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Innovation as a function of company performance

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The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

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Abstract

This thesis aims to provide clarity on which factors within an organization positively affect its performance in terms of innovation. Innovation is seen as a critical component of a company's strategy in achieving market differentiation and profitability, yet for many, it remains a frustrating pursuit. This study aims to empirically model the relationship between a firm's investment in innovation and the effect of this investment on its performance. The method used is Structural Equation Modeling with data gathered from our online survey of 128 respondents from firms within the EU. This work addresses two research questions, the first being to confirm that a firm's innovation performance is influenced by both a commitment to human factors focusing on softer values in combination with strong R&D and technical capability. Secondly, whether the presence of innovation inhibitors influences this relationship. The findings showed that a firm's innovation performance is improved when it prioritizes creating an environment and culture that nurtures innovation only when activated through a strong commitment to technical and R&D excellence, but not without this technical capacity. Secondly, the introduction of innovation inhibitors reconfirmed the first finding, and the relationship between both the human factors within a company and its technical capability, as well as the relationship between this technical capability and its performance was stronger in their presence.

Keywords

Innovation, Innovation Management, Innovation Strategy, Disruptive Innovation, Structural Equation Modeling, SEM

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1 Introduction

For companies aiming to differentiate themselves within their market and pursue high performance, there is extensive research showing that investing in, and implementing innovation strategies is essential (Adams, et al., 2006, p. 21). Despite the challenges associated with defining and managing innovation, past research has highlighted a variety of benefits for companies that mange to mobilize innovation strategies effectively, allowing them to achieve higher profits and market share (Prajogo & Ahmed, 2006, p. 499). In practice, industry has also followed this trend, as according to *2018 Gartner CEO and Senior Business Executive Survey* C-suite executives are heavily pursuing innovation and digital business transformations across their enterprises. As an example, according to the survey, 63% of CMO's surveyed expect spending on innovation-related budgets to increase in 2019. However, despite massive investments in both management time and money, innovation remains a frustrating pursuit for many.

One reason for this frustration is that innovation is broadly used, and can refer to product, process, organization and new market creation (Schumpeter, 1942). This study focuses on organizational innovation that is notoriously hard to measure. It aims to model the relationship between a firm's investment in innovation and the effect of this investment on its performance.

This research is built on past studies but proposes some new avenues of investigation by studying the technological side (such as the influx of artificial intelligence), and human factors (such as the prioritization of diversity and gender equality). This allows not only for a model describing the relationship between organizational innovation and a firm's performance but also allows for a better understanding how the latest trends in management and human resources influence this relationship, particularly in the presence of innovation inhibitors.

1.1 Problem Discussion

Innovation as a term is broadly used and too frequently supports a variety of business activities, describing an impractical variety of industry situations (Christensen, et al., 2015). Often it is confused with creativity, which itself is a crucial aspect of innovation (Viki, 2016), but not enough to explain how successful innovation management leads to superior firm performance. In the context of this research, the modern definition of innovation by Joseph Schumpeter is referred to, which is *the commercial or industrial application of something new—a new product, process, or method of production; a new market or source of supply; a new form of commercial, business, or financial organization* (Schumpeter, 2017, p. xix). In his writings, he consistently refers to the distinction of innovation from invention (or creativity) were new ideas must be linked to commercialization or value creation. In his word's *innovation involves the (1) commercial application of (2) any new idea* (Schumpeter, 2017, p. liv). This paper has attempted to expand on this and build a definition of innovation that combines Schumpeter's and Christensen's work that states:

Innovation is a firm's ability to manage a set of resources and activities required to turn creative ideas into useful and marketable products with sustainably profitable business models.

The question being addressed by this study is not whether firms should employ innovation strategies and practices, but how to do so effectively. There are numerous academic studies that address this theoretical problem both on a holistic level (Prajogo & Ahmed, 2006) and on a more granular level focusing on specific aspects of innovation within the context of an organization such as *Knowledge Management Tools* (KMT) (Vaccaro, et al., 2010) and *Innovation Management* (Adams, et al., 2006). This research focuses more on a holistic perspective yet compliments the existing research by also exploring the effect of adding new technologies and cultural influences onto the results.

Practically, despite the positive relationship between a firm's investment in innovation leading to improved firm performance, past studies claim to have identified a lack of holistic frameworks that allow practitioners to manage their resources better in pursuing these superior results (Adams, et al., 2006, p. 21).

By addressing the theoretical questions, this study intends to facilitate practitioners by providing a robust set of findings that allows for better forecasting of how innovation, when integrated into an organization, has the potential to provide improved performance and thus value to their firm.

1.2 Problem Formulation and Purpose

This paper builds upon the research conducted by Prajogo and Ahmed in their work, *Relationships between innovation and stimulus, innovation capacity, and innovation performance.* Their work focused on examining both the human factors and

technological aspects together with innovation performance as opposed to in isolation. This simultaneous examination allowed them to explore the interplay between the two on the effect of performance, as independently these are not able to fully account for the range of determinant possibilities (Prajogo & Ahmed, 2006, p. 500). It is their integrated approach that makes the model relevant for this research.

This study aims to address two specific research problems. Firstly, the study aims to model and understand, when company executives mobilize innovation strategies within their firms, how do these influence the firm's performance? Methodologically parts of the reference model mentioned are replicated. For this purpose, Structural Equation Modeling (SEM) was used since it is particularly suitable for investigating human factors and subjective aspects of an organization's technical capability that are difficult to measure using other methods. For that purpose, a questionnaire to collect data that is in line with current research was also created.

Secondly, the original model was extended by adding three additional variables, these being the influence of artificial intelligence, as well as cultural diversity and gender equality. Essential to this second part is also the introduction of innovation inhibitors and understanding their effect on innovation performance.

This research was further constrained to companies, and more specifically their employees, operating in Europe.

1.3 Delimitations

There were several aspects that could play an important role yet were excluded from the study. These were *traditional financial metrics*, *innovation friction*, and *perception gap*.

Despite these being an important aspect of a company's performance relative to managing innovation internally, these were excluded as the impression was that elements of these are addressed in other sections of the study and the intention was to verify and extend Prajogo and Ahmed's work in a structured way. Additionally, the authors were limited by resources to fully explore all potential elements of a firm's innovation management and decided to limit the SEM model to better build on the reference study.

The ambition of the study is to empirically evaluate how innovation is used at an organizational level to influence performance. Despite these limitations, it must be acknowledged that these remain relevant and potentially significant as an area of further research beyond this study and are individually clarified in more detail here.

1.3.1 Traditional Financial Metrics

When reviewing a company's performance, focus naturally falls onto traditional financial metrics such as revenue and profitability. Traditional financial metrics were excluded from this study for two reasons.

Firstly, traditional financial metrics are reliable measures of a company's internal financial performance and are made up by sales revenues, net profit, return on sales, assets as a percentage of sales, and return on assets to list a few examples. As these are internal facing, they do not provide an external or market-based view of performance. From financial measures alone it is not possible to assess how well a company performs relative to external benchmarks of market growth, competitive pricing, product and service quality, and satisfying and retaining customers (Best, 2009, p. 66). To specifically consider the contribution of innovation to a company's revenue and profitability, a separate individual, or set of metrics would be required.

It could be argued that either identifying existing or devising a new standard of financial metrics that quantify the contribution of innovation could have been included in this study, these would, however, require the availability of financial data. The challenge associated with obtaining relevant financial data was the second reason traditional financial metrics were excluded from this study. Financial data is available for publicly traded companies, but for private companies, this information is harder to obtain and verify. Furthermore, and closely tied with the problem of defining innovation, is how companies categorize an innovation budget is not consistent.

Revenue and profitability are metrics driven by a wide variety of factors beyond just a company's innovations, so to simply connect the two would give deceiving results. As such, these were excluded from this study.

1.3.2 Innovation Friction

Innovation friction describes the friction within companies, and despite being perceived as negative, can in certain instances be productive, and yield a variety of benefits (Hagel III & Brown, 2005). It is a general term that could also describe

the condition within a firm as much as a firm's relationship with its target users.

Predictably, misunderstandings often arise when people with different background and skills sets try to collaborate. Therefore, companies and more specifically, management face a constant challenge of balancing and harnessing the friction within their firm's internal environment.

As an extension of this concept of friction, it can also exist between a product or service produced by a company and its key target users. This represents the friction between the internal capacity of the firm to increase its capabilities and meet the expectations of the market.

Assembling teams with committed people is off course an ideal objective for management, but the diverse clash of capable and highly specialized people can easily lead to conflict. Harnessing and effectively navigating this in an attempt to build shared meaning, intention, and trust helps to emphasize the benefits, and better avoid internal friction, which contributes to limiting the capacity of the team to meet the expectations of end users and the market (Hagel III & Brown, 2005).

1.3.3 Perception Gap

Perception gap describes the divided perception of a firm's level of innovation amongst the different layers of an organization's employee hierarchy. Quoting from the study by Dobni, Klassen, and Nelson, who attempted to measure this gap empirically:

There is a gap between the most senior levels of management and mid-level management in the perception of innovation in the organization. Top management often perceives the organization to be more innovative than the rank and file – in some cases this gap exceeds 10 per cent. Perception is reality, and the initial challenge for leadership will be to ensure commitment to continue to embed innovation culture, all the while managing the enterprise as an ongoing concern. (Dobni , et al., 2015)

As an example, when examining the practice of managing projects that focused on the delivery of an innovation process, a recent *Economist Intelligence Unit* survey (Gale, 2009) showed, 48% of respondents answered that adhering to project management practices (developed as corporate guidelines) helps them better manage project risks. Of this group, only 26% answered that they themselves have identified and managed risks in their own project review process, showing that despite the perceived capability, there still exists a perception gap between management intent and actual execution within a company.

1.4 Thesis Structure

The first chapter aims to outline the purpose or the research and quantify the theoretical problem being studied.

Following this, the second chapter is a literature review that summarizes the current theory related to the problem and itemizes the factors that influence innovation performance. More specifically, the independent components that make up the model are defined, and the relationship between an organization's softer values, technical competence, inhibiting factors, and their combined influence on performance are each explored. This chapter also covers the research framework as well as listing the hypotheses to be tested.

Chapter 3 outlines the methods of the research design and the SEM methodology.

In Chapter 4, the results of the quantitative analyses are presented and subsequently analyzed in Chapter 5. The final chapter, Chapter 6, is a summary of the primary conclusions of this research, and its practical implications.

2 Theory

The research for this study was built on the theory used to conduct two primary past studies. The first, and most prominent is Prajogo and Ahmed's work that follows the assumption that management of the innovation process consist of two key components, technology drivers and human factors. This categorization is significant as the second reference paper points to an innovation model compiled by Vrakking (Vrakking, 1990) that prescribes cross-pollination of several areas. This includes technological resources which focuses on the management of the accumulation of knowledge in regard to both existing and emerging technologies, together with the management of human resources through leadership, team-building, career management and productive culture. In general, this literature implies the need to merge technology and R&D together with organizational and cultural considerations rather than examine technology or culture in isolation in relation to innovation management (Prajogo & Ahmed, 2006, p. 500).

Following this convention, the following subsections examine the technological and human factors of innovation, as well as their inter-relationship which eventually ties back to innovation performance.

Throughout this paper, the following categorizations are referred to and define two primary elements of innovation, which are:

- Innovation in the context of *technology*.
- Innovation in the context of *human factors*.

Studies that focus on the technological aspects of innovation emphasize the importance of research and development (R&D) capabilities within a company, and promote the idea that strong R&D leads innovative firms (Napolitano, 1991) (LeBlanc, et al., 1997).

In contrast, studies focusing on human factors promote the importance of organizational structure and cultural aspects. This line of research examines the importance of people and management style within a company as the primary driver of performance of innovation strategies.

Finally, this study is adapted to follow the Organizational Innovativeness (OI) strand of research as classified by Wolfe in his work from 1994, *Organizational innovation: review, critique, and suggested research directions* (Wolfe, 1994). OI research has several specific characteristics outlined below:

- The objective is to discover the organizational characteristics which determine innovation performance.
- The unit of analysis is the organization, and the research model is a variance model, commonly characterized by a regression model.
- The data collection method usually employs a cross-sectional survey.

2.1 Technology as an element of Innovation

In the context of this study, an organization leverages technology as a driver within its innovation strategy. As part of the review both technology and R&D are examined, as well as Artificial Intelligence (AI) and Machine Learning (ML) as a technological influence.

2.1.1 Technology

Technology is a vital aspect of any organization's innovation strategy. A firm's competence in technology not only affects the products it releases and the processes it develops but can also play a significant role in shifting the fundamentals of a particular market or industry. These shifts can result in either or both the destruction of existing markets and the creation of new ones (Tushman & Anderson, 1986).

As technology is embedded both in a company's products as well as internal processes, the literature on the topic of innovation often highlights the connection, by promoting technology as an enabler for a company to push radical new products as opposed to focusing only on existing market needs (Berry & Taggart, 1994).

This study thus interprets and defines technology as the technical asset and knowledge a firm holds based on its operational activities and acquisitions.

2.1.2 Research and Development

The literature tightly connects R&D to innovation and is presented as the body within a firm that harbors technology. Companies labelled as innovative are credited for their high R&D investment, and the strength of these technical departments (Harryson, 2003).

The role of R&D within an organization is not limited to merely manufacturing or product development but can equally apply to service companies. Strategically R&D is utilized in many ways to either attack (or defend) a market, increase market share or create an entirely new market for the organization (Lowe, 1995).

In relation to strategy, a firm's ability to leverage R&D (and thus innovation) is described in David Teece's early work *Profiting from Technological Innovation* (Teece, 1986) where he emphasizes the role of patents, which are a primary output of a firms R&D. This is key to his concept of appropriability regimes which describes a framework exploring how innovators could maintain sustained profits from their innovations, as well as when they may be susceptible to displacement. According to this concept, a firm with a healthy appropriability regime can rely on licensing and other contractual arrangements, based on valuable patents, to extract rents from their innovations (Pisano, 2006, p. 1123).

In summary, the interpretation of the literature defines R&D as the body that develops, integrates, and mobilizes technology as an asset within an organization.

2.1.3 Artificial Intelligence, Machine Learning and their Role in Innovation

AI and ML describe general-purpose technologies that already have, and are likely to continue, to impact many industries (Varian, 2018). In the last five years, remarkable progress

has been made using multilayered neural networks in diverse areas such as image recognition, speech recognition, and machine translation. According to the *Financial Stability Board* report from November 2017, AI and ML have the potential to substantially enhance the efficiency of information processing, thereby reducing information asymmetries.

Spyros Makdridakis, in his article *The Forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms* examined parallel inventions of the industrial, digital and AI revolutions. He claims that the impact of AI on firms and the nature of employment will be significant primarily due to intensified global competition among firms and the use of big data and AI in decision making.

As an example, applications of AI include Natural Language Processing algorithms (LPN) to determine the collective mood of populations by analyzing the content of messages on social media. Referencing a particular company, this was used to gauge the relationship between the collective mood of the public and their influence to predict the crowd behavior (Lima, et al., 2016).

In the field of finance, companies are implementing AI in automated portfolio management, algorithmic trading, loan and insurance underwriting, fraud detection, financial news, sentiment analysis, and automated financial analysis reporting.

These examples highlight that AI and ML have the potential to be highly disruptive technologies both in the context of value-creating for clients and consumers but also on internal organizational processes which are directly related to innovation. As opposed to other technologies, AI and ML show the potential to have a significant impact on how innovation is managed within an organization and thus included within this study as its own construct.

2.2 Human Factors as an Element of Innovation

The *Human Factors* in regards to innovation within a firm describe a scenario where an organization's resources are focused on nurturing an environment that promotes innovative practices so that both individuals and teams are not only motivated but also have the means and capability to practice innovation effectively (Hauser, 1998).

The various aspects of these human factors of innovation are discussed below.

2.2.1 Leadership and Innovation

A primary factor of successfully managing innovation is the commitment of an organization's top management to innovation-driven goals. This is particularly significant if the strategic ambition is radical as the process of implementing innovation strategies of this nature tends to be both high risk and require significant capital and resources (Prajogo & Ahmed, 2006, p. 501).

Furthermore, in terms of a firm's performance, leaders need to be willing (and capable) to leverage frontier technologies as well as promote an environment in which innovation can flourish (Martensen, 1998).

2.2.2 People and Culture

There is extensive literature that explore practices that relate to the management of people so as to emphasize an environment that promotes innovation. This is a result of the strong connection identified, that ties culture as a significant factor in influencing innovation performance (Prajogo & Ahmed, 2006, p. 501). Amongst these practices, particular attention is given to empowerment and involvement.

Empowerment promotes a culture where employees feel a high level of autonomy and trust, and less constrained by traditional rules and workplace boundaries, thus enabling better practice and pursuit of innovation (Spreitzer, 2017). In addition, studies have also shown that empowerment is positively related to innovative behavior (as defined within those studies) and that employee empowerment is also closely tied to decentralized organizational structures, and considered an essential predictor of innovation within an organization (Prajogo & Ahmed, 2006, p. 502).

Creativity is also closely linked to innovation, and research shows that creativity is boosted (thus, innovation output increased) when cross-functional and cross-department collaboration is promoted within an organization. Various studies show a strong relationship between a firm's promotion of cross-functional teamwork and subsequent product performance (Kahn, 1996).

It is important to note that creativity can be perceived as a vague term so for the purposes of this research is linked to invention, or more specifically a critical element of the knowledge worker as defined by Peter Drucker in his article *Knowledge Worker Productivity: The Biggest Challenge.*

Among Drucker's six factors which outline knowledge worker productivity, innovation, learning, and the ratio of quality to quantity play key roles and are relevant in framing a definition of creativity (Drucker, 1999, p. 83).

Finally, relevant rewards also play an essential role, specifically those that are beyond monetary compensation. As an example, recognition of achievement is an important motivator. Appreciating the importance of these rewards is relevant, as a significant challenge for innovation managers is the fact that only a small portion of creative ideas will make it to market, let alone make a significant impact, and how this should be navigated effectively so as to not stifle motivation for innovation within the organization (Barney & Griffin, 1992).

Reflecting on the earlier definition of innovation, employees working within these functions need to be both motivated and supported in their ability to maximize their creativity (Prajogo & Ahmed, 2006, p. 502).

2.2.3 Knowledge Management

Knowledge Management (KM) relates to the framework used by management to gather and transfer knowledge within their organization so as to enhance their firm's ability to innovate (Nonaka & Takeuchi, 1995). In a practical sense, this describes an organizations ability to identify the value of new external information, integrate it, and effectively apply it, all of which is essential for innovation performance. It has also been shown that a firm's ability to identify and absorb external information is vital in its ability to generate ideas internally as part of the innovation process. The development of knowledge management has identified the relationship between a firm's innovation output and its investment in knowledge and knowledge workers (Prajogo & Ahmed, 2006, p. 502).

The concept of knowledge management is captured by Ikujiro Nonaka in his article *The Knowledge-Creating Company* where he outlines that much of the success of a series of well-known Japanese companies can be attributed to their unique approach to managing the creation of new knowledge. Specifically, this depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole (Nonaka, 1991).

Reviewing literature within KM identifies several vital practices. At a strategic level, it is important for executives to identify that knowledge is an asset and essential ingredient within a firm's strategic arsenal. As such, the management of this knowledge (that can take the form of patents and technologies as an example) requires an enterprise level investment. Operationally firms should prioritize their worker's ability to manage and share knowledge, as this has been identified as one of the primary enablers of creativity.

In summary, the literature suggests that the purpose of knowledge management is to minimize constraints and promote flexibility within an organization's human capital that leads back to a decentralized way of working described earlier. As such it is important for organizations to promote a way of working that is encouraging and promotes creativity which involves identifying, absorbing, and generating ideas (Prajogo & Ahmed, 2006, p. 503).

2.2.4 Cultural Diversity

Cultural diversity refers to a company's tendency to employ and promote people of all cultures and ethnicities to all levels of an organization, including senior management positions. Innovation practices and management are so dependent on a variety of human factors it is not surprising that cultural diversity is seen as an important issue to consider. Recent research conducted by McKinsey & Company has shown that companies in the top quartile of their sample for ethnic diversity are thirty-five percent more likely to have financial returns that outperform their national industry medians, and that when companies commit themselves to diverse leadership they are more financially successful (Hunt, et al., 2015). Furthermore, in terms of the context of this study, a recent article from Forbes quoted a Boston Consulting Group report stating:

Increasing the diversity of leadership teams leads to more and better innovation and improved financial performance (Powers, 2018).

An important consideration is that to realize the benefits of diversity it is important for companies to pursue Diversity Management (DM) voluntarily, thus representing intent and a strategic response to diversity (Davis, et al., 2016, p. 83). In essence, this means companies should aim to treat all people within their organization equally and impartially irrespective of their immutable characteristics. This is particularly important for all employee-employer interfaces

where decisions most visibly reflect equal employment opportunities such as recruitment and selection, promotions and rewards, recognition, career planning and professional development including but not limited to leadership programs and mentorship opportunities (Davis, et al., 2016, p. 82).

2.2.5 Gender Equality

Gender Equality in this context refers to the ratios of men to women in a company's senior management. Gender inequality in the workforce has been a well-publicized issue, and despite the situation improving, there is still a significant earning gap between men and women, and women are still highly underrepresented in the executive office.

This is in contrary to the fact that research shows that gender equality more often translates into better company financial performance (Desvaux, et al., 2010, p. 1). It could off course be argued that financial performance is separate to innovation performance of a firm however as according to the earlier definition, the outcome of innovation needs to have some commercial value, making some connection between the two plausible. In fact, the link between gender diversity and financial performance is a primary motivation for including this construct in the study and to better understand the relationship between gender diversity and innovation performance excluding financial metrics.

The same McKinsey and Company report identified two key boundaries that women experience in a professional setting. Firstly, *double burden* syndrome, being the combination of work and domestic responsibilities. The significance of this is highlighted when examined together with the second boundary being *anytime-anywhere* performance model where senior managers are expected to be always available at any time in any location (Desvaux, et al., 2010, p. 6). This in part explains why despite a growing trend of an increase in female university graduates over the last four decades, this does little to address the under-representation of women in senior management and alone is not a solution to the issue (Desvaux, et al., 2010, p. 4).

To address this, the report identified a set of thirteen key initiatives that companies should employ to address female under-representation in senior positions. Of these thirteen, the importance of CEO commitment and women's individual development programs stood out as particularly important (Desvaux, et al., 2010, p. 8). Specifically, the report found for firms to address gender diversity, the most effective initiatives were (Desvaux, et al., 2010, p. 14):

1. *Visible monitoring by the CEO and the executive team of the progress in gender diversity programs.*
2. *Skill building programs explicitly aimed at women.*
3. *Encouragement or mandates for senior executives to mentor junior women.*

This compounding evidence indicates that in terms of assessing the human factors of innovation and its effect on firm performance, it is important to include gender equality as a factor in this study.

2.3 Innovation Inhibitors

To understand the variables affecting innovation, it was equally important to investigate factors that inhibit the process of innovation and prevent companies from reaching their full potential.

Factors that hinder innovation have been written about extensively and cover a wide range of topics such as inappropriate internal company structure, insufficient planning and evaluation models, organizational routines, cultures, and leadership that stifle innovation, and an overall strategy that is reluctant to experimentation (Chang, et al., 2012, p. 441).

In the pursuit of innovation, many companies encounter internal and external barriers, or inhibitors, that limit the development of the right capabilities to support innovation. While forces of change could potentially stimulate exploration, internal resistance within a firm can often prevent innovation occurring. How much impact the removal of inhibitors has on a company's disruptive innovation capability as well as how difficult their removal is, depends on the nature of these barriers (Assink, 2006). As such, understanding these inhibitors and developing distinctive capabilities to bridge the internal gaps they create should be an integral part of a firm's innovation strategy (Assink, 2006).

The variables outlined below focus on factors most often associated with the implementation of disruptive innovation by companies. Some parallels can also be drawn between these variables and some of those covered in earlier sections of this paper. By including these, the ambition was to observe how significantly these inhibitors impact a firm's innovation performance.

2.3.1 Strategic Gap

Strategic gap discusses the gap within organizations that describes what senior management plans to accomplish, and what they actually manage to accomplish.

From a broader context of pursuing goals, an organization's leaders conceive a leadership position and develop benchmarks to monitor progress, that together are an organization's strategic intent (Hamilton III, et al., 1998, p. 406). The vehicle to achieve these goals is the mobilization of a company's core capability. This is different from core competence, which refers to technological and production expertise at various points of the value chain, whereas core capability more broadly describes the entire value chain. An example to highlight this difference, capabilities are visible to the end consumer, whereas competences often are not. As such, core capabilities are ideal for strategic level analysis (Hamilton III, et al., 1998, p. 407). For success, both are required and should be optimally misaligned so that corporate goals target the projected market as well as the corporation's future capabilities (Hamilton III, et al., 1998, p. 408).

This is highly relevant to the unpredictable nature of pursuing innovation. Thus, a strategic gap between intent and capability can adversely affect the potential of a company to pursue innovation in achieving its goals.

2.3.2 Business Unit Autonomy

For established firms developing disruptive innovation, Christensen is a proponent of tasking the development to an independent business unit or company as opposed to integration within the mainstream units. This refers to the theory of resource dependence, stating that a company's actions are limited to satisfying the needs of the entities outside the firm, these being customers or investors, which provide the primary resource needed for the company to survive (Christensen, 2011, p. 101).

For managers tasked with developing these innovations, the research shows they have two options: Convince the firm to invest in pursuing an innovation that is unproven and likely does not fulfil the requirements of the existing customer base. Or alternatively, create an independent entity to embed within emerging customers for whom the disruptive innovation is attractive. There is strong evidence suggesting that the second option provides a much higher probability of success (Christensen, 2011, pp. 102-103).

Only those new product endeavors that receive adequate funding and resources have the chance to be successful, thus it is logical that the patterns of a company's innovations mirror the patterns in which resources are allocated (Christensen, 2011, p. 103). As such if organizational units are not given genuine autonomy to pursue innovation, the likelihood of success diminishes.

2.3.3 Innovation Integration

Should a firm aim to insure against disruption, an approach recommended by Henderson, Clark, and others who developed the theory of supply-side disruption, is the opposite of independence, this being integration. The idea of integration is that in order to deal with new architectural innovations, firms need to continually challenge themselves to understand the linkages in their organization and evolve them to meet and assimilate innovations that emerge. Integration has been shown to be an effective proactive strategy to deal with what otherwise might have been disruption. Moreover, even though it was designed to target supply-side threats, integration also allows firms to develop capabilities to more effectively manage all disruptive threats after the fact—both demand- and supply-side.

That said, while integration does provide insurance, there is a clear premium to be paid. To proactively use integration to prevent disruption often involves sacrificing short-term competitiveness and even market leadership. Thus, real dilemmas are introduced for the firm in terms of trading off profitability and sustainability (Gans, 2016, pp. 97-98).

2.4 The Relationship Between Technology, Human Factors, and Inhibitors and their Influence on Innovation Performance

For this study it is important to not only understand how technology and human factors within the context of innovation influence performance, but also the relationship between the two. Within the reference research, the technological aspects were categorized as *innovation capacity* and the human factors, *innovation stimuli*. Keeping this convention, the theory implies that the possibility to affect a firm's capacity for innovation is directly influenced by its investment in innovation stimuli and the motivation of its knowledge worker (Drucker, 1999). It is also important to understand how this

relationship is affected by the presence of innovation inhibitors.

In practice, existing research suggests that simply having the capability in terms of advanced technology and a competent R&D team is not enough to truly influence innovation performance. Factors such as leadership and organizational culture are essential in leveraging this capacity for the benefit of the firm's competitiveness. As such, not only is it important that an organization is structured so as to promote this leverage for the firms benefit, but adoption of external ideas and technologies also require a culture that can implement these if they are to derive any competitive advantage (Prajogo & Ahmed, 2006, p. 503).

Based on the literature review within the primary reference study as well as the multiple parallel studies cited, it is fair to assume that the relationship between innovation stimuli and capacity of a firm, particularly in the presence of inhibitors, is as important to understand as each of these individually in relation to a firm's innovation performance.

2.5 Research Framework and Hypothesis

As a starting point, the framework of the study was to build on the previous research of Prajogo and Ahmed, which looked to explore the following relationships:

- The strength of the relationship between the technological and human factors of innovation management.
- How these influence innovation performances.

To explore this, the research was based on a model shown in *Figure 2-1*.

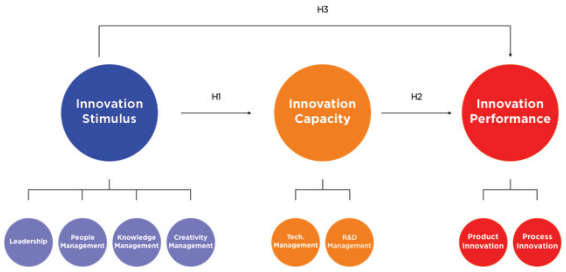

Figure 2-1 Integrated Model of Innovation Management

Using this model innovation stimulus is defined as the organization's willingness to pursue innovation, and specifically allocate resources to realizing the potential of innovation. Innovation capacity describes a firm's potential to innovate, referring specifically to the skills and strengths of its R&D capabilities and technology-based assets.

The assumption of past research is that should a firm not pursue innovation adequately than its potential, or innovation capacity remains underutilized either partially or fully. As such, a linear model with a two-stage relationship between the independent and dependent variables is shown where the stimulus factor determines the innovative capacity of a company, which subsequently influences innovation performance.

Similarly, to the original research, the direct relationship between stimulus and performance is also explored to understand whether stimulus can be linked to performance, independently of capacity.

By doing so, the research examines whether the stimulus aspects have two roles in not only harboring a company culture and environment conducive to innovation that directly influences a firm's ability to mobilize its innovation capacity but also as a factor that drives innovation performance independently. The original study thus assumes that an organization's innovation capacity in part supports the impact innovation stimulus on innovation performance. As such, three hypotheses were derived that are tested:

Hypothesis 1: There is a significant relationship between stimulus factors and capacity factors of innovation management.

Hypothesis 2: There is a significant relationship between capacity factors of innovation management and innovation performance.

Hypothesis 3: There is a significant relationship between stimulus factors of innovation management and innovation performance.

By retesting the original three hypotheses, the aim is to test the robustness of the original results. The first study was tested against managers of Australian firms, and this study will test this same theory in firms from Europe. This is relevant for two reasons, firstly this study examines the influence of comparing Australia's commodity focused economy with Europe's more diverse economy. Secondly, technology and management practices have evolved radically since 2006, when the original study was conducted, and this has had a significant impact on how firms operate in terms of internal processes.

In addition to triangulating the original findings, the study also aims to examine the influence of three additional constructs which were not tested in the original study but have the potential to influence the results significantly. These are the effect of cultural diversity and gender equality as innovation stimuli and artificial intelligence and machine learning as technologies on innovation capacity, and thus innovation performance. This is illustrated in *Figure 2-2* and subsequent hypotheses are listed below:

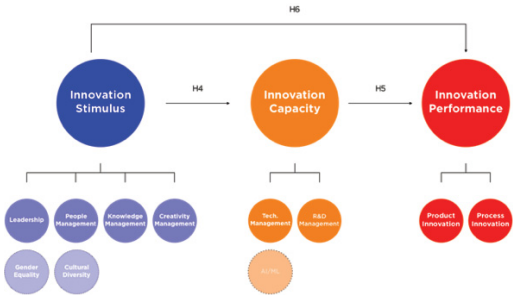

Figure 2-2 Integrated Model of Innovation Management with Extended Constructs to Innovation Stimulus and Capacity

Hypothesis 4: There is a significant relationship between stimulus factors and capacity factors of innovation management with the inclusion of gender equality, cultural diversity as stimuli, and AI and ML as capacity.

Hypothesis 5: There is a significant relationship between capacity factors of innovation management and innovation performance with the inclusion of AI and ML.

Hypothesis 6: There is a significant relationship between stimulus factors of innovation management and innovation performance with the inclusion of gender equality and cultural diversity.

Finally, it was important to understand how the relationships between stimuli, capacity, and innovation performance was influenced by the presence of innovation inhibitors, so the theoretical model to explore this is shown below in *Figure 2-3*.

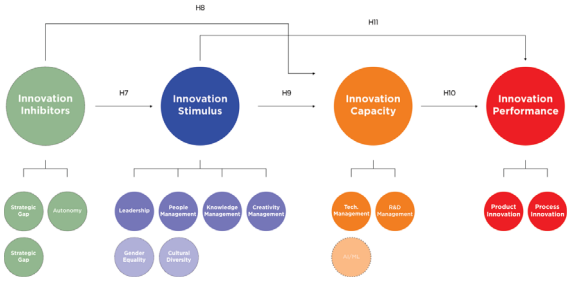

Figure 2-3 Integrated model of Innovation Management with Extended Constructs to Innovation Stimulus and Capacity in the Presence of Inhibitors

This led to the following hypotheses:

Hypothesis 7: There is a significant relationship between innovation inhibitors and innovation stimuli.

Hypothesis 8: There is a significant relationship between innovation inhibitors and innovation capacity.

Hypothesis 9: There is a significant relationship between stimulus factors of innovation management and innovation capacity in the presence of innovation inhibitors.

Hypothesis 10: There is a significant relationship between capacity factors of innovation management and innovation performance in the presence of innovation inhibitors.

Hypothesis 11: There is a significant relationship between stimulus factors of innovation management and innovation performance in the presence of innovation inhibitors.

3 Methodology

This research was conducted using Structural Equation Modeling (SEM) methods which are used primarily to establish the relationship between latent variables and indicators. This section of the paper outlines the steps taken to assemble the SEM model, as well as the operationalization of the various constructs.

3.1 Stages of Structural Equation Modeling

As a method, SEM is a combination of multivariate analysis, factor analysis and regression analysis. SEM is ideal as it is not only possible to confirm (or reject) one or more hypothesis about an existing relationship between various variables, but also estimate simultaneous dependency relationships and estimate measurement error within these variables (Hair Jnr., et al., 2010).

Confirmatory factor analysis (CFA) is a special instance of SEM and is used to both present and interpret the results of this study. CFA is the measurement aspect of SEM and shows relationships between latent variables and their indicators. The complimentary aspect is the structural component, or the path model, which shows how the variables of interest (often latent variables) are related. With the help of CFA, the hypotheses were tested around relationships between observed variables and their underlying latent constructs. Traditional statistical methods typically utilize one statistical test to determine the significance of the analysis, however, SEM,

and CFA specifically, relies on several statistical tests to determine the adequacy of a model's fit to a data set. The SEM process can be described in six stages:

1. Defining individual constructs.
2. Developing the overall measurement model.
3. Designing a study to produce empirical results.
4. Assessing the measurement model validity.
5. Specifying the structural model.
6. Assessing structural model validity.

The first three of the stages mentioned above, constitute the research methodology for this paper and are outlined in the following subsections.

3.1.1 Stage 1: Defining Individual Constructs

A high-quality measurement theory is necessary to obtain useful results from SEM (Hair Jnr., et al., 2010). Therefore, researchers need to invest extensive effort at the beginning of the research process to ensure that the measurement quality will enable valid conclusions, with a key focus being the definition of suitable theoretical constructs.

Once defined, the researcher operationalizes the constructs by selecting an appropriate measurement scale and type. It is important to note that it is common to use previous research studies to defined constructs, and study how past research has operationalized these, and a similar approach is taken in this study as discussed earlier. This replication of past research is an effective way to maintain the quality of new studies, as it is an evolution of theories and collected data that have likely shown a sufficiently good model fit. This extends to the gathering of data, where it is also common for past questions from similar research to be included in questionnaires (which is the data gathering method both in this study and the reference paper), to be replicated for the same reasons (Hair Jnr., et al., 2010). As mentioned, this paper references the constructs from past research, along with their working definitions as listed below and shown in *Figure 3-1*:

- Innovation stimulus (IS)
- Innovation capacity (IC)
- Innovation performance (IP)
- Innovation inhibitors (IH)

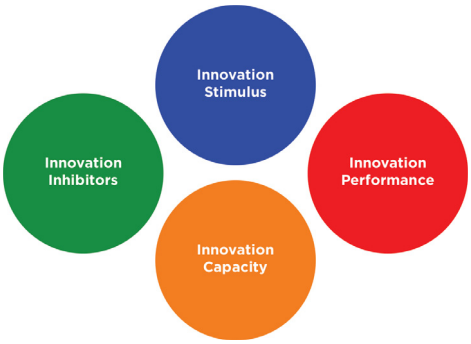

Figure 3-1 Identified Constructs

3.1.2 Stage 2: Developing the Overall Measurement Model

With the constructs specified, the next stage is to assemble the measurement model. In doing so, not only the relationships between constructs defined but also the nature of each construct (reflective versus formative) specified (Hair Jnr., et al., 2010). In the model, the set of measured variables (indicators) are explained by only one underlying construct without exception. Constructs are unidimensional in that each of the measured variables is hypothesized to relate to only a single construct. As such, the constructs are unidimensional, and all cross-loadings are set to zero.

The ambition was to include as many indicators as possible to fully represent each construct and maximize the reliability however, due to resource limitations and external academic recommendation the number of variables has been narrowed to get the smallest number of indicators that can still adequately represent a construct. It is important to acknowledge that more indicators are not necessarily better. Even though more indicators do produce higher reliability estimates, they also require larger sample sizes and can make it difficult to produce genuinely unidimensional factors (Hair Jnr., et al., 2010).

The path diagrams depicting the measurement model shown earlier in this paper, display fourteen measured indicator variables and four latent constructs. The error terms are not allowed to relate to any other measured variable, and the measurement model is congeneric.

Six measured items indicate the IS construct, and three measured items each indicate the IC and IH constructs. The model is over identified for innovation stimulus constructs but under identified for both the innovation capacity and innovation inhibitor constructs. In the proposed model, all the indicators are hypothesized as

reflective, in that the direction of causality is from the latent construct to the measured items.

3.1.3 Stage 3: Designing a Study to Produce Empirical Results

During this stage, the initial work focused on performing an initial screening for missing data. As a part of this, initial data analysis procedures to identify any problems in the data are also conducted, which includes but is not limited to issues such as data input errors. An SEM solution that produces an error variance estimate of less than zero (a negative error variance) is termed a *Heywood Case*, but such a result is logically impossible because it implies a less than zero percent error in an item, and by inference, it implies that more than one hundred percent of the variance in an item or a construct is explained. As both the innovation capacity and innovation inhibitor constructs have only three measured variables, particular attention is given to check the SEM solution for a *Heywood Case.*

Several classification variables were also collected with the questionnaire. The questionnaire itself targeted executive and senior manager level respondents however, responses from supervisors and individual contributors were also collected and included. All respondents completed the questionnaires online and anonymously. The questionnaire was sent to firms based in Europe, and the aim was to collect between one hundred and one hundred and fifty completed responses.

It was anticipated that if the model was over identified, then based on pretests, it was expected the communalities would exceed 0.5, and may even exceed 0.6, with sample size being adequate. If the model contained under identified factors, or if some communalities fell below 0.5, then a larger sample would have been required.

3.1.4 Questionnaire

The questionnaire has a closed question structure, and is included in its entirety in *Appendix A*. It is divided into three parts. In the first section, the participant is introduced to purpose and scope of this study, and it was is emphasized that all collected data remains confidential.

The second part contains the closed-ended questions in which a five-stage Likert scale is used to measure each construct, and is used to reduce bias (Krosnick & Presser , 2009; Allen & Seaman, 2007). The scale ranges from "1: Strongly disagree", "2: Disagree", "3: Neutral", "4: Agree" and "5: Strongly agree". Finally, the questionnaire consists of three to five questions of each measured variable and is distributed online via email and other messaging services.

The third part involves gathering the demographic data of respondents, which includes, geography, education level and occupation. This section of the survey also asks the respondent whether they would like to get a copy of the results at the conclusion of the study. Finally, recipients are also encouraged to forward the survey to other suitable candidates to maximize the number of gathered responses.

3.2 Operationalization of the Theory

To evolve theoretical concepts to empirical variables, four instruments were constructed as discussed earlier.

The first focused on measuring human factors within an organization which facilitate innovation stimuli, and the second contained three harder technical constructs which capture innovation capacity. In addition, the third instrument focused on factors limiting innovation within a firm and contained three constructs. The last instrument contained two constructs measuring two types of performance, these being product innovation performance and process innovation performance.

Development of the scale for the constructs was adapted from previous studies examining innovation stimuli, capacity, and inhibitors, as well as referencing a variety of industry-based reports. This second source proved to be particularly valuable when looking at constructs that had a significant social aspect, in particular, gender equality and cultural diversity. The details of this work are covered extensively in the literature review.

In terms of measuring innovation performance, this construct was assembled by capturing product and process innovation and referencing criteria from the reference study. The criteria used were the number of innovations, the speed of innovation, the level of innovativeness (novelty or newness of the technological aspect) and being the 'first' to market. These characteristics were applied to both product and process innovation.

4 Results

This section summarizes the results of the data collection. Firstly, detailed demographics of the respondents are presented in order to understand the population that has been surveyed, and how

the results relate to this population. Secondly, a usable data set was generated in order to perform an SEM analysis. A full summary of the raw results is added in *Appendix B*.

4.1 Respondent Demographics

The survey was sent out to a broad network of working professionals in Europe. Some of these in turn voluntarily spread the survey further to assist in increasing the number of responses and broadening the reach of the study. The collection period ran for four weeks, and during this time period 128 responses from participants from the following countries were collected:

- Denmark
- Germany
- Italy
- Netherlands
- Norway
- Sweden
- United Kingdom
- United States of America
- Australia
- Luxembourg
- Belgium
- India
- Malaysia
- Netherlands
- Switzerland
- United Arab Emirates
- France
- Singapore

As the focus was on European respondents, those from countries outside were filtered away. The vast majority of the responders were from Sweden (40.46%), followed by Germany (11.11%), and Denmark (5.50%) in third place.

The respondents came from a wide variety of industries, but in terms of job functions, almost half described themselves as either company executives (23.70%) or working with R&D (19.50%), marketing (14.40%), and finally engineering (10.20%). As a whole, there was a wide variety while also much crossover between the functions the respondents described, however, this was deemed acceptable based on the previously covered theory describing the effective implementation of innovation within an organization. Specifically, the importance of cross-collaboration and the alignment of a company's business and innovation focused strategies.

Another important characteristic was that the vast majority of responders (72.2%) were senior personnel within their companies, which was the intention. This included C-level (25.39%), directors (15.07%), and managers (31.74%), with the remaining being supervisors or individual contributors. Even though senior personnel within companies were being targeted, it was valuable to compare these responses with supervisors and individual contributors, in particular when considering variables such as strategic gap as an inhibitor, as well as various other human centric factors.

For the companies themselves, the results proved to be quite polar. The majority of the respondents came from companies with either under fifty employees (30.15%) or over one thousand employees (32.50%). This was replicated in terms of annual revenue where most of the respondents came from companies reporting a revenue of under ten million Euro (44.12%) or over one billion Euro (27.70%).

4.2 Data Reduction and Processing

In order to perform the analysis, the raw collected data from the survey was reduced into a useable data set of refined responses that constituted the input of each construct in the SEM model. It was important to review and compare the raw data with the survey questions and exclude those that could be interpreted as similar in order to avoid any collinearity issues. For this reason of similarity, the questions connected to variables to PD1, PI3, TM2, and L3 were not considered. For further clarity the full questions associated with these variables are listed in *Appendix A*.

Initially, a component matrix was produced, and any items showing a score above 0.70 were marked. Following this a rotated component matrix using Varimax and Kaiser Normalization was generated, and items that returned a score of below 0.70 were removed, leaving the final results that were carried over into the SEM model analysis.

After the non-compliant questions were removed, the validity of the data was verified by generating a *Total Variance Explained* table. The result produced was above 72%, which is considered appropriate. The final data that was used to drive the AMOS model are summarized below in *Table 4-1* and also shown in the updated path diagram in the following section.

As part of integrating this data into AMOS an additional check to determine if any additional

data reduction was required by performing an *assessment of normality*, specifically testing the values to be less than 5.0 for the Kurtoise value. The summary of this test is outlined below in *Table 4-2,* and no additional items were removed from the data set.

The original theoretical path diagram, along with all the matrices described as part of the data reduction are included in *Appendix C* for further reference.

Table 4-1 Final Rotated Component Matrix[a]

	Component			
	1	2	3	4
PDI2	0.837			
TM1	0.821			
TM4	0.780			
RM4	0.758			
PI2	0.754			
PI1	0.749			
A1	0.318		0.311	
L4		0.867		
PM2		0.786		
I1		0.764	0.326	
L2	0.376	0.752		
SG1			0.841	
SG2			0.781	
A4				0.924

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 5 iterations.

Table 4-2 Assessment of normality

Variable	min	max	skew	c.r.	kurtosis	c.r.
SG1	1.000	5.000	-0.124	-0.531	-0.396	-0.848
SG2	1.000	5.000	-0.199	-0.853	-0.469	-1.005
L2	1.000	5.000	-0.338	-1.447	-0.723	-1.547
RM4	1.000	5.000	-0.767	-3.283	-0.448	-0.958
TM4	1.000	5.000	-0.703	-3.010	-0.372	-0.795
TM1	1.000	5.000	-0.516	-2.210	-0.633	-1.356
A4	1.000	5.000	0.093	0.399	-0.461	-0.987
PI2	1.000	5.000	-0.075	-0.322	-0.671	-1.437
I1	2.000	5.000	-0.026	-0.111	-0.923	-1.976
L4	1.000	5.000	-0.317	-1.359	-0.707	-1.513
PM2	1.000	5.000	-0.815	-3.488	0.134	0.287
PDI2	1.000	5.000	-0.523	-2.241	-0.608	-1.301
PI1	1.000	5.000	-0.649	-2.780	-0.158	-0.339
Multivariate					16.223	4.308

4.3 Goodness of Fit

To be able to analyze the SEM model and draw some conclusions from the research, it was important to first test the data for model fit. This focuses on comparing the estimated covariance matrix to the observed covariance matrix generated from the measured data (Hair Jnr., et al., 2010). To generate a fit, first the chi-square ($\chi 2$) value was calculated, which is the fundamental measure of differences between the observed and estimated covariance matrices. Chi-square is represented by:

$$\chi 2 = (N - 1)$$

With this being the observed sample covariance matrix - SEM estimated covariance matrix where N = number of samples.

As opposed to other multivariate techniques, in SEM degrees of freedom (DF) is not derived from the sample size, but instead based on the size of the covariance matrix, which in turn comes from the number of indicators in the model (chi-square, on the other hand, is affected by sample size). DF is defined as:

$$df = 0.5(p*(p+1)) - k$$

Where p is the total number of observed variables and k is the number of estimated parameters.

The implied null hypothesis of SEM is that the observed sample and SEM estimated covariance matrices are equal, meaning that a perfect model fit is assumed. In testing the fit, the $\chi 2$ value increases as differences (residuals) are found while comparing the two matrices. With the $\chi 2$ test complete, whether the statistical probability that the observed sample and SEM estimated covariance matrices are equal in a given population was assessed. This probability is the traditional p-value associated with parametric statistical tests.

Generally, when a p-value for the $\chi 2$ test is shown to be small (statistically significant), it indicates that the two covariance matrices are statistically different, thus there are issues with the model fit. Ideally, the results return a relatively small $\chi 2$ value (and corresponding large p-value), indicating no statistically significant difference between the two matrices, supporting the idea that a proposed theory fits the results that were measured (Hair Jnr., et al., 2010).

Running the reduced data through AMOS returned a Chi-Square Goodness of Fit ($\chi 2$ GOF) value of 75.232, and the degrees of freedom (DF) value was 59. The subsequent statistical

probability was found to be 0.076. Despite the probability exceeding 0.05, it was assumed that the model was statistically significant, with 95% confidence.

To provide further robustness, the data was cross-checked with additional fit methods. The primary reason is that using χ2 GOF alone has two limitations. Firstly, χ2 is a function of sample size N, thus as N increases, so does χ2 even if the difference in the model remains identical. Secondly, it is likely that χ2 will grow with an increase in observed variables and model complexity. As such this can make achieving a satisfactory model fit difficult, and it is important to cross reference these results with alternative models of fit that have been developed to compensate for these biases that do influence the χ2, but have no impact on the actual fit. (Hair Jnr., et al., 2010). As such, the fit was further tested using the following:

- Goodness of Fit Index (GFI)
- Tucker Lewis Index (TLI)
- Comparative Fit index (CFI)
- Root Mean Square Error of Approximation (RMSEA)
- Root Mean Square Residual (RMR)

Starting with GFI, the test generated a value of 0.907. This is an acceptable value, considering that typical values range from 0 to 1 with over 0.90 being considered a good fit.

The TLI is a comparison of the normed chi-square values for the null and specified model, which to some degree takes into account model complexity. TLI is not normed, and thus its values can fall below 0 or above 1. Typically models with good fit have values that approach 1, and a model with a higher value suggests a better fit than a model with a lower value. The validity of the data was confirmed by a returned TLI value of 0.964.

The CFI is also an incremental fit index, and in a similar way to TLI, is normed so that typical values also range from 0 and 1, with higher values indicating better fit. As an index, CFI has many desirable properties, namely it's relative (but not complete) insensitivity to model complexity, making it is among the most widely used indices. CFI values above .90 are usually associated with a model that fits well, and the model returned a value of 0.972.

The value generated for RMSEA (which is an absolute fit index) is 0.050 and is below the 0.08 guideline. Empirical studies have shown that RMSEA is best suited to use in a confirmatory or competing model strategy, where sample size exceeds five hundred respondents. For low sample sizes, RMSEA typically does not give results as good as other methods (Hair Jnr., et al., 2010).

The error in prediction for each covariance term creates a residual. A common rule is to scrutinize any standardized residual exceeding |4.0| carefully. Standardized residuals are deviations of individual covariance terms and do not reflect the overall model fit. Root Mean Square Residual (RMR), is the square root of the mean of these squared residuals. The model returned a value of 0.073, where values under 0.1 are considered acceptable.

Considering these results, the model does show an acceptable goodness of fit. In general, it is important to acknowledge that these are considered guidelines and can vary dependent on the structure and complexity of the data set and model. A full fit summary is shown below in *Table 4-3* for reference.

Table 4-3 Goodness of fit summary

Goodness of fit Indices	Construct	Reference value
χ2 GOF	75.232, p= 0.07	0 < χ2 GOF
GFI	0.907	0.90 < GFI < 1
TLI	0.964	0.90 < TLI < 1
CFI	0.972	0.90 < CFI < 1
RMSEA	0.050	RMSEA < 0.08
RMR	0.073	-4.0 <RMR< 4.0

4.4 Full Structural Equation Model

After completion of the data reduction, the SEM model was reconfigured in AMOS to test the hypotheses. The results obtained are discussed below and also shown in *Figure 4-1*, as several indicators from the original theoretical model were removed.

The innovation performance construct showed strong relationships with the observed variables PDI2, PI1, PI2, which correspond to measured variables such as a firm's use of latest technology in new products and services, the technological competitiveness of the firm, and a firms' speed of adopting the latest technology. In contrast, indicators related to its pace of new product development, the number of new products brought to market, and the rate of change in its processes showed a less definite relationship with a firm's innovation performance.

The innovation capacity construct showed strong relationships with indicators TM1, TM4, and RM4. These related to indicators measuring firms where R&D plays a major role in its business strategy, firms that attempt to stay on the leading edge of new technology in their industry, and generally continuously following the next-generation of technologies. In contrast the results showed that measured variables relating to firms that tried to anticipate the full potential of new practices and technologies, pursed programs to acquire technological capabilities in advance, or having an R&D strategy characterized by high-risk projects with a chance of high return, did not have a particularly strong relationship with the capacity construct. An important observation was that the results did not show a strong relationship between the AI and ML indicator and the innovation capacity construct, so this was removed and the significance of this discussed in the next chapter.

The innovation stimulus construct showed a strong relationship with observed variables L2, L4, PM2. Of these indicators those associated with a firms' senior executives actively encouraging change and learning in the pursuit of excellence, a high degree of unity, and maintaining the freedom of both top-down and bottom-up communication showed a strong relationship with the innovation stimuli construct.

In contrast, the relationship was not as strong between the stimulus construct and indicators that represented the formalized and regular measurement of employee satisfaction, and a work environment that prioritized health, safety and well-being. This weaker relationship could potentially be explained by these having become more commonplace and are perceived as regular workplace features in most Western cultures as opposed to essential stimuli of innovation. A significant result was that the additional indicators introduced to the reference study measuring gender equality and cultural diversity did not show a strong relationship with the innovation stimuli construct and were removed.

Finally, the innovation inhibitor construct showed strong relationships with indicators I1, A4, SG1, and SG2. In addition to the variable describing a firm's organizational structure and internal practices that enable cross-functional communication and learning (I1) there were other similar variables connected with integration relating to developing intellectual property in cooperation with external partners, and good insight and connection with end customers which

Figure 4-1 Final SEM Model

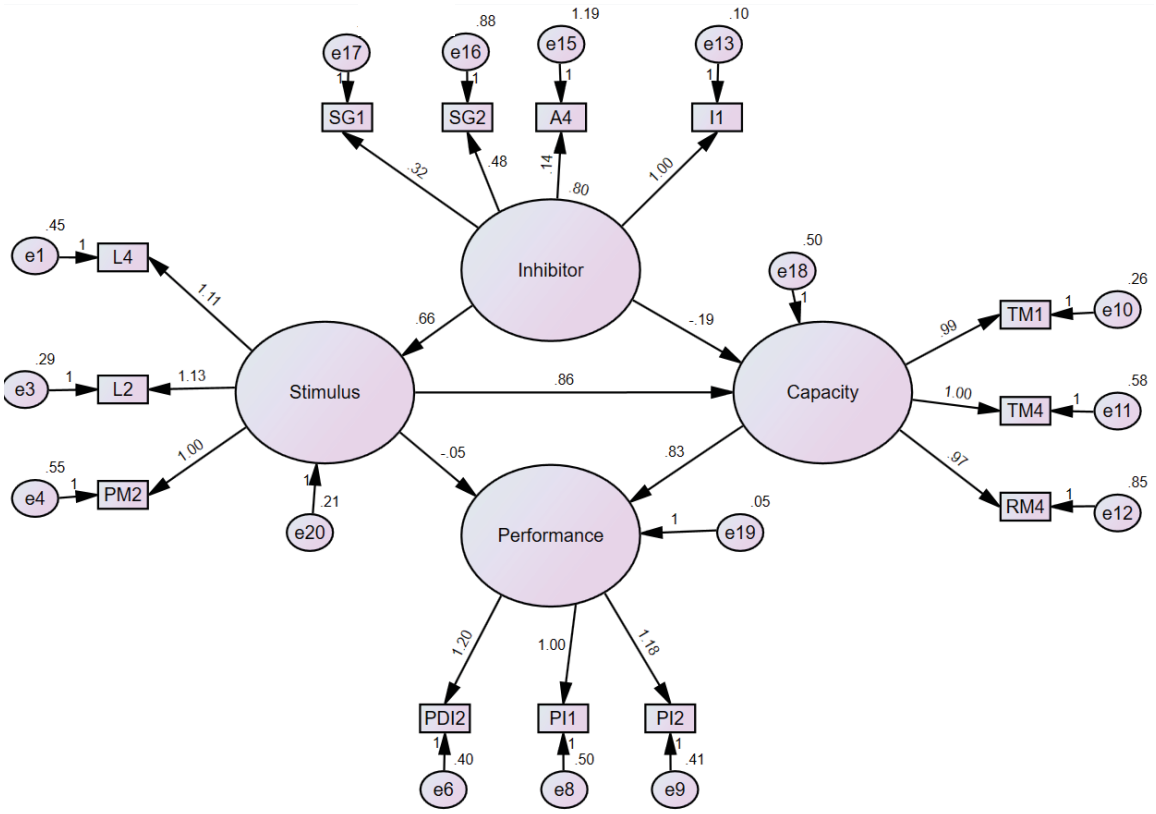

Table 4-4 Regression Weights

			Estimate	S.E.	C.R.	P	Label
Stimulus	<---	Inhibitor	0.657	0.158	4.149	***	IS
Capacity	<---	Stimulus	0.861	0.273	3.152	0.002	SC
Capacity	<---	Inhibitor	-0.190	0.213	-0.892	0.372	IC
Performan --	<---	Stimulus	-0.054	0.098	-0.550	0.582	SP
Performan --	<---	Capacity	0.829	0.131	6.323	***	CP
PI1	<---	Performance	1.000				
PDI2	<---	Performance	1.196	0.150	7.990	***	PPDI2
PM2	<---	Stimulus	1.000				
L4	<---	Stimulus	1.109	0.151	7.330	***	SL4
I1	<---	Inhibitor	1.000				
PI2	<---	Performance	1.176	0.149	7.903	***	PPI2
A4	<---	Inhibitor	0.140	0.126	1.115	0.265	IA4
TM1	<---	Capacity	0.986	0.110	8.982	***	CTM1
TM4	<---	Capacity	1.000				
RM4	<---	Capacity	0.972	0.139	6.990	***	CRM4
SG2	<---	Inhibitor	0.482	0.137	3.510	***	ISG2
L2	<---	Stimulus	1.129	0.145	7.806	***	SL2
SG1	<---	Inhibitor	0.317	0.120	2.636	0.008	ISG1
TM1	<---	Capacity	0.848				
TM4	<---	Capacity	0.755				
RM4	<---	Capacity	0.694				
SG2	<---	Inhibitor	0.418				

Table 4-5 Standardized Regression Weights

			Estimate
Stimulus	<---	Inhibitor	0.787
Capacity	<---	Stimulus	0.733
Capacity	<---	Inhibitor	-0.194
Performan --	<---	Stimulus	-0.054
Performan	<---	Capacity	0.985
PI1	<---	Performan	0.722
PDI2	<---	Performan	0.814
PM2	<---	Stimulus	0.710
L4	<---	Stimulus	0.776
I1	<---	Inhibitor	0.941
PI2	<---	Performan	0.804
A4	<---	Inhibitor	0.114
TM1	<---	Capacity	0.860
TM4	<---	Capacity	0.754
RM4	<---	Capacity	0.678
SG2	<---	Inhibitor	0.417
L2	<---	Stimulus	0.842
SG1	<---	Inhibitor	0.290

were excluded. Relating to autonomy, the primary variable described a firm not requiring new non-incremental innovations to conform to existing product architectures or manufacturing processes (A4), however variables that referred to delegating innovation to a dedicated innovation team, and that disruptive innovations were free to target new customers regardless of market size were excluded. A similarly strong relationship was seen with indicators connected with a firm's ability to meet product launch deadlines (SG1) and sales forecasts (SG2), and these related specifically to strategic gap.

The path diagram illustrating the final relationships between the latent constructs and indicators is shown in *Figure 4-1*. For further clarity of the results, additional values are also summarized in *Table 4-4* and *Table 4-5*, which show the relationship between the observed and endogenous variables. As a measure of robustness, standardized values of between 0.5 and 0.95 are expected to indicate a good fit, and the majority of the values are within this range.

5 Analysis

The analysis of the gathered results was performed over three scenarios. Each scenario considers the SEM model analysis of the relationships between innovation stimuli, capacity, and performance, both with and without the presence of innovation inhibitors. This discussion relies on the SEM path diagrams shown below, and for clarity, bold arrows indicated a strong relationship and light-colored arrows a weak relationship. In addition, the meaning of the SEM analysis is discussed in detail, and significant outcomes of the research are highlighted.

The three scenarios and subsequent analysis follow the structure of the hypotheses outlined earlier in this paper. The numerical results of all three scenarios are listed in *Table 5-1*, followed by an outline of the individual test of each hypothesis.

Table 5-1 SEM value summary

	Hypotheses	Standardised path scenario	p-Value	Result
Scenario1	H1	0.686	0.001	Confirmed
	H2	0.963	0.001	Confirmed
	H3	-0.020	0.822	Rejected
Scenario 2	H4	0.686	0.001	Confirmed
	H5	0.962	0.001	Confirmed
	H6	-0.042	0.689	Rejected
Scenario 3	H7	0.787	0.001	Confirmed
	H8	-0.194	0.372	Rejected
	H9	0.733	0.002	Confirmed
	H10	0.985	0.001	Confirmed
	H11	-0.054	0.582	Rejected

The first scenario, shown in *Figure 5-1*, focused on evaluating the relationship between innovation stimuli directly with innovation performance, and indirectly through innovation capacity. This re tested the reference study and was connected to the first three hypotheses which were:

Hypothesis 1: There is a significant relationship between stimulus factors and capacity factors of innovation management.

Hypothesis 2: There is a significant relationship between capacity factors of innovation management and innovation performance.

Hypothesis 3: There is a significant relationship between stimulus factors of innovation management and innovation performance.

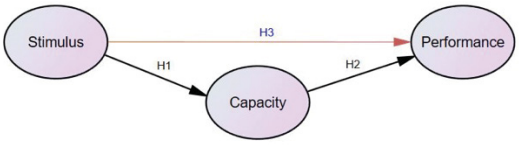

Figure 5-1 Scenario 1 SEM Diagram

The results show that the first two hypotheses were confirmed, with the third being rejected. This is consistent with the result of the reference study and shows that the relationship between innovation stimulus and innovation performance is mediated through innovation capacity. The direct relationship between innovation stimulus and innovation performance was not statistically significant.

It would be natural to conclude that human factors, represented by stimulus, have little influence on a firm's innovation performance. Whereas it is easy to make a connection between a firm's technical capacity and its innovation performance, ruling out innovation stimuli would however be oversimplifying the outcome. In contrast, an alternative is presented that suggests that the effect of human factors on performance is realized through a firm's hard technological characteristics and capabilities. In further tying this to theory, the result suggests that organizations that successfully create a culture and environment contusive to innovation are also likely to excel in building the required elements needed for technological excellence, and thus high levels of innovation performance.

Reflecting on the results of the survey, the indicators that remained as part of the SEM model can also contribute to this. Those variables that remained and were connected to stimuli consisted of survey questions which focused a lot on encouraging both vertical and horizontal communication within a firm. Performance on the other hand was primarily connected to a respondent's somewhat subjective perception of their firm's technological strength, such as *using the latest technology in our new products*. Considering this, it is hard to naturally make a connection between the two. One theory is that had the survey been restructured by firstly limiting it to directors and C-level executives, those that define and implement most company initiatives, the relationship between stimuli and performance would have been much stronger. Additionally, perhaps modifying the questions further so as to develop the survey in a more cause-effect sequence mirroring the typical relationship between strategic humanistic initiatives implemented to improve specific performance metrics would also signify a stronger relationship between the stimuli and performance constructs.

This is further reinforced when considering the vast literature, including classic works of academics from Christensen to Drucker that highlight the influence of human factors on the performance of organizations, achieved through better understanding the knowledge worker. In addition to tuning the survey or the respondents, perhaps had other types of innovation as defined by Schumpeter (as an example market innovation) been included in the measure of performance, or had additional financial or strategic marketing metrics been included, the direct relationship between innovation stimuli and innovation performance perhaps may have been stronger.

The second scenario re-tested the first three relationships, with the addition of variables found to be relevant based on research, that was not part of the original reference study. To innovation stimulus, gender equality and cultural diversity were added, and to innovation capacity, AI and ML was added. The analysis is shown in *Figure 5-2,* and these additions lead to the following three hypotheses, which were:

Hypothesis 4: There is a significant relationship between stimulus factors and capacity factors of innovation management with the inclusion of gender equality, cultural diversity as stimuli, and AI and ML as capacity.

Hypothesis 5: There is a significant relationship between capacity factors of innovation management and innovation performance with the inclusion of AI and ML.

Hypothesis 6: There is a significant relationship between stimulus factors of innovation

management and innovation performance with the inclusion of gender equality and cultural diversity.

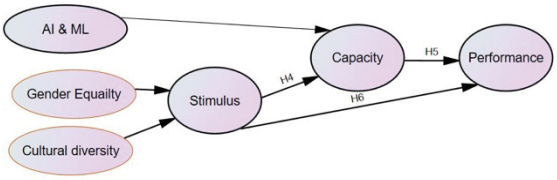

Figure 5-2 Scenario 2 SEM Diagram

The path diagram shows that with the inclusion of gender equality, cultural diversity, and AI and ML, the relationship between stimuli, capacity and performance was unchanged from the first scenario. In addition, the analysis showed that neither AI and ML had a significant relationship with innovation capacity nor gender equality or cultural diversity with innovation stimulus.

The numerical results for hypotheses H4, H5, and H6 listed in *Table 5-1* show that the addition of gender equality, cultural diversity, along with AI and ML were similar to the first scenario thus matching the previously verified relationships between innovation stimulus, innovation capacity, and innovation performance. Even with these additional variables, the relationship between innovation stimulus and innovation performance is mediated through innovation capacity, and the direct relationship between innovation stimulus and innovation performance was not statistically significant.

The theory discussed in the literature review gave the impression that human factors relating to gender and cultural diversity, positively influenced a firm's ability to innovate, as well as improve its financial performance. The results did not reflect this. An explanation for the contrast could be connected to the diverse range of recipients in terms of industry, geography, and also position in their organizational hierarchy.

The literature suggests that for the successful implementation of gender equality and cultural diversity into an organization, a critical factor is that these initiatives require leadership to proactively prioritize, manage, and communicate these. The survey results showed less than 50% C-level or director level respondents, and as such a company may have strong initiatives, however, their visibility and impact would vary depending on who in the organization is asked. As an example, a question such as *Senior managers are trained in managerial methods that promote and support diversity* could generate vastly different answers depending on the position of the respondent and their awareness of company policies. In a similar way respondent in different geographies or industries, would also feedback very different answers for a question such as *My firm has strong role models and mentorship opportunities consisting of both men and women in senior positions*. In this example, it is suggested that the definition of "available strong role models for both genders" is highly subjective to industry and cultural norms as well as the gender of the respondent. What these examples can hope to highlight is that there may be strong initiatives present that did not show up in the data, thus affecting the outcome of the analysis and proving consistent with the challenges raised in the literature review of this paper.

It should also be noted that the theory regarding the benefits of gender equality and cultural diversity often measures performance in terms of financial metrics, yet these were excluded from the definition. Similarly, to the first scenario, had performance been measured in terms of financial metrics as opposed to defining innovation performance on product and process innovation, the outcome may have changed.

In the second scenario, the inclusion of AI and ML as a variable of the technology construct also had minimal impact. Firstly, the diversity of the respondents may have contributed to this in a similar way to the human centric variables discussed. However, an additional factor could be that AI and ML are relatively new technologies and are still making their impact on a broader range of companies. It is almost certain that the majority of companies do have several touch points with AI and ML, perhaps even unknowingly through third party services, yet is not consistently present as a key strategic feature of their innovation management processes. The survey results showed that the majority of respondents indicated that AI and ML were not currently present in their company's products or internal processes, nor was it relevant in the coming 2-5 years (over 65% considering both cases). This indicates that AI and ML, and its definition, are perhaps simply not mature enough yet to be applicable or recognized this broadly. Another probable reason is that AI and ML are often still perceived as the focus of innovation in of themselves and as such, not seen as a contributing factor of a company's innovation capacity in general. As both AI and ML mature the influence of this technology in decision-making processes and other areas of management

will certainly expand in a similar way seen in the financial industry. Even though the analysis did not show a strong relationship in the results, this particular relationship would be interesting to research further.

The final tested scenario focused on exploring whether the presence of innovation inhibitors influenced the relationships between innovation stimuli, innovation capacity and innovation performance. The analysis is shown in *Figure 5-3,* and the tested hypotheses were:

Hypothesis 7: There is a significant relationship between innovation inhibitors and innovation stimuli.

Hypothesis 8: There is a significant relationship between innovation inhibitors and innovation capacity.

Hypothesis 9: There is a significant relationship between stimulus factors of innovation management and innovation capacity in the presence of innovation inhibitors.

Hypothesis 10: There is a significant relationship between capacity factors of innovation management and innovation performance in the presence of innovation inhibitors.

Hypothesis 11: There is a significant relationship between stimulus factors of innovation management and innovation performance in the presence of innovation inhibitors.

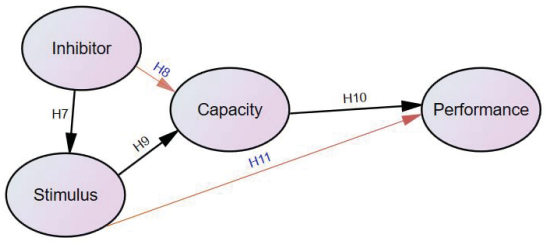

Figure 5-3 Scenario 3 SEM Diagram

The results from the third scenario showed that even in the presence of innovation inhibitors innovation stimulus and innovation performance is still mediated through innovation capacity and that the direct relationship between innovation stimulus and innovation performance was not strong. In addition, the results showed that in the presence of innovation inhibitors, the relationship between innovation stimuli than innovation capacity, and capacity and innovation performance was slightly stronger than in the first two scenarios.

In part, this could be attributed to the fact that the variables for defining innovation inhibitors (autonomy, integration, strategic gap) are directly related to how the resources of a company are allocated so as to maximize a team's ability to innovate.

This becomes evident when considering the individual survey questions connected to the inhibitors construct. The questions defining the construct are primarily described by aspects of autonomy, communication and decision making, an example being variable A4 (*innovations not needing to conform to existing architectures and manufacturing processes*). In this study these relate innovation inhibitors much more strongly to how stimuli as opposed to capacity are defined. Not to suggest that innovation capacity is not dependent on the allocation and management of human capital, however in this study, the capacity construct is much more dependent on quantifiable factors.

In some way, this paradox captures the motivation of the study. To further highlight the point, a company can prioritize R&D and technology yet still neglect many essential aspects (such as those aspects described by Christensen's *resource dependency*) that would allow innovation to be flourish. This also allows for an understanding as to why the relationship between innovation stimulus and innovation capacity is stronger in the presence of innovation inhibitors. Building on the conclusion that innovation stimulus enhances a company's ability to innovate through its capacity, in the presence of inhibitors, this relationship naturally becomes stronger. This is further confirmed by the fact that the relationship between innovation capacity and innovation performance, is also slightly stronger than in the first two scenarios, and in practice may have both a positive and negative affect on a firm's innovation performance.

In summary, the findings were relatively consistent with past studies but contradicted what was outlined by theory and industry observation when it came to human factors and their direct influence on the innovation performance of a firm. This provides an interesting opportunity for further study where a similar model would be re tested on a more specific industry or narrower cultural demographic.

6 Conclusion

The motivation for writing this thesis was to provide some clarity for practitioners on the

factors within an organization that positively effect company performance in terms of innovation. Innovation is seen as a critical component of a company strategy in achieving market differentiation and profitability. Despite the countless resources allocated towards innovation, it remains a frustrating pursuit for many. Via quantitative methods, this study aims to model the relationship between a firm's investment in innovation and the effect of this investment on its performance.

As a research topic dating back to the 1930s, this study is based on a large body of academic theory and industry reports. Based on past studies, a range of variables was identified that are known to influence a company's ability to innovate, which were divided across human factors, technical capability, and inhibitors that prevent innovation from being realized. Based on these, an online survey was constructed to collect data from companies within Europe to understand and measure these factors. Over a four-week period, data from 128 respondents was collected.

Using this data SEM methodology was used to answer two research questions. The first research question was to verify the results of reference study that had shown that a firm's innovation performance was influenced by a firm's commitment to both human factors focusing on softer values when combined with a strong commitment to R&D and technical capability, but not when the commitment was on human factors alone. The second was to understand how the presence of innovation inhibitors influenced this relationship.

The research showed that in regard to the first research question, innovation performance is improved when a firm focuses on creating an environment and culture that nurtures innovation, only when activated through a strong commitment to technical and R&D excellence, but not without this technical capacity. For the second question, this was not changed, however, the relationships between both human factors and technical capability, and between technical capability and innovation performance were both slightly stronger in the presence of innovation inhibitors.

For managers and practitioners, the results conclude that:

For a firm to achieve high performance in innovation, a firm's leadership must first develop a culture and environment that promotes innovative thinking and practices, which empowers the firm's employees to innovate. With this in place, a firm is positioned to leverage its R&D and technological capacity to deliver more innovative offerings, outcomes, and a higher level of innovation performance.

This aligns with the theoretical research which emphasized the importance of human factors in a firm's creative pursuits and implied that leaders should ensure an innovative culture is established prior to simply committing to R&D and technology capabilities. Inhibitors to innovation magnify the effect of these human factors on a company's technical capacity.

A benefit of this study is that the hypotheses were tested simultaneously as opposed to most past studies which explore only the relationship between technology and performance (hypothesis 2) or the relationship between human factors and performance (hypothesis 3) in isolation (Prajogo & Ahmed, 2006). The reason being, considering these in isolation would only address part of a larger problem, and thus limit any findings in their ability to be really applicable in practice.

The implications of the study for practitioners, is an overview as to how an investment in innovation could be structured in order to maximize performance. This becomes particularly relevant when limited resources must be effectively allocated. For the academic community, this study further builds on past research by providing an analysis on how human factors and technical capability simultaneously contribute to performance as opposed to a large number of past studies which isolate the two.

In terms of challenges, this study was affected by the complex nature of innovation, in particular the difficulty of measuring the elements of innovation management as the data collected was subjective. In addition, the sample of respondents covered a broad range of recipients, geographies and industries. The intention was to attempt to holistically gather as much data as possible to understand how innovation performance could be maximized. However, this presented an additional challenge as many of the survey questions could be interpreted very differently from the perspective of a director as opposed to an individual contributor within an organization. Despite having a broad range of responses to analyze and address the research questions, this also made the data vulnerable to responses from recipients that either did not understand or had varying insights on any number of top-level company initiatives.

The study also allows for three distinct directions for future study. Firstly, it would be valuable to retest this model on a narrower band of recipients, namely either within the same industry, or within a tighter geographical or cultural span. Retesting the model with a more homogenous group would certainly affect the consistency and composition of the data gathered and allow conclusions to be drawn about maximizing innovation in a more practical way for a particular industry or geographic region.

Secondly, the study highlights the factors that contribute to maximizing innovation performance but does not explore implementation. A future study could aim to explore the methodology of putting the findings into practice within various types of firms and industries.

Finally, it would be interesting to explore reversing the relationships of the model and exploring research questions that show the impact on a company's culture, if a firm is achieving excellent innovation performance, and whether this could be effective in reducing the prevalence of innovation inhibitors.

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8 Appendix A

This first appendix outlines the structure of the questionnaire that was sent out. After a four-week process we collected 128 responses:

8.1 Descriptive Data

- "Name of your company (not obligatory)"
- "Describe the main industry"
- "Please select your organizational level.
- "Please select your job function."
- "Which country are you based in?"
- "What was the annual turnover in Euro (€) of your company in 2018
- "What best describes the number of employees in your Firm "We appreciate your cooperation in gathering more responses. If you feel comfortable with this, please enter their email address below (or forward them the link directly:
- "Please leave your comments, questions or suggestions below"
- "Would you like to get compiled survey result (If yes, we will email you results by end of June)? "

8.2 Innovation Performance

8.2.1 Product Innovation

- "The level of newness (novelty) of our firm's new products, as compared to our major competitors." (PDI1)
- "The use of latest technological innovations in our new products and services." (PDI2)
- "The speed of our new product development is fast." (PDI3)
- "The number of new products our firm has introduced to the market are high." (PDI4)

- "The number of our new products that are first to market (early market entrants)." (PDI5)

8.2.2 Process Innovation

- "The technological competitiveness of our company." (PI1)
- "The speed with which we adopt the latest technological innovations in our processes." (PI2)
- "How up-to-date and novel are the technology used in our processes are?" (PI3)
- "The rate of change in our processes, techniques and technology." (PI4)

8.3 Innovation Capacity

8.3.1 Technology Management

- "Our company always attempts to stay on the leading edge of new technology in our industry." (TM1)
- "We make an effort to anticipate the full potential of new practices and technologies." (TM2)
- "We pursue long-range programs in order to acquire technological capabilities in advance of our needs." (TM3)
- "We are constantly thinking of the next generation of technology." (TM4)

8.3.2 R&D Management

- "We have an excellent communication process between R&D and other departments." (RM1)
- "Our R&D pursues truly innovative and leading-edge research."(RM2)
- "Our R&D strategy is, in a significant part, characterized by high-risk projects with a chance of high return."(RM3)
- "R&D plays a major part in our business strategy."(RM4)

8.3.3 Integration of AI

- "We integrate AI in our current products and services and/or internal processes."(AI1)
- "Our firm actively monitors developments in AI, and we plan to integrate AI into our products and services and/or internal processes in the coming 2-5 years."(AI2)
- "AI is not relevant to our firm either now or in the coming 2-5 years."(AI3)

8.4 Innovation Inhibitors

8.4.1 Integration

- "Our organizational structure and practices allow good cross functional communication and learning, and our team has good insights and understanding of the purposes and work of most, if not all the firm's departments. "(I1)
- "As a firm we constantly explore new technologies and business models, and this is a part of our ongoing strategy. Often this is integrated by engaging with industry organizations, experts, and universities to better allow us to develop our technologies."(I2)
- "Our internal departments are provided good insights and are tightly connected with the needs of the end customer."(I3)
- "Our firm focuses on developing intellectual property internally as opposed to relying on external partners whenever possible. " (I4)
- "As a strategy, our firm upgrades our technology capabilities, and works on multiple generations of our technology simultaneously."(I5)

8.4.2 Autonomy

- "Our firm is committed to pursuing new innovations via a dedicated innovation team." (A1)
- "New innovation development within the organization is resourced by the same staff that are also committed to the firm's main stream R&D activities."(A2)
- "In our company disruptive innovations efforts are free to target new customers regardless of market size."(A3)
- "New non incremental innovations that are developed do not need to confirm to the firm's existing product architectures or manufacturing processes." (A4)

8.4.3 Strategic Gap

- "Our company meets product launch targets the vast majority of the time." (SG1)
- "Our company's products mostly meet sales forecasts." (SG2)
- "Our company adopts new ideas and develops them into reliable products and services, according to our own internal targets and standards." (SG3)

8.5 Human Factors

8.5.1 Leadership

- "Senior executives share a common understanding and similar beliefs about the future direction of our organization." (L1)
- "Senior managers actively encourage change, and implement a culture of improvement, learning, and innovation towards 'excellence'."(L2)
- "Employees, regardless of position, have the opportunity to share and are encouraged to implement the organization changes either internally, or to our products and services."(L3)
- "There is a high degree of unity of purpose in our company, and we have eliminated barriers between individuals and/or departments."(L4)

8.5.2 People Management

- "Our organization provides training and development process, including career path planning, for all our employees."(PM1)
- "Our company has maintained a cooperative environment between the management and employees, seeing themselves in the same team."(PM2)
- "Employee satisfaction is formally and regularly measured." (PM3)
- "Employee flexibility, multi-skilling and training are actively used to support performance improvements." (PM4)
- "We always maintain a work environment that contributes to the health, safety and well-being of all employees."(PM5)

8.5.3 Knowledge Management

- "The build-up of intellectual capital is of strategic importance to management in order to gain competitive advantage."(K1)
- "We always formally upgrade employees' knowledge