-mouth, print journals and since recently social-media activities.

Growth and organisational development

The organisation implements a closed innovation strategy with a careful involvement of closest clients. Innovation is incremental. Investment in production machinery is expensive, therefore, careful consideration takes place before large R&D initiatives are launched. The organisation is growing, however potential challenges are related to wrong decision regarding innovation, trends that are changing, lack of resources, enforced shift to more biodegradable packaging with less carbon footprint which is presenting new product challenges.

Past experiences and challenges

The organisation attempted to implement innovation initiatives without the support from the client. The initiative failed as according to the respondent the organisation did not have the capability to understand future market trends. The organisation did not have a
formal department, not an organisational role that would carry the responsibility for analysing market trends and predicting future client requirements.

Observation of external appearance

The mission and vision of organization A is to support other products to stand out, be different, make an impact, add value and make a lasting positive impression. They present themselves with a focus on combinations of style and sustainability. The management promotes their customer service ethos, technical expertise and highly collaborative approach with clients, customers and suppliers. The management style the entire organization is friendly and flexible. The organization exists for over one century. In terms of innovation, they are the leading manufacturer and distributor and offer unique solutions of their product branch.

4.2 Company B

Background

A window and door manufacturer. The customer area of the company includes Austria’s two biggest counties, lower Austria and Vienna. Company B focuses on special constructions designed to improve client equipment.

Innovation process

The goal of the organisation is to be leader in custom made products. Company B produce small numbers of their product; however, their products are seen as high quality luxury goods.

The organisation conservative and utilises old-fashioned patriarchal, authoritarian decision making model. However, the initial idea generation comes from outside the organisation and is inspired by customer requests. Customer orders, call for tenders of public companies or the plans of architects request the knowledge of the organisation and therefore generate the initial idea. They take orders whenever the capacity in the office is available, however, due to their high-quality goods long labour hours are required which is occasionally lacking in the organisation. A scare resource can be the employees in the production line. If there are too less employees to fulfil current orders, workers are being leased for short periods of time. The threats of such projects can be reduced to a minimum. The initial conversation with the head of the organisation, who is as well skilled and experienced in technical features and the in-house planning predefine what is technically possible.

If an order is accepted, is decided by the head of the organisation. Once it is accepted, the innovation and research process begins. This is done by two to three people, who draw sketches and calculate physical characteristics. This process includes a trial and error and back and forth with the production staff. The production staff adds knowledge when it comes to assembly or installation issues. Once a prototype is finished, external knowledge is used again. Independent research facilities are used to test and certify the thermal and building physics of the product. This guarantees and proves the organisations competitive advantage. After this step, the product is being produced and installed at the customer. This process is either being financed by the customer and his willingness to buy a high-end product or as well with grants for research projects form the federal government or research facilities in
wood processing industries. In total, it can be stated that the organisation devotes around 50 to 60 percent of their business concept to special custom-made products.

R&D

The R&D projects can last from weeks or months in planning and testing and afterwards just weeks in the actual production. This depends on factors of improving and renewing existing products or on fulfilling complex architectural requests which have to find a solution and be tested forth and back.

Network

To a certain extent, relationship with partners, suppliers or competitors is necessary. The connection to their suppliers is on a professional level. For auxiliary goods, certain quality standards are required by the organisation but other there is no collaboration or formal bond. When it comes to main body parts such as window glass or metal constructs, the relationship to those suppliers is stronger. Typically, there is a year-long collaboration existing and products are being developed together, depending on what is technically possible from all sides. There are certain standards which are given and known by the organisation. This can mean as well that those bought in addition parts are main drivers for end price and therefore crucial decision makers.

This relationship takes place in mutual exchange or collaboration for developing certain products. Reasons for this collaboration can be scale of the project or given requirements at call for tenders. Other regular network partners are research units of universities, customers or the visit of fairs. The projects with universities can be both, improvements or incremental changes. If a collaboration takes place it mostly depends on projects on university side or call for tenders which initiate or require a collaboration. The fairs which are being visited are B2B fairs. They help the organisation to recognise new materials, processes and products. Here, ideas are generated and as well possible collaborations initiated. If ideas cannot be fulfilled in-house, collaborations are founded with partners, suppliers and competitors. Depending on the scale of a project, R&D is done together with competitors and afterwards distributed together as well.

Organisational structure

Many employees in the workforce were taught and worked for the organisation since their very start in their professional life. This takes place for example through apprenticeships. Therefore, the interaction and collaboration among employees can be described as very positive. Since the culture and aim of the organisation was always towards inventions and something new, the employees attitude towards change can be described as positive as well. There are around 24 employees in total. The employees behind the desk are fife and the others are in manufacturing and assembling. The age of the workforce in the office is between 30 and 40, the age of the workforce in the workshop is around 40 to 50 years. As the organisation is rather small, hierarchies are flat as well. The employees in the office are one level under the head of the organisation. The cooperation between those employees and the head of the organisation is professional and build on mutual respect. Since not every small supplier product can be made in house, the attitude towards not-made-here goods is neutral. The use of supply products is necessary to the standardisation of the bought goods and to focus on the main part of the wood manufacturing business.
Organisational culture

The organisation is currently led top down in an authoritarian way. However, there is change recognisable due to the youngest family generation is getting involved and aims at a more democratic nevertheless strict and detailed leadership style. Change and new ideas always have been in the main focus of the organisation and therefore lead to their success. In this industry, if the aim is on quality instead of quantity it necessary leads to be innovative and fulfil special architectural wishes on a regular basis.

Marketing

Marketing activities are almost non-existing. The company experiences a high demand via word of mouth and due to their exceptional reputation for custom made products. The word of mouth comes from customers, as well as from architects who plan exceptional structures and then need a partner who is capable and willing to develop and produce this. The network itself of the over 100 years old family business is another factor of the increased demand. Fairs and exhibitions are just being visited but not exhibited. Past experience showed that the costs of exhibiting at a fair were higher than the value added. Therefore, fairs are visited to extend the network and be inspired by new ideas and technical possibilities.

Growth and organisational development

Company B is in operation since 1912 and family owned ever since. The company was passed on from father to son and is now in 2018 in third generation. The organisational development did not show noteworthy mannerism, from the very start on they focused on custom made, high quality window and door products.

Past experiences and challenges

As an everyday challenge can be listed to meet a balance between time and money that is invested into the creation of a new product and the actual assembling of the product. However, most products of the organisation are high end goods, it is a challenge to justify the high price for research and development.

Observation of external appearance

Company B mission and vision is to be modern and traditional at the same time. They present themselves with a focus on special constructs which continuously need new innovative solution rather than standardized mass production. The company aims to be a reliable supplier with an emphasis on superior service provision. The family owned organization exists for over 100 years. Their unique selling proposition in innovation is special constructs, fitted individually to the customer.

4.3 Company C

Background

Company C is a globally leading in technology and capital goods with a combination of material and processing knowledge. Products and system solutions are used in combination with steel and other materials to serve the automotive industry, consumer goods industries, aerospace, oil and gas industries globally.
Among others, the organisation has two brands which focus on fence systems for vegetable protection and frame solutions for windows or doors. Those two brands have been main subject of this interview; however, they cannot be seen as separate organisations and impacts of the organisation around will be considered.

**Innovation process**

The way an innovation is implemented stems from two different ways. Organisation employees share newly generated ideas via email feed with one another, ensuring the whole organisation is copied in. In three months’ time, about 400 ideas were generated this way. Customers are not able to paste their ideas in this tool. However, the problems or thoughts of customers are still inserted into the tool. This can happen via the project manager himself or any other employee who got the information of customers, such as sales representatives for example. From those 400 ideas, about half met the subject of innovation and could be used for further steps. Second, another way of finding innovations are the once a year tech-days for chosen employees from all hierarchies and departments from all production sites in Austria. Those employees are chosen carefully and are meant to represent a mix of the entire organisation. It is a two-day event where various ideas are gathered and analysed afterwards.

Once an idea is generated the next step is the evaluation from two idea managers if the idea meets the subject of innovation and can technically and financially be conducted. The number of only two idea managers which evaluate is chosen deliberately in order to ensure a lean and fast innovation culture with not too many bureaucratic ways. After this evaluation, the department manager agrees or disagrees to the chosen ideas which are going to be carried out as next projects. From this point on the idea is being operated not anymore in the innovation management tool, but in the project management tool. This means a concrete budget and realisation plan. The budget for individual innovation projects can reach from several hundreds of thousands of euros to millions. In the year 2017, a total sum of 159 Million Euros have been invested in innovation projects. The last authorisation is done by the control committee of the organisation’s location where the two mentioned brands are located. In this committee, the CEO, CFO and innovation manager take the final decision if the project will be carried out.

**R&D**

The third way of doing research and development are workshops on a smaller scale just for the production site from the brands of fence and frame solutions. Those workshops are a similar line-up of employees but take place unregularly when there is a need of ideas. Another way of idea generating are grants or sponsorships from the European Union. Here problem is defined and the organisation works on a solution in cooperation with other partners.

**Network**

Collaborations with partners, universities or other research facilities happen on a regular basis. Customers are seldom involved in innovation projects, they rather just request products where they already did the innovation.

The people involved inside the organisation which contribute all on innovation are employees from simulation technics, sales and production. This tight collaboration is necessary due to feasibility studies. From evaluation of an idea to the production colleagues from production are involved as well. This can mean technicians but rather not down to the lowest level of construction worker. This cooperation helps to evaluate the production costs of a product.
which determines as well the final price and therefore decides if it will go in production or not.

**Organisational structure**

A classical knowledge management system does not exist in the organisation due to the absence of need since the ways in the innovation department are rather short. The team in the R&D department consists of five employees who all sit together on the same floor and have a rather familiar relationship. The hierarchy is kept low in order to enforce creativity. The head of the department is responsible for administrative work as well and follows a democratic leadership style. Decisions are made in common before the project is forwarded. The age of the employees varies between 25 and 45 years.

**Organisational culture**

Employees of the organisation are given incentives to create and paste their ideas into the internal innovation management tool. Those incentives reach from personal award in the organisation such as presenting and mentioning the idea creator and the idea at corporate celebrations and as well monetary incentives.

The attitude to not-here made goods is rather neutral, the bought products are small devices such as screws or nails and play a subordinate role. Where great collaboration takes place is at the plant manufacturer. The manufacturer decides what the machine is capable of doing and therefore what the organisation can deliver to its customers. Here the negotiations can take up to years since once installed the machines are being operated for decades.

**Marketing**

New clients are generated via various marketing activities, exhibitions at fairs and customer visits. Those activities are operated by sales department in cooperation with technicians. The R&D department monitors regularly their customers and the customer’s customers in order to stay up to date technically and know what the latest requirements are.

**Growth and organisational development**

Company C exists since before the second world war and was partly state owned. Since 1946 it became a public company and exists in the current way. The organisational development can be described as bureaucratic and moved to a cost and process optimisation focus.

**Past experiences and challenges**

As challenges regarding markets, the changes in ways of delivery are mentioned. The customer request just in time delivery, so they do not have to invest in storage. Due to the long time it takes to adjust the machines for production it is a challenge to produce small batch sizes on a frequent level instead of producing great masses and then store it. The machines are built for a certain batch size with few automatic processes. The changes in customer behaviour request now smaller amounts but more often. This means that the capacity of the machines is not fully utilized and the price of one price rises due to the rather long lead time. If the batch size falls under a certain border, the profitability of this machine is given no longer. The setup time and adjustment time are rather high in comparison to production time. To produce small batch sizes on the existing machines is one of the current challenges.
In terms of involvement problems, regal and environmental regulations were mentioned. Those regulations are the outer framework in which the organisation operates. Safety issues can be mentioned as an example, which are anyways met by the organisation’s internal requirements.

**Observation of external appearance**

With their vision and mission, Company C aims for maintaining their leadership in their field of technology. Their goal is to be ahead of everyone else in the branch at all times. They claim their products have a high quality so they last a lifetime and they build their success on their know-how advantage. In accordance, the management is as well focused on technology and quality advantage and operates in a dynamic, specialised and innovation driven way. To invest heavily in high performance in R&D to ensure their competitive advantage is a key objective. The service for their customers, a close collaboration with suppliers and a focus on motivated and skilled employees is being promoted. The organization has more than 50 years of experience in their field. Their innovative products are leading in providing solutions for this branch specific issue. Those products are high performing to serve high-tech segments.

**4.4 Company D**

**Background**

Company D focuses on engineering and technology with specialisation in optimization and efficiency improvement of cement plants. The offer reaches from successful process- and mechanical design to fuel optimization and alternative fuel implementation. The organisation offers technology on the latest level such as high efficiency burners for kiln and calcine and further developed complex design for firing almost any kind of alternative fuels. In total the organization occupied 130 employees.

**Innovation process**

The interviewed person (head of department and founder) and the development engineer worked together in another company. One day, the development engineer developed a new product idea and shared it with the head of the department. Together they patented the idea and established new collaborations with customers to develop the idea in practice. When the original company went public and wanted to get rid of sections which were not profitable yet, the interviewed person and the development engineer bought out this section in form of a management buyout and afterwards founded their own company. This way of doing the research and development in a rather big organisation enabled a broad product research with little financial limitations and little personal and financial risk. When this innovation was in the interviewers hands, he made it market-ready further on.

Further innovations happened when a process technician was on a business trip in Italy and came back with the idea and possible customers to sell a new type of technology for cement plants. After market research, the interviewer found out that this innovation is risky and was discouraged by other experts. However, the technician assured the functionality and quality of the innovation and was therefore given the approval of selling this innovation to Italian customers. This idea worked out and turned out as a main section for the business since it solved a problem that has never been solved before globally.
R&D

In the cement industry, every five years there is a new type of problem. This was due to new environmental constraints in the European Union which offered new challenges in emission control for example. Therefore, the employees searched constantly for solutions to control those restrictions. The product development happened in cooperation with customers. Those customers were chosen after personal relationship and ability to fit the technological requirements. The reason why the organisation does not do this implementation part on its own is simply due to the kind of technology. The cement plants need to be tested in real life and the facilities are too big to be rebuild in a laboratory. This way of building up the innovation meant that the organisation did not need to bear all of the development costs themselves since all of the installations are paid by the customers. The customers benefit is that they get a solution to their challenge but otherwise they do not participate on the innovation.

An innovation can come as well from the production plant as well which approach the organisation with an idea and ask them to conduct this project at their plant. If such a cooperation takes place, the patents from this solution are being shared between the production plant and the organisation. This can take place in form of the production plant has the rights to use this technology internally in their group however, the sales and marketing rights globally belong to the organisation.

The investments for R&D reach from 500,000 Euros to 2 Million Euros. For the projects in cooperation with customers, the investments were up to 20 Million Euros, which were fully paid by the customer.

However, the decision if an innovation is being realised is down to two persons in the organisation. This is the technical and the economical head of the group. The economical head is as well the founder.

Network

The network consists of customers and universities in the fields of technology and processing engineering. Research funding is as well made use of in cooperation with universities.

The organisation’s reputation in the industry can be stated as a crucial driver for their network. If some inventor approaches a customer with a new patent or idea, the customer sends the inventors with their ideas to the organisation.

Organisational structure

The KMS can be described as a challenge. Usually there are two to three highly advanced process technicians which know more than anybody else. Therefore, it is a challenge to transfer this knowledge to the subsidiaries in Malaysia, Brazil and Mexico since this knowledge is necessary in order to sell the machines there. To solve this issue, the organisation gathers once a year the vital technicians on one point in the world to discuss and keep everyone on the same level. This happens in form of up to three days training courses. The main innovation happens in the headquarter in Austria and is passed on to the subsidiaries.
Organisational culture

The bureau in Malaysia can be stated as an example for organisational culture. From the 20 employees there, all world religions were represented and all collaborated on a relaxed level. The work atmosphere can be described as liberal and intercultural. When the organisation was founded, the interviewee was around 40 years old. The employees which are occupied with innovation are 7 people which are between 30 and 50 years old. The hierarchy can be described as flat with short decision paths. In each subsidiary, there is just one technical and one economical director. To assure each director leads the team in accordance to the organisations values, role model effect can be described as an essential way.

Marketing

Conferences with technical presentations are mentioned as a main way of getting in touch with customers. The organisation is regularly invited to hold presentations on their developments and new technologies. Those conferences are organised area wise in Europe, Latin America, North America, Asia and Indian. When the organisations notices that a solution functions in one area, this idea is presented in other areas then as well. Around eight conferences are being visited a year. On a regular basis, the organisation gets in touch with customers and serious order intentions are being shown right after their presentation. Another way of marketing are professional journals. Technical articles are published as well as regular advertisements.

Growth and organisational development

The company emphasised since the start on challenges and new regulations in the cement industry. The focus was from early on international, concerning customers and employees. This focus remained until now, 2018.

Past experiences and challenges

An innovation project needs a certain system and structure. As a challenge, it can be stated that innovative employees are not always organised on the professional level which is needed. Therefore, it is crucial to get those innovative employees to adhere to the budget and time plan.
As another challenge, the KMS can be stated as mentioned above.

Observation of external appearance

The mission and vision of Company D is to offer innovative technologies for tailor-made solutions. Their ability is to adapt constantly to new external factors such as legal, environmental factors and then find the most fitting solution for those challenges. They present themselves as outstanding in their technological performance. The management focuses on an efficient company infrastructure, a highly skilled staff and a specialised supplier base. The collaboration with all partners is essential. The organization exists for 25 years, in the past ten years they pioneered in the development of state of the art technologies. Their innovative key technologies reduce production costs and improve environment. The focus lies on optimization and alternative material implementation in existing mechanisms.
4.5 Company E

Background

Company E takes part in non-profit organisations such as IUC Halland aiming to enable and speed up innovation in manufacturing industry at the regional level in Halland. The objective of the previously mentioned organisation is to assess the needs of organisations operating in the manufacturing industry, advice on how to proceed with innovation, create projects, and facilitate experience exchange and competence development for organizations involved. Representatives from the manufacturing union and regional representatives are board members of the organisation. This organisation keeps track of announcements from the European Union for potential project funding that go in line with the objectives of IUC Halland.

Company E is a prototyping company that works mainly with the automotive industry. They produce parts only with the equipment that they have. 10 weeks is a very long time to go from 3D model to a quality assured part. It would usually take less than 10 weeks to complete a project, therefore, the organisation does not have the time to invest into new technology (technology assessment, adaptation, installation, education etc.).

The firm has its own capacity in engineering, model milling, prototype foundry, casting parts, machine department, and extensive quality assurance. The organisation operates in the domestic market and internationally. The domestic market is quite fragmented e.g. some companies focus on prototyping but they do not cast parts on their own, they mill the model send it to a foundry buy the castings and build the machine. Company E also compete with volume manufacturers, production companies which are also capable of producing prototypes. Company E has clients in Denmark, Germany, Austria, Switzerland, and France. The biggest international competitors are based Germany and the UK. The organisations in Germany and the UK are role models that Company E aspire to become (capacity, operations, and quality perspective).

The organisation works closely with their clients and are closely involved in client’s product development at the early stage. Organisation E have the capacity in all necessary product development areas such as engineering, model making, casting and machining. Control of quality and lead times as well as continues development of the item that is being developed. The organisation is very innovation centric, however the focus of the organisation is improving efficiencies, process development, testing new products, modifying technical composition, using software simulation software, optimising or automating process of machines. Innovation is about improving operational efficiencies and developing new capabilities.

Innovation process

Company E is a subcontractor. The organisation gets a 3D model from a client that Organisation E is supposed to produce. The organisation does not innovate products from that perspective. They provide feedback to the client on the part design itself in a structured way e.g. a particular 3D model may not be possible to produce with any available process in which case the organisation would recommend certain changes to the model. Organisation E then gives feedback to the client regarding the changes made and challenges that incurred during the build.
Innovation from Organisation E perspective is to improve, develop new processes, to test new ideas. Regarding casting alloys, Organisation E conducts tests to modify the chemical composition of alloys, to test different heat treatment methods, work with simulation software where the castings are simulated and improve the simulation, to optimise the processes for casting machines, automate the programming of the machines, make the machines self-programming machines. The knowledge to develop new capabilities is developed internally, with the help of machinery manufacturers, software and other specialist consultants. In order to automate some of the activities carried in at Organisation E the organisation seeks financing from outside organisations such as Almi (governmental financing board that occasionally hand out innovation checks, maximum 50% of funding for developing something). In that particular project, most of the work was completed by Unnaryd Modell. The organisation also hired consultants from an organisation providing machine software solutions, CAD software providers, and machine builders. Through this collaboration Unnaryd Model developed a solution to resolve their challenge.

R&D

The organisation does not have its own R&D department, however, R&D takes place through collaboration with other partners in their network. The parties involved attend meetings, discussions, get involved in testing initiatives. Company E works closely with suppliers to enhance the properties of materials used in production. Collaboration allows all the members involved to reduce R&D related costs, but most importantly generate new ideas more efficiently and faster.

Company E has developed an internal not fully formalised process for R&D: Input → Opportunities (defined idea for a project, from customers, sales department, from production, from research institutes and other directions) → Quarterly R&D meetings → Prioritisation → Planning → Summarising. The reason a degree of structure for R&D development was initiated was only because they always need to secure the resources (to ensure there is no clash of projects and resources are available).

Network

Networking is very important part of Company E. The CEO is always trying to meet people in different areas such as foundry but also IUC, TEK, visiting customers, discussing capabilities with them, exhibitions to meet with suppliers (machines, they invite suppliers to visit Organisation E to test/demo their products).

The organisation collaborates very closely with other organisations within their network. Partnerships are very important for innovation. Very often these organisations instead of investing financial capital they invest their time to work on specific projects with their partners. Protecting intellectual property is not their concern. Being completely open with their partners is the only thing that allows them to innovate. Their suppliers know all the specifications and the working of the project to the smallest detail. Information exchange with partners and other network parties is what drives innovation within the organisation. Such approach to information helps organisation E to develop capabilities and knowledge faster than they could by trying to accumulate relevant information on their own.

A similar relationship exists with the client organisations as well. To meet the client requirements organisations, have to exchange full information on the project details leaving no room for secrecy. The only client concern is knowledge leak, however, in order to prevent
loss of intellectual property, client intellectual property management teams are heavily involved. The work with clients includes signing non-disclosure agreements.

**Organisational structure**

The organisation consists of around 40 people. The CEO outlined that the organisation is not very structured, but the structure is not always beneficial when it comes to innovation. The reason a degree of structure for R&D development was initiated was only because they always need to secure the resources (to ensure there is no clash of projects and resources are available).

All the decisions regarding innovation are made at the board level which consists of three members: the CEO, the production manager and the sales manager. Other staff members e.g. the sales team, the engineers etc. are involved in the innovation process to an extent where they pass on the information regarding client requirements, current capabilities and potential ways of extending their capabilities and improving efficiencies. All of the information is processed at the board level and based and decisions on future projects are made.

**Organisational culture**

Organisation is very much innovation driven. The organisation is very ad hoc and everyone is working on the information that comes in. There is no one individual within the organisation that synthesises all the information. Being an open organisation is vital to the success of the organisation. Accumulating and assessing information on their own would be too slow and costly, being part of an open network and closely collaborating and openly exchanging information with network partners allows to eliminate such costs and speed up new idea generation. The organisation to an extent implemented processes for new idea generation and innovation, however, that was a recently established procedure. The CEO of the organisation believes that some structure when it comes to innovation is important, in order to ensure that ideas are actually implemented, however, he also believes that too much structure may hinder innovation. Although Company E is over 30 years old the organisation still contains its entrepreneurial spirit. Innovation at Company E is always about improving processes and to grow the business through gaining more market share.

According to the CEO of Company E, they are pushing innovation, when the organisation is at its best then everybody benefits.

**Marketing**

Trade shows are a very important platform for the organisation to meet new business partners and clients, learn about latest technologies and how those technologies could enhance their product offering and operational efficiencies. The organisation also gains clients through word-of-mouth and partners in their business network in Sweden also Business Sweden. In two years from starting to attend exhibitions abroad Company E went from 0 contacts to 30 potential customers. EuroGuss exhibition where they went with no contacts and significantly expanded their clientele abroad. They also use consultant to improve export activities, Business Sweden, German Chamber of Commerce and regional agencies in Germany. Company E reaches many of their clients through various institutions such as IUC.
Growth and organisational development

The organisation has increased its customer portfolio since they took a more proactive approach to seeking new clients via exhibitions and by taking part in industry meetings.

Past experiences and challenges
Establishing presence in European markets outside Sweden. By attending relevant exhibitions in Europe, the organisation obtained leads which were converted into customers.

Observation of external appearance

Company E sees knowledge and the usage of it as an enabler for competitive advantage as mission and vision. They focus on projects which are unique and challenge them and combine the latest technology with skilled employees in order to lead the market segment. The management is organized with an aim to high quality and short lead time. Customer needs and collaborations with partners, especially during the development process, are both seen as primary concern.

4.6 Company F

Background

The organisation is based in Switzerland and focuses on high security government documents. They are world leading in intelligent, secure and decorative foil products and moreover in other areas of hot stamping technology and foil-based optically variable security features. As of now, 2018, more than 110 countries worldwide use their technological advancements.

Innovation process

The organisation developed a worldwide unique technology which is exclusively used and merchandised by them. This innovation of the secure non-holographic technology was invented by three technicians and is kept confidential since 1999. The customer involvement can be described as vital since every government has different requirements and needs for their documents. The organization invests around 30 percent of their turnover in research and development. With a turnover of 70 Million Euros this means 21 Million Euros a year is being invested into innovation.

R&D

New innovation is done two ways. Either pro-active or re-active. Re-active could be a counterfeit. The occasion of a counterfeit has not happened ever since on a professional level. Pro-active innovation happens on a regular basis. The development process can take from 6 months to 24 months. This is due to research and development and testing and qualification in cooperation with the customer and their requirements. New technologies which are implemented can be nano-text, RFID or metallisation. This technology is combined with the foil-based optically variable security features.

Network

Network plays a vital role for the organisation. However, in the security branch no one shares the exact procedure of how the product is made, the product is being analysed and
feedback is given on a regular basis. This happened at security conferences where technologies are presented and the ideal combination of technologies is being discussed. Information is being exchanged for specific projects, presentations, call for tenders or with experts such as forensics. Collaborations occur with scientists from other companies or from universities, with component supplier or with printer manufacturer. The network and reputation is crucial for the organisation when it comes to call for tenders at governmental orders. Although, their technology is unique and the securest and hardest to counterfeit on the market, the customer has to require such high security. The collaboration with component suppliers or other partners are based on the requirement of high quality products and build up to last years.

Organisational structure

Organisational culture and identification of the employees with the organisation is crucial for the collaboration inside the company. The hierarchies are flat and paths between the departments are short to ensure a flexible and relaxed working environment. In order to transfer knowledge and vision/mission two ways are being used. On a broad basis, every two months a meeting for all employees takes place. This meeting, called “lunch and learn” involves all employees from different management levels and organisational departments as far as for example the facility team is included too. Those meetings are meant to transfer the culture to every employee, to see what impact their work has in the big system and as well to motivate them. However, they are used as well to get feedback out of questions or conversations from employees which could possibly contribute interdisciplinary. The other event is expert meeting which take place as needed in the departments or between departments. Corporations can occur between the creative innovation team and the fact focused production team. The age of the workforce in the innovation team reaches from 35 up until 65 years old. Departments are being lead variable depending on its needs. The innovation team has liberties as long as the work is done no matter how or when. This is specially the case with the department “design and origination”. Departments like this have as well less budgetary restrictions.

Organisational culture

The company is lead bottom up, on a personal basis with liberties for the employees. The employees appreciate each other and are aware of what their work contributes to the organisation as such.

Marketing

The client acquisition happens at fairs and exhibitions as well through networking and call for tenders. The vital contacts are customers, suppliers and forensic experts. As the project life cycle of security documents can take up to years, the network is vital in order to meet the customer in advance before the customer defines what is being requested from such a document.

Growth and organisational development

The organisation continuously devotes their effort to innovation. Internationally certified high security production plants guarantee stable quality in mass industrial amounts. The organisation offers full solutions which include foil delivery, project consultancy and machine and stamping technology. Their optical variable device respond is exclusive in the response to government security requirements such as easy to verify, easy to communicate
Empirical findings

and hard to counterfeit. In total the organisation employs around 4500 people and is still family owned with 120 years of history.

Past experiences and challenges

Changes the market are monitored and adapted continuously. This can mean the involvement of new technology in documents. An example for this is cloud based information. Due to security issues cloud services are becoming less in the secure document industry and the focus shifts again to physical reliability evidence.

As mentioned above, the collaboration between departments with require various leadership styles can be a challenge as well. This depends on the personality of the employee and the work area. In short, the accountant needs other characteristics than the designer. This issue cannot be deviated from the security industry but is a general topic in an organization's structure.

Observation of external appearance

Company F aims to supporting resource efficiency, reduce its environmental impacts and perform in a way that meets its customers' expectations. They present themselves as world leading in security solutions. The management is certified according to ISO 9001 for its quality management system among other certificates concerning environmental management and management of security printing processes. Ideas reach maturity quickly and reactions or adoptions to new problems or technologies is done on a regular basis. The organization is partly owned by a group of companies and collaborates to a certain extend with this group or other partners. The organization exists for 30 years with a consistency in innovation solutions. In terms of innovation, the organization is a forerunner and innovation leader in their field with the develop of ground-breaking, unique features.

4.7 Company G

Background

Company G manufactures tailored equipment for organisations within the print and paper industries. The company has also started producing solutions for organisations within the tissues market. Company G is a leader in core handling equipment and also provides roll handling equipment. Product development is highly dependent on client requests or challenges that client organisations are facing or will face in the near future. These challenges are often the result of new government regulations at a state or in Europe at European Union level. The challenges for print and paper industries are also created further up the supply chain, for example the ability for paper suppliers to meet the demands of packaging companies which often requires the development of new technical capabilities. The organisation operates domestically and internationally with 80% of their sales being generated outside of Sweden in North and South Americas, China and Europe.

Innovation process

The organisation mainly innovates in a reactive manner. New solutions are designed together with the client, developing a product that would resolve the challenges the client organisation is facing. The organisation also generates new product ideas by assessing the data gathered via the sales teams and client site visits. The data gathered during the site visits also helps company G to predict market trends and identify future challenges. If the identified challenges or request for specific solutions from clients are of a complex nature, the project is
forwarded to the R&D department where deeper level research is conducted and solutions are designed.

Company G does not design solutions to resolve challenges in distant future mainly because of two reasons. Paper and print companies are conservative organisations that are risk-averse and are reluctant to engage in innovation initiatives that are not designed to resolve the present challenges. The leading organisations within the paper and print industry tend to be the first ones to face new challenges. The newly developed solutions are then pitched to other clients, however, until clients experience the same challenges, because of their nature, they do not adopt new solutions until more companies use the solution.

Initially company G was only serving paper and print industries. As demand for the products was fluctuating, the company decided to find markets that could be served using the technology that the company possessed at the time. After conducting research on potential markets that the company could enter and serve new targets using current technology it was identified that tissue market was profitable. However, as the market, the end product, the way organisations within the tissue market operated, their business model were significantly different to the paper and print market, new skills and knowledge were required. New competencies were developed by learning from other tissue market suppliers and employing salespeople who had been working within the tissue market. As more knowledge was accumulated a better understanding was developed on how to serve the market.

Packaging and tissue markets are still growing even though they are mature markets. The number of organisations within the market is the same, however, the need for specific solutions drives growth.

R&D

R&D department consists of one individual who assesses the information available, conduct additional research and develops case specific solutions. R&D initiatives are paid for by the client organisations. Solutions developed for specific clients within paper and print industry are then pitched to other clients. Solutions that were developed for specific clients within the tissue (paper tissue) market are kept confidential. Information exchange between company G and the tissue market clients is limited to meet the project requirements. The organisation is reluctant to use external consultants for R&D initiatives. Very often solutions are developed theoretically and only when clients agree to implement particular solutions, the solution is tested. As it often takes significant amount of time until certain solutions are purchased, consultants who had worked on developing them, may no longer be available, meaning that the skills and knowledge required to implement the particular solutions is lost. R&D then supports the sales team and implementation team.

Network

Company G is involved in various manufacturing industry initiatives locally. Bi-monthly meeting are organised in order to discuss various challenges that manufacturers are facing the topics discussed range from developing the right competences to finding educating people to join their companies. However, product related information share is not common within the organisation. All the information that is required to develop certain products is generated internally.
Company G also takes part in IUC Halland initiatives that is aiming to help organisations within the manufacturing industry to develop new competencies that would help them to increase or develop competitive advantage.

**Organisational structure**

Flat organisational structure within the organisation which eases information and knowledge flow. No formalisation, nor procedures exist. Employees are enabled to talk to each other freely whenever a specific matter requires attention and assistance from other peers, subordinates, or superiors.

**Organisational culture**

Innovation driven culture. The organisation understands the importance of knowledge. Information is collected from client organisations and carefully assessed in order to identify new problems that the organisation could find solutions to.

**Marketing**

The organisation attend exhibitions, however, not to the same extent as in the past. Mainly because the information that exhibition attendees were interested in in the past is available online and therefore, they cannot justify their attendance. Client site visits are the main methods of selling new products to existing clients.

**Growth and organisational development**

The organisation is strategic about its growth and development. About 10 years ago the organisation conducted research on the future of the industry the organisation was operating in. After the research findings were shared, it was understood that the organisation had to identify new markets that could be served with current or marginally altered products that the organisation was manufacturing. The organisation takes a proactive approach to innovation.

**Past experiences and challenges**

The organisation finds it challenging to convince the clients that the products that the organisation has manufactures are going to be a necessity at client organisations in the near future.

**Observation of external appearance**

Company G’s vision and mission is to improve their customer’s productivity and profitability with the aim to remain their preferred supplier. The appearance claims to occupy the leading position in terms of quality and performance products with superior functionality and reliability. The management focuses on high standards for the quality and safety of their products with industry expertise, technical knowledge and constant improvements. For more than three decades, the organization’s innovation is being a pioneer in development of new solutions. Their competitive advantage is seen in investing substantial resources in the research and development of new products.
4.8 Company H

Background

Company H is a small Swedish company that operates in the production of cable mounts market and other equipment required for cable mounting. Company H also manufactures mangles that Company H holds a leading position in the market. The organisation operates domestically and internationally. Internationally it serves clients in UK, Denmark, Norway, Finland, Slovenia and Poland. The organisation produce the product and the product is then distributed via retailers. Business growth takes place in a form of acquiring new partner distributors (retailers).

Innovation process

Innovation process starts with information acquisition. It is the client product requests or new ideas generated internally that initiate innovation initiatives at the organisation. Company H does not have formal innovation procedures. New product development is mostly the result of customer product requirements. Top management also generates new product ideas that are inspired through informally collected information. The organisation employs reactive and proactive approach to innovation.

New product development starts with two individuals (top management) then 3D graphic designers are involved, occasionally an external person is involved if specific knowledge and capabilities that are not found at the organisation are needed. The last step of innovation is production. For new product development, the organisation mostly uses internally generated knowledge.

Information and knowledge accumulation at Company H is normally a result of interest in new products introduced by competition. Company H does not actively look for knowledge that would specifically help them develop new product ideas. Knowledge accumulation is a result of genuine interest rather than anything else, however, according to Company H new knowledge always leads to new product ideas. The importance of new product development is well noted within the organisation. According to Company H, without new product development initiatives the organisation would lose its relevance. Company H also tries to develop new products for new markets, however, the organisation does not have a formal research department. Many of the decisions related to innovation are based on snippets of information.

Changes in the market environment require the organisation to adapt. IT is changing client behaviours and requirements. Clients require faster business transactions and prefer online sales platforms instead of old fashioned via the telephone agreements. Because of the nature of competitors and product similarities price becomes the grounds for competition. As a result, to reduce price and maintain a level of profitability increasing organisational efficiencies and reducing production costs are essential. Company H tries to increase efficiencies and reduce costs by upgrading current machines or acquiring new ones (at least once a year). The organisation also tries to learn from other manufacturing organisation within the network cluster to improve efficiencies and identify new business opportunities.

R&D

No formal R&D department, nor any formal procedures for R&D. New product ideas are mostly generated at the top level. During later stages more people (up to 8) are involved

in the development process. The importance of R&D is understood within the organisation, however, R&D mainly takes place on the factory floor as an official R&D department is not seen as necessary to implement new product or process improvement initiatives.

R&D initiatives are funded internally. In the past some of the R&D initiatives were funded by Swedish House of Commerce and EU organisation. The funds were used for market research purposes.

**Network**

Clients are an important source of knowledge helping the organisations to direct new product initiatives. Suppliers are not involved in the innovation process in any way, however, organisations within the industrial cluster play an important role in process innovation. Company H is part of several business networks that organises meeting to address the challenges that organisations within the manufacturing industry are facing. The participants share their knowledge and understanding. Within the network, they share the knowledge regarding process efficiency improvement.

The organisation also leverages the network of another organisation that it has ownership rights to. The acquisition of share was merely an investment and not a strategic move aiming to strengthen their current capabilities.

**Organisational structure**

Organisation has flat hierarchy which allows quick information flow. According to Company H, because of flat hierarchies, quick product solutions can be implemented. Such organisational structure makes company H more flexible and allows to better serve the needs of their customers. Knowledge within the organisation is share in an informal manner. Since it is a small organisation, all employees are aware of existing and upcoming projects.

Innovation project initiatives are generated by the top management. Only people with relevant knowledge are involved in the innovation process.

**Organisational culture**

Innovation driven organisation culture, however, it is the business owners that develop innovative ideas and select the most valuable ones. The rest of the employees execute the tasks to implement new ideas.

**Marketing**

The organisation does not have a marketing strategy. New clients are acquired by directly contacting them by telephone and arranging a meeting for product demos. New clients are approached when company H anticipates the need of new partners/distributors.

**Growth and organisational development**

The organisation continuously attempts to develop new product ideas in order to outperform competition and find additional source of income.
Past experiences and challenges

Employee turnover is a challenge that the organisation faces. Employees do not stay with the company for a very long time.

Observation of external appearance

Their vision is to enlarge the product assortment which they offer, continuously update their production, keep a major focus on the quality of their products and finally become the major supplier for wholesalers in their branch. The organisation presents themselves as leading player in the five product categories which they offer. They put a focus on their technology and the automatic and high qualitative way it is operated. Since the organisation's establishment, there have been few changes in management. The management focuses on being up to date to new technologies, customer satisfaction and optimising the production process. Close collaboration to customers, suppliers and wholesalers is continuously worked on and enlarged. Company H started in 1969 and adapted ever since to new technologies and trends within consumer goods and supplements for the industry sector. Their innovation focuses on current product improvement and current challenges.

4.9 Findings summary

The following table provides an overview of empirical data allowing the reader to see the differences in industries that the interviewed organisation operate in, organisational size and type of a firm.
### Table 4: Empirical findings summary

<table>
<thead>
<tr>
<th></th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company D</th>
<th>Company E</th>
<th>Company F</th>
<th>Company G</th>
<th>Company H</th>
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</thead>
<tbody>
<tr>
<td><strong>Industry</strong></td>
<td>Foil and laminates for printing</td>
<td>Windows</td>
<td>Metal production</td>
<td>Machine parts</td>
<td>Prototypes</td>
<td>Security printing</td>
<td>Print and paper</td>
<td>Metal part production</td>
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<td><strong>Size</strong></td>
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<tr>
<td><strong>Position in the market</strong></td>
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<td>Leader</td>
<td>Leader</td>
<td>Leader in the domestic market</td>
<td>Leader</td>
<td>Leader</td>
<td>Leader in one business segment</td>
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<td><strong>Type of business</strong></td>
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<td>Public company</td>
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<td><strong>Approach to innovation</strong></td>
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<td>Reactive &amp; Proactive</td>
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<td>Now reactive, proactive behaviour in the past</td>
<td>Reactive and proactive</td>
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</table>
## 4 Empirical findings

<table>
<thead>
<tr>
<th>Model of innovation</th>
<th>Closed</th>
<th>Open In &amp; Out</th>
<th>Open In</th>
<th>Closed</th>
<th>Open In &amp; Out</th>
<th>Open In</th>
<th>Closed</th>
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<tr>
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<td>Witnessed exploratory</td>
<td>Incremental</td>
<td>Incremental</td>
<td>Witnessed exploratory</td>
<td>Witnessed exploratory</td>
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<td>R&amp;D dept. scale</td>
<td>Formal, independent R&amp;D department. Focus: only product dev.</td>
<td>Formal R&amp;D department (gather information and process it)</td>
<td>Formal R&amp;D department (decentralised)</td>
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<td>Formal R&amp;D department</td>
<td>Formal R&amp;D department</td>
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<td>R&amp;D model</td>
<td>Engineers</td>
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<td>Max length of innovation projects</td>
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## 4 Empirical findings

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(Source: own construct.)
5 Analysis and discussion

In the chapter analysis and discussion, the analysed scientific literature will be opposed to the empirical data. This is structured in the three main parts knowledge, openness and scale. In the end of this chapter, the innovation strategy circle will be presented with the empirical data included.

Organisational development and growth depends on organisation’s ability to adapt changing market environment, identify new opportunities and prepare for and eliminate threats (Majeed, 2006). The previously listed activities are activities that require knowledge for their completion, making knowledge the core part of an organisation driving growth. Knowledge on how to produce product that an organisation was producing throughout its existence is no longer sufficient (Rothwell, 1992). Market dynamics affect multitude of industries through various channels. Occasionally it is governmental regulations directly impacting organisations operating in specific industries (Hillier, 2017), however, often it is also the suppliers of those organisations that are also affected (Skippari, et al., 2017). High-technology industries have to adapt to withstand dynamic market environment to compete and to gain greater share in their respective markets (Hill & Sarin, 2003), low- and medium-technology industries have to do the same. Therefore, knowledge for LMTs is as important as it is for HTs.

5.1 Knowledge

Empirical data collected from eight organisations operating under LTM industry category provided evidence to confirm that knowledge is a core part of LMT innovation processes. According to (Hirsch-Kreinsen, et al., 2006) main knowledge source is their clients who provide LMTs with product requirements. Our empirical findings confirm that client knowledge and other data such as customer feedback is key for the implementation of future product and process innovations within most of the organisations we interviewed. However, the data also showed that knowledge on:

- Market trends
- Competition and competitors’ new products
- Government regulations
- New technologies for internal processes
- New properties of the materials used in the production process
- Developing new organisational capabilities

Our findings indicate that based on this information, the assessed LMTs are able to identify opportunities and threats enabling them to understand skills and knowledge gap needed to leverage the opportunities and neutralise threats. Such knowledge drive product and process innovation at the organisations analysed. However, knowledge accumulation on its own does not drive successful innovation initiatives (Chou, 2005). Organisations need a process through which information / knowledge is assessed, selected and absorbed. KBV suggests that knowledge absorption mechanisms are essential for knowledge utilisation (Zahra & George, 2002). Zahra & George (2002) introduced two subsets of absorptive capacity: (1) potential which includes the assessment and identification of relevant knowledge and (2) realised, which is concerned with absorbing and exploiting the
knowledge. The process encapsulates four key steps (1) acquisition, (2) assimilation, (3) transformation, and (4) exploitation. The presence of knowledge absorption mechanism was evident through most of the organisations assessed, however, the process was not specifically designed to work in such a flow. It seemed that for the assessed organisations it was a logical way of accumulating and absorbing knowledge. Knowledge acquisition initiatives started with a clear understanding about the problems that the organisations were trying to find solutions to, therefore, knowledge processing activities were focused and had a logical flow.

Relevant knowledge at LMTs is classed as knowledge that is related to specific problem. The decision makers at the assessed organisations decide which problems are to be selected by assessing the problems using an internally developed criteria. Although respondents at some of the assessed organisations claimed that no selection criteria for problems to work on developed, their concerns regarding R&D activities stated otherwise. The key decision criteria for problem selection were:

1. Return on invested
2. Resource availability
3. Current capacities and time required for the new capacities to develop

Organisation cannot search and would not search for knowledge without knowing specifically where that knowledge is going to be used. Nickerson & Zenger (2004) have witnessed the same pattern in their research finding: problem is identified before knowledge is accumulated. However, a strong foundation of knowledge is an important prerequisite, as without existing knowledge, organisations will not be able to identify profitable problems (Escribano et al., 2005). Therefore, it is not enough for organisations to have expertise in their area, the capability to identify and understand problems that present and potential clients have is essential for accumulating relevant knowledge and most importantly innovation.

The second subset of absorptive capacity is realised (Zahra & George, 2002). Within this subset, the acquired knowledge is assimilated using organisational analysis routines and processes in order to interpret the data (Zahra & George, 2002). At the assessed LMTs this process is not formalised. The data gathered from various sources is discussed during monthly, bi-monthly or quarterly board meetings, occasionally involving mid-level relevant employees. Knowledge is usually gathered in an informal way through the business network or from client organisations. The information is discussed and ideas for innovation are generated and a further plan of action is developed. At this stage, the assessed organisations know what further information, knowledge and capabilities are required for innovation projects.

At a some of the assessed organisations knowledge acquisition and processing was less formalised. Company H states “Our data is gathered directly from our clients by the heads of the organisation who have constant direct communications with client organisations”. Client requests are combined with existing knowledge and information on competitors’ products. The information is discussed only at the board level in the informal environment. If resources allow organisations develop new products and approach existing clients with new products.

Based on the information above we have identified three types of knowledge acquisition and processing leading to knowledge absorption, integration to innovation initiatives:
**Group 1**: Informal unscheduled, any-time discussion when new relevant information is received and key individuals within the organisation identify potential opportunities

**Group 2**: Organised/scheduled monthly, bi-monthly or quarterly board meetings selectively including relevant employees to take part in the session. Involvement of Research Institutes allows for the development of more complex problem solutions

**Group 3**: R&D departments with at least one full-time employee devoted to the cause all year long

*Figure 7: Capability for resolving complex problems*

(Source: own construct.)

* RI – research institutes

The three types of knowledge analysis and absorption had different outcomes in the observed organisations. The ability to identify and select organisational employees possessing relevant skills and knowledge allowed the assessed organisations to enhance their internal capability to identify, prioritise and select relevant knowledge leading to more profitable problem identification. Furthermore, selective employee involvement allowed identification of knowledge gaps leading to a deeper understanding of additional knowledge needed to resolve the selected problems and resolve more complex problems.
Problem complexity chart shows the nature of the problems that organisations were selecting and initiating innovation projects. Group 1 were the lowest in problem complexity and Group 3 were the highest in problem complexity. Group 1 were concerned with moderate product improvement such as slightly changing the design of the product to befit new product installation requirements, whereas Group 3 engaged in more advanced product improvements requiring higher level product or process adaptations such as necessary complex modifications to address near future product needs.

Organisational structures may have an impact on internal capability to harness internal talent (Khatri, 2009). Top management may not be aware of the skills and the knowledge that employees possess (Grant, 1996). Management may not be aware of the kind of expertise employees have outside of their specialised task routines. Low power distance creates favourable environment for increased efficiency and higher level of employee involvement (Khatri, 2009). Because of low power distance:

1. Employee participation and commitment to the delegated tasks increase.
2. Jobs enable employees to grow professionally
3. Communications among employees take all directions, vertical and horizontal

Source: Khatri (2009).

Because of flat organisational structure and low power distance the assessed organisations capable of resolving complex problems had effective communications and employee participation, low level (e.g. sales data) information necessary for high level decisions is delivered to the board level empowering decision making (Grant, 1996). However, across all the organisations assessed, low power distance and flat hierarchies were present. We identified that organisations that invested into employee education and rewarded the generation of new ideas were capable of identifying and selecting more complex
problems. Group 3 organised innovation workshops, enables employee capability and skills development, encouraged the generation and sharing of innovation ideas and were rewarded for it. Group 2 enabled employee capability and skills development and ensured inclusion in innovation projects. Group 1 did not particularly include employees in the innovation process, the ideas were generated at the board level and employees were tasked to implement them. At one of the organisations falling under Group 1 category the tenure of employees, especially the younger ones, the organisational tenure was short. We assume that one of the reasons was low inclusion and low interest in the job itself, which could potentially be linked to job satisfaction. Employee willingness to share knowledge is affected by many various factors such as employee agreeableness, team members’ extraversion, performance beliefs and one’s own job satisfaction (de Vries, 2006). Therefore, organisational environment, culture and potential for growth may be affecting more profitable problem identification because of knowledge dissemination.

At the assessed organisations, falling into Group 3 category for knowledge processing, the organisational structure allowed the management to obtain a better overview of the activities carried at the organisation, develop a good understanding on the skills and capabilities of employees, and obtain relevant information to support decisions making within the organisation. Furthermore, the management was able to select the people relevant for specific innovation projects enhancing profitable problem identification and effective solution discovery.

Group 2 and Group 3 have the capability to understand what additional knowledge they need to resolve problems and have informal processes to acquire that knowledge. In a case when project complexity is high and resources available do not match the project requirements, the assessed organisations, falling into Group 2 specification, form closer collaborations with network partners. These organisation exchange information and knowledge in order to develop solutions that would benefit all the parties involved in the innovation process.

The assessed organisations that successfully implemented innovation activities were able to identify relevant business network partners and leverage the knowledge available within the network. In specific cases presented in the empirical data section, R&D collaborations did not require financial investment, instead labour hours and equipment were ‘pooled in’ by the collaborating parties to produce solutions to the problems selected. According to Tottie & Lager (1995) ability to operate in a network and leverage network knowledge drives organisational success.

Group 3 also get involved in collaborative R&D initiatives, however, not as frequently as Group 2. Perhaps the reason behind this phenomenon is broader range of capabilities available within Group 3 organisations and an R&D department that contributes towards innovation initiatives. Group 1 worked on less complex problems and the involvement of network partners was limited to client feedback or suggestions. Existing product improvement were very marginal, however, company H engaged in explorative innovation via existing innovation processes. Our findings indicate that openness and network involvement allowed these organisations to identify and resolve more complex organisational problems. However, the degrees of openness varied among the organisations assessed.
5.2. Openness

Most of the organisations analysed for this thesis project had various degrees of organisational openness, with a few organisations implementing more closed innovation strategy. Our data indicated that the influencing factor for determining organisational openness were client organisations and the nature of the markets that the client organisations were operating in. One of the organisations analysed for the thesis project served two very different markets with very similar products. Their working experience with the two different markets was diverse. Clients within target market A were more open, information and knowledge transfer was seen as beneficial and necessary between the client and the supplier. Target market B were quite the opposite. The client organisations are secretive and provide only enough information for the supplier to complete the order. The level of secrecy is so high that the supplying organisation is not allowed to visit their client’s factory. The products developed for the client are strictly limited for use within the client organisation. The organisation supplying the two different target markets believes that it is due to the nature of the market B. Market B is a mature market and organisations operating within that market were called “more conservative”. Product development processes are considered a big secret within the market, therefore, organisations within market B have taken very strict security measures to protect their secrets. Our findings indicate that the nature of specific industries impact the level of application of open innovation. More mature industries are often composed of more conservative organisations. Furthermore, industries such as security print requires a level of ‘closedness’ to ensure product credibility.

The majority of the assessed organisations implemented open innovation, however, the degree of openness and the dimensions of openness (Botero, Vihavainen, & Karhu, 2009) open innovation cultures (Lichenhalter et al., 2013) differed across the organisations. The dimensions of openness show the direction of knowledge or technology sharing for example external knowledge or technology used internally – inbound, or internal technology and knowledge shared with external entities (Botero, Vihavainen, & Karhu, 2009). Lichenhalter et al., (2013) proposed innovation cultures that provided a more detailed insight on openness. Lichenhalter’s et al., (2013) innovation cultures included “isolationists”, “technology fountains”, “technology sponges” and “technology brokers”. “Technology fountains” and technology sponges” are equivalent to outbound and inbound open innovation dimensions. These innovation cultures were identified across the analysed organisations.

In our population of analysis “technology brokers” stated that because of their approach to innovation, an open collaboration with their network partners, they were able to implement innovation project quicker than it would be possible to implement on their own. “Technology brokers” implement innovation initiatives the quickest compared to the other companies analysed that were assigned to other innovation culture groups. One of the assessed organisations simultaneously implement inbound and outbound innovation depending on the circumstances. Because in- and outbound open innovation was not applied continuously the organisation was not assigned to the “technology brokers” innovation culture category and instead was positioned between “technology sponges” and “technology fountains”. Simultaneous use of inbound and outbound open innovation was used when very specific expertise was required for specific products, in which case the organisation would be open to collaborative partnerships with competitors and share the ownership of the completed products. This approach allowed the organisation to gain access to specialist knowledge outside of the organisation to complete urgent projects. The organisation admitted that one of the key challenges that it often faces is labour shortage. It is plausible that the organisation
employs in-out open innovation approach as a necessity to be able to complete projects on time rather than as a strategic measure.

“Technology sponges” were actively scanning for relevant knowledge, market trends and other data that would be valuable for innovation purposes. These organisations worked with numerous partners within their business network including research institutions. The knowledge generated, however, was kept inside of the organisation and used internally. This was particularly evident at an organisation operating within the security print industry.

For the purpose of this study and for additional clarification we created innovation culture called “followers” and positioned it under closed innovation. “Followers” are organisations that in essence implement closed innovation strategy. Our “follower” innovation culture use external sources to a limited extent in a form of market/industry reports from third parties. “Followers” mainly obtain knowledge from their clients. Client requests drive innovation within these organisations. Innovation projects are also funded by the client organisations. Because “followers” receive all the knowledge required for implementing innovation projects from the client, financial and other organisational resources can be utilised in other areas. However, in long-term perspective the supplier develops high dependency on the client for innovation. The departure of an important client may paralyse innovation processes within the organisation or the client may use their increased power to force the supplier to absorb part of innovation project costs.

“Isolationists” solely use their own internal expertise and knowledge that was generated internally. The organisation assigned to “isolationist” innovation culture used client feedback to an extent as a mere consideration instead of as a core guideline, which is what “followers” do. “Isolationists” within the sample population were still innovation driven. Both “isolationists” using the knowledge created new products and targeted new markets using solely internally generated knowledge and both of them became leaders in the market for the radically new products that they produced.

5.3. Scale

Most of the assessed organisations engaged in incremental and exploitative innovation. Innovation projects were related to product, process or both product and product innovation. For product innovation, incremental innovation added additional features or functionality. For process innovation, main focus was on extending machine capability, improve the efficiency of the machines used, and improve the process design allowing to reduce production related costs. Some of the organisations in the sample population augmented their offering with additional services making the product more attractive the potential client.

Explorative innovation requires departure from existing knowledge and takes a long time to implement (March, 1991). Knowledge absorption processes and mechanisms designed to cater exploitative innovation needs cannot support knowledge needs for explorative innovation (Park & Kim, 2015). According to Tushman (2003) the implementation of explorative innovation would require assimilation of external knowledge. Companies G, H and D implemented a more closed innovation strategy generating their knowledge internally, however, showed signs of exploratory innovation in their organisational history. Company H was an exception out of the three. Company H said “We
use client feedback extensively and analyse our client’s needs in order to generate new solutions”.

Our findings go against the set norms witnessed for explorative innovation. Explorative innovation at Company D was driven by one individual at a small organisation, who refused to accept market research findings predicting the failure of his new idea. When the idea was implemented it became the core revenue generator at the organisation. Company H, was continuously looking for ways to utilise their machines to produce new product for new markets. The product that was developed at Company H was fundamentally different compared to their usual line of products. “The new product granted us a leading position in the new product area in the domestic market”, so company H. The knowledge used to develop the product was generated internally. As the product developed was not very complex in nature internal capabilities were sufficient to implement explorative innovation. Company G entered a new market by modifying current products. To gain the understanding of the new market Company G hired new talent to join the sales team.

The three cases prove that LMT organisations can implement explorative innovation when new opportunities are identified. LMTs often operate in mature, saturated markets (Hirsch-Kreinsen, 2008), which means that pressures to look for additional sources of revenue exist. Jansen et al, (2006) suggested that innovation mechanism and organisational learning designed for exploitative innovation is not sufficient to support explorative innovation. Park & Kim (2015) listed the required models of learning specifically necessary to support exploitative and explorative innovation. Our empirical data suggested that LMTs are capable of exploratory innovation, provided that the products produced are not complex in nature and that presently owned technology and machines with small alterations can produce parts to construct new product or that the current products with little alterations can be sold in new markets. Whether exploitative or explorative innovation is chosen, knowledge accumulation, and integration of knowledge allowed firms to achieve a strong or a leading position in the markets they serve.

5.4. Implications

A combination of academic literature and empirical data helped crystallise the understanding of innovation strategies within the low- and medium technology industry category. We have learned that knowledge drives employee performance and that internal knowledge, attitudes, perceptions and organisational culture influences the decisions regarding the selection of innovation strategies.

By analysing empirical data, we have identified possible connections between organisational learning activities and the ability to identify and design solutions for more complex problems as part of the innovation processes in the organisation. The organisations assessed that possessed the ability to identify and resolve more complex problems had innovation driven cultures. Employee participation in innovation idea generation was rewarded. Workshops aiming to get representatives from all parts of organisation to exchange knowledge and information possessed, discuss innovation and attempt to generate innovation ideas were organised. In general, the organisations that were able to identify and resolve more complex problems (Group 3, Figure 6, p.58) had the environment for employees to grow professionally and develop their skills (Group 2 and Group 3, Figure 6, p.58). Employees of an organisation falling into Group 1 (Figure 6, p.58) category had minimal involvement in the innovation process. The environment for professional growth in term of new skills and
knowledge development was limited and employee turnover was a factor often negatively impacting the organisation. Therefore, we can conclude that an environment where employees can develop professionally and develop their capabilities and skills increases organisational innovation capacity.

We have also identified that organisations with an environment enabling employees to learn and develop their skills and capabilities were more open. These organisations were capable to identify relevant network partners to obtain knowledge and information supporting innovation initiatives or engage into collaborative innovation initiatives with network partners. The collaboration with the network partners enables these organisations to develop new solutions in faster manner as organisations could leverage the knowledge pool available and eliminate the time required to gain new knowledge or extend existing knowledge for specific projects. In addition to time, organisations participating in innovation partnerships were able to reduce the use of financial resources. This was particularly emphasised by an organisation possessing “technology fountains” innovation culture.

Regarding the scale of innovation (exploitative or explorative) three organisations have at some point in their history implemented explorative innovation by developing radically new products or entering completely new markets with modified existing products. All of these companies were implementing different degrees of closed innovation strategies. The “followers”, however, had a direction and the decisions related to explorative innovation were backed by observation, market research and planning (Company D and G) to prevent financial losses. The “technology isolationist” generated new ideas for radical innovation in an erratic manner. The ideas were backed with very little research. The main objective for Company H when generating new ideas is to find additional sources of profits. Along with the attempt to generate new innovative ideas Company H invested into another manufacturing organisation.

Company G stated - “We attempted to predict 10-year market trends of already mature industry that we are in and conduct research on which other markets we could serve”. Company D generated a new product idea and tested the success with market research of which the findings suggested that the product would fail, yet Company D ignored the findings and continued with their explorative innovation. Company H was randomly looking for new opportunities to generate additional profits. These decisions to implement explorative innovation cannot be linked with poor financial outlook as historic financial data to support such assumptions was not acquired, however, it is quite likely that these organisations understood the uncertainty within their respective markets and proactively took action to prevent worst case scenario.

All of the remaining organisations assessed implemented exploitative innovation continuously leveraging network knowledge. The logics would suggest that organisations involvement in network collaborations would be able to generate innovation ideas for exploratory innovation in a more efficient manner than organisations implementing closed innovation. The analysed organisations may have not implemented explorative innovation because their involvement in network partnerships and knowledge exchange had a very focused scope, or perhaps stability in their business environment did not require the search for additional sources of revenue through the means of exploratory innovation.

Figure 8 visualises the positions, in terms of strategies implanted, of organisations assessed for this Master’s Thesis.
Figure 9: Innovation strategy circle - empirical data

(Source: own construct.)

* Companies D, G and H normally implement exploitative innovation, however, the companies have implemented exploratory innovation in the past, therefore, D, G, and H also hold the same position on the exploitative side of the circle.

Figure 9 provides some of the pros and cons of implementing a specific combination of innovation strategies, opportunities and challenges.
The graphs above combine the previously discussed innovation factors and positions the analysed organisations in terms of innovation strategies implemented. Based on the data we gathered from the eight companies we can draw a conclusion that for the assessed LMTs it was not a particular innovation strategy, openness of the innovation or the scale of innovation (exploitative or explorative) that enabled the organisations to establish a leading or strong position in the markets that they were serving. It was the ability to identify relevant knowledge and absorb that knowledge that were the key factors in enabling the organisations to develop a strong position in their respective markets. The assessed organisations, depending on the innovation strategy chose different sources for knowledge acquisition.

The factor that all of the organisations have in common is culture. All of the assessed organisations had a pro-innovation culture (or at least a pro-innovation mind-set at the board level – Company H) with a solid understanding in importance of knowledge and new capability development and the true meaning that innovation had to their business; these organisations understand that they only have two alternatives: to innovate or surrender.
Based on the information in this section we can provide key managerial implications:

- Ability to identify relevant knowledge for innovation initiatives and absorb and apply holds a greater significance than a particular or a mix of innovation strategies.
- Problem identification requires existing knowledge
- Organisations enabling employee capability and skill development identify and find solutions to more complex problems (see definition p.2) that are more valuable to the organisation
- Organisations that enable employee development are better at identifying relevant network partners and relevant information needed for innovation initiatives
- “Technology fountains” – organisations implementing inbound and outbound open innovation had shorter innovation lead times
- Assessing future trends and implementing contingency planning activities help eliminate future threats

During empirical data analysis we have discovered additional information that contribute to the purpose of the study. We have discovered that although the companies in our population did not have a formalised processes for innovation, the steps that they undertook before launching and during innovation initiatives were similar and formed a pattern (see figure 9: Innovation process flow).

Figure 11: Innovation process flow

(Source: own construct.)
1. Management decisions
Management selects problems or projects to work based on internally set criteria. Based on the circumstances and possibilities, management will decide the level of organisational openness for information and knowledge exchange and the level of network involvement.

2. Knowledge acquisition
If the organisation is taking an open approach to innovation knowledge search starts internally and moves to the business network. The information gathered outside of the organisation e.g. within the business network influences innovation decisions regarding the development of the innovation, the new capabilities and knowledge needs. Based on the new information, previously made decisions on the openness and network involvement might be altered.

Regional, national and even European Union level innovation systems had an influence on the projects that were chosen at the assessed at least at one point during the existence of the assessed organisations. The assessed organisations actively sought after funding projects and tailored their innovation initiatives to match the funding criteria.

3. Implementation
The knowledge and the availability of resources drive decisions regarding the scale of the innovation project. Depending on the market environment the previously mentioned factors may determine the decision to aim for explorative innovation.

The innovation process pattern identified at the LMTs assessed signify the importance of knowledge at LMTs and the influence of knowledge on selecting innovation strategies. We have witnessed that LMTs are capable of explorative innovation in their own LMT environment, provided that the innovation projects that they are developing are not high in complexity.
6 Conclusion

The conclusion will present the key findings of this Masters’ Thesis. The purpose of this study will be elaborated and the research question will be answered. In the end, limitations and further research will be presented.

The purpose of this study was to crystallise the understanding of how LMTs innovate and which innovation strategies they use in order to strengthen or develop on their competitive advantage. In accordance with the literature review, the empirical data confirmed that new knowledge acquisition and application is a key drive for innovation. An organisation needs certain knowledge in order to create new knowledge as needed for innovation. The interviewed organisations held either a leading or a strong position in their respective markets as a result of their drive for innovation. The organisation analysed did not have a formal structure for innovation, however, after analysing the data it was evident that the organisations were following a similar pattern for innovation.

All of the eight researched organisations showed continuous exploitative innovation strategies, however three of them have implemented explorative innovation as well. All of the organisations assessed held objectives such as efficiency refinement, implementation and execution of the ideas generated. The ideas mostly concerned the improvement of established designs or the expansion of productivity and distribution channels. Explorative innovation, as analysed at three organisations, demands extensive commitment of resources such as research, risk taking and experimentation. At these organisations explorative innovation was possible because of the existing conditions such as ability to use existing machinery to produce new products, ability to modify existing products for different use and produce new products of which the development does not require new complex knowledge and competencies. Organisations could enter completely new markets with modified existing products. New market entry required the organisations to employ sales people with previous experience in the new markets that the organisations were aiming to enter.

The assumption that the low nature and the market environment of LMTs and allow solely exploitative innovations, was not confirmed by the empirical data gathered for the study. LMTs are capable of explorative innovation in their LMT environment, given that those innovation projects are not complex in nature. Long-term strategic planning activities were not witnessed at the organisations assessed, however, all of them acknowledged the need for continuous innovation and importance of knowledge and skills in their respective markets. Only one of the assessed organisations conducted market research for long-term business planning. Some of the assessed organisations were searching for additional sources to generate revenues through investment to other organisations or market analysis activities for new opportunities. Four organisations with closed innovation strategies were found, however, only one of the four organisations had a pure “isolationist” innovation culture. The other three organisations had “followers” innovation cultures basing their innovation initiative decisions on the client data. Two out of these four organisations process a reactive way of product development. A reactive way of innovation can be a sign of a short-term planning R&D. However, the two other organisations with a closed innovation strategy explicitly operate in a long-term planning R&D as the nature of their products require perspectives in periods of years.
In the following the research question of this masters’ thesis is stated and will be answered subsequently:

**How organisations under low- and medium-technology industry category innovate and what is the impact of the chosen innovation strategy or a combination of innovation strategies on organisation?**

The researched organisations showed an emphasises on identifying the abilities of employees and selectively appoint them to suitable tasks. To selectively involve employees in problem solving allows the organisation to resolve more challenging problems. The procedure of identifying, prioritising and selecting relevant knowledge. The ability to identify and understand internal knowledge and skills, identify knowledge gaps, generate and apply the new knowledge lead to competitive advantage and therefore allowing the assessed organisations to establish strong market positions. The organisational culture of innovative organisations is lead in a low power distance way. The authors believe that low power distance was one of the factors enabling knowledge utilisation. The low power distance enforces a higher level of employee involvement, professional development of employees and the communication among employees is vertically and horizontally given.

The question which innovation strategy leads best to a competitive advantage is answered in the following. For the eight interviewed LMTs, the main reason why they are market leader is not their innovation strategy or scale of innovation per se. In fact, the organisation’s ability to identify and absorb relevant knowledge is decisive factor. The relevant knowledge for LMTs is knowledge which is related to a specific problem. How the problems are filtered and chosen depends on the decision makers in an organisation and their internally set criteria. The gathering of knowledge is usually informal through business networks or from client organisations. Criteria for gathering knowledge or selecting problems do not exist at all researched organisations, however recurrent objectives could be identified. Those criteria are return on resource invested, resource availability and current capacities and time required for the new capacities to develop.

The authors of this thesis have identified three different types of processes for knowledge assessment and absorption processes which lead to the implementation of innovation initiatives. A process can start with informal and unscheduled discussions with key individuals when new information is received. Another process can be scheduled and organised meetings with selectively relevant employees. The last process which has been identified is similar to the previous one, however, involves an R&D department with at least one full-time employee, dedicated to implementation of innovation initiatives. The latter is able to identify and find solutions to more complex problems compared to the other ones. Organisations with R&D departments containing at least one full-time employee have expertise to hand to quickly assess more complex innovation ideas and assess resource requirements for a particular innovation project.

The interviewed organisations analysed data such as market trends, competition, government regulations, new technologies and materials and developing new organisational capabilities. This data allowed the LMTs to identify and understand knowledge and skills gap needed to leverage opportunities and neutralise threats.

The authors of this thesis developed a strategy positioning map with the literature findings at the beginning of this study. This map includes the four strategies of innovation:
open exploitative, open explorative, closed exploitative and closed explorative. The map was filled with the empirical data gathered and challenges and benefits of each segment were listed. To be in the open exploitative segment means for organisations to face challenges developing trustworthy relationships and maintaining relationships. Typical is to have fast knowledge absorption and short innovation lead-times. Open explorative LMTs were not found in this study. Closed exploitative organisations showed to be highly dependent on their customers in order to innovate. The risk for this segment is that those organisations miss market or product opportunities which they are not aware of due to their constricted knowledge pool. Organisations which apply a closed explorative innovation strategy face the same challenges as closed exploitative strategies. They could potentially miss bigger opportunities which only knowledge outside their current knowledge pool could help identify.

The factor that the organisations shared in common was understand of the importance of innovation. The interviewed persons emphasised on the pro-innovative culture and their employees understanding of how essential R&D is for the continuity of the organisation. The majority of the researched organisations do not have formalised innovation patterns. The steps they undertake before and during innovation initiatives depend on the product or are steered by management that are responsible for R&D within their organisations.

Our final conclusive remark is that within the analysed LMTs a superior innovation strategy did not exist. The authors of this thesis have witnessed a variety of combination of innovation strategies all yielding results allowing these organisations to enjoy strong or leading market positions in their respective markets. The key factor for these organisations was continuous innovation, understand of their internally possessed knowledge and capabilities and ability to fully utilise internal resources.

6.1. Limitations and further research

The findings of this study are based on eight case studies which are selectively chosen and analysed by the authors of this paper. The paper only assessed LMTs that held a strong or a leading position in their respective markets. The inclusion of poor performing organisations could help lay a stronger basis for our claims that knowledge utilisation and drive for innovation are the key factors leading strong organisational performance. The organisations assessed operated in various industries, however, the authors’ objective was to assess innovation strategies in LMT industry category and not specific industries. The authors understand that different market environments create and hinder growth opportunities and opportunities for innovation. One or two employees were interviewed at each organisation assessed for the study. The empirical data did not provide information about open explorative innovation strategies in LMTs. It is arguable that the absence of empirical data about open explorative innovation does not provide holistic view about the four innovation strategies, however, it is a finding in its own right. The authors believe that open innovation organisations engaged into collaborative innovation projects saw no necessity to engage into risky, uncertain initiatives. Furthermore, different markets present these organisations with unique opportunities and challenges. Perhaps the closed explorative organisations were facing greater market uncertainty than the explorative innovation itself.

Further research could further investigate explorative innovation at LMTs and factors driving influencing LMT organisations to implement explorative innovation to develop a
deeper level understanding. Furthermore, as the authors of the paper did not witness open explorative innovation in the empirical findings, it would beneficial to investigate and identify open-explorative LMTs. For the authors of this study it is questionable to which extent they exist and their success in LMT industries. Other research could include interviewing multiple employees in an organisation which deal with innovation. The multiple views on different hierarchical levels could reveal more insights on the processes inside an organisation.
References


References


review of GLOBE's and Hofstede's approaches. Journal of international business studies, 37(6), 897-914.


References


unified view of working, learning, and innovation. Organization Science 2 (1), 40–57.


## Appendix

### A1 – research gap

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Title</th>
<th>Journal</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Heidenreich, M.</td>
<td>Innovation patterns and location of European low- and medium-technology industries</td>
<td>Research Policy</td>
<td>The central questions of this article were (1) whether a specific innovation pattern of low and medium-low industries exists, and if so, (2) whether this pattern can be the basis for an autonomous, economically successful development.</td>
</tr>
<tr>
<td>2005</td>
<td>Hirsch-Kreinsen, H., Jacobson, D., Laestadius, S., &amp; Smith, K. H.</td>
<td>Low and medium technology industries in the knowledge economy: the analytical issues</td>
<td>Book: Low-tech Innovation in the Knowledge Economy</td>
<td>To explore some of the issues and to underline the main aspects that have been focussed upon in the PILOT project.</td>
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<tr>
<td>2008</td>
<td>Jiang, J., &amp; Guan, J. C.</td>
<td>An analysis of relative efficiency to Chinese low-</td>
<td>Studies in to measure relative efficiency of technological innovation in</td>
<td></td>
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<tr>
<td>Year</td>
<td>Authors</td>
<td>Title</td>
<td>Journal</td>
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<tr>
<td>2008</td>
<td>Heanue, K. P., &amp; Jacobson, D.</td>
<td>Embeddedness and innovation in low and medium technology rural enterprises</td>
<td>Irish Geography</td>
<td>The implications of Entrepreneurial Orientation (EO) for firm performance in low- and medium-tech (LMT) industries.</td>
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<tr>
<td>2009</td>
<td>Grimpe, C., &amp; Sofka, W</td>
<td>The integration of old and new technological paradigms in low-and medium-tech sectors: The case of mechatronics</td>
<td>Research Policy</td>
<td>the role that location plays in the innovation processes of low and medium technology firms.</td>
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<tr>
<td>2009</td>
<td>Freddi, D.</td>
<td>The integration of old and new technological paradigms in low-and medium-tech sectors: The case of mechatronics</td>
<td>Research Policy</td>
<td>Search patterns of information (where the information comes from, comparison between HT and LMT) and knowledge for innovation.</td>
</tr>
<tr>
<td>2011</td>
<td>Hervas-Oliver, J. L., Garrigos, J. A., &amp; Gil-Pechuan, I.</td>
<td>Making sense of innovation by R&amp;D and non-R&amp;D innovators in low technology contexts: A forgotten lesson for policymakers.</td>
<td>Technovation</td>
<td>This article addresses the internal transformation of low- and medium-tech (LMT) sectors from a technological perspective, analysing the absorption of radical new technologies by low- and medium-technology (LMT) firms and their integration into frameworks dominated by older technologies.</td>
</tr>
<tr>
<td>2007</td>
<td>Robertson, P. L., &amp; Patel, P. R.</td>
<td>New wine in old bottles: Technological diffusion in developed economies.</td>
<td>Research Policy</td>
<td>To analyse how R&amp;D activities differ in innovation from non-R&amp;D activities, especially in the context of low and medium–low tech (LMT) sectors where most of the firms are SMEs.</td>
</tr>
<tr>
<td>2004</td>
<td>Chang, P. L., &amp; Shih, H. Y.</td>
<td>The innovation systems of Taiwan and China: a comparative analysis</td>
<td>Technovation</td>
<td>Innovaiton systems</td>
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<tr>
<td>2010</td>
<td>Hansen, T.</td>
<td>The Danish fabricated metal industry: A competitive medium-low-tech industry in a highwage country.</td>
<td>Geografi sk Tidsskrift -Danish Journal of Geography</td>
<td>Innovation strategies</td>
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<td>Year</td>
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<td>Journal/Conference</td>
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<td>2017</td>
<td>L. Dooley, B. Kenny &amp; D. O’Sullivan</td>
<td>Innovation capability development: case studies of small enterprises in the LMT manufacturing sector</td>
<td>Small Enterprise Research</td>
<td>Focus lies on SME LMTs innovation and create value from external sources through internal systems.</td>
</tr>
<tr>
<td>2009</td>
<td>T. Kuen-Hung, W. Jiann-Chyuan</td>
<td>External technology sourcing and innovation performance in LMT sectors: An analysis based on the Taiwanese Technological Innovation Survey</td>
<td>Research Policy</td>
<td>Researches internal innovation versus outsourcing innovation or smaller scale projects on Taiwanese LMTs.</td>
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<td>2009</td>
<td>L. Santamaria, M. J. Nietob, A. Barge-Gil</td>
<td>Beyond formal R&amp;D: Taking advantage of other sources of innovation in low- and medium-technology industries</td>
<td>Research Policy</td>
<td>LMTs (Spanish manufacturing firms) research non-formal R&amp;D activities and the use of external sources such as consultants, the hiring of personnel, collaboration agreements or external R&amp;D.</td>
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<tr>
<td>2015</td>
<td>H. Hirsch-Kreinsen</td>
<td>Patterns of knowledge use in ‘low-tech’ industries</td>
<td>Prometheus – Critical studies in innovation</td>
<td>This paper investigates the empirical taxonomy of innovative LMT firms based on the dimension of knowledge. Four different patterns of knowledge use in LMT were identified: market-, supplier-, firm specific and R&amp;D based knowledge.</td>
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<tr>
<td>Year</td>
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<td>Title</td>
<td>Journal</td>
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<td>2012</td>
<td>R. Cappellin</td>
<td>Knowledge creation and innovation in medium technology clusters</td>
<td>Emerald Group Publishing Limited</td>
<td>Opposition of innovation networks and interregional knowledge creation with focus on internal capabilities</td>
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<tr>
<td>2017</td>
<td>F. Lambrechts, W. Voordekers, N. Roijakkers, W. Vanhaverbeke</td>
<td>Exploring open innovation in entrepreneurial private family firms in low- and medium-technology industries</td>
<td>Organizational Dynamics</td>
<td>Open innovation and decision making in LMTs</td>
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<td>2017</td>
<td>M. A. Villamizar, A. Cobo, R. Rocha</td>
<td>Characterisation of the Manufacturing Sectors of High and Medium-High Technology Compared with Other Industrial Sectors</td>
<td>Journal of Technology Management and Innovation</td>
<td>Innovation of LMTs compared to non-technical sectors</td>
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<td>2016</td>
<td>S. Fabiana Matos Da; O.Edson</td>
<td>Innovation development process in small and medium technology-based</td>
<td>RAI Revista de</td>
<td>Observation of LMT innovation sources and analyzing organizations decision makers</td>
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<tr>
<td>Year</td>
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<td>Title</td>
<td>Conference</td>
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<td>2015</td>
<td>C. Fassio</td>
<td>How Similar is Innovation in German, Italian and Spanish Medium-Technology Sectors? Implications for the Sectoral Systems of Innovation and Distance-to-the-Frontier Perspectives</td>
<td>Industry and Innovation</td>
<td>Cross country comparison of European organisations and types of innovation and source of knowledge</td>
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<tr>
<td>2011</td>
<td>M. Nouman, L. Warren, S. Thomas</td>
<td>Researching the 'Forgotten Sector': Low and Medium Tech (LMT) Innovation - Present Light on Future Trends</td>
<td>First International Technology Management Conference</td>
<td>Focus on LMT and the status of its scientific research. Specially the topic of innovation and the role of individual, the nature of learning processes, the dynamics of demand and influence of institutions within organisations</td>
</tr>
</tbody>
</table>
A2 – Interview Guide

1. Background
   Background
   Challenges/Threats
   Opportunities
   Actions
   Company objectives

2. Innovation process
   Innovation journey from idea generation to implementation
   Innovation initiator (who starts innovation?)
   Ideas (who screens the ideas for innovation?)
   Triggers for innovation (who screens the ideas, who initiates?)
   External information or only internal?
   Acquiring resources and capabilities needed for the innovation process
   Technology absorption and sharing
   Challenges within the innovation process

3. R&D
   Where does R&D take place
   R&D expenditure
   Client/partner involvement in the R&D process
   Key objectives for R&D
   R&D challenges and threats

4. Network
   Level of collaboration (how open are you with your clients/partners, why?)
   Joint development, joint collaboration etc.
   Information exchange (to what extent do you exchange information, what kind of information, level of trust)
   Sharing internally developed technology and charging royalties etc.

5. Organisational structure
   Hierarchies
   Management structure: top-down, or bottom-up
   Age of workforce
   Information dissemination and employee involvement in R&D activities

6. Organisational culture
   Leadership style (values, beliefs assumptions, outcomes that support the presence of support of innovation, creativity, risk-taking)
   Attitude towards change
<table>
<thead>
<tr>
<th>Organisation initiatives</th>
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<tbody>
<tr>
<td>Attitudes to not-made-here goods</td>
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</tbody>
</table>

7. **Marketing**

How are potential clients reached

8. **Growth and organizational development**

Growth patterns and reasons behind

Growth projection

9. **Past experiences**

Changing markets

Process problems

Development problems

Involvement problems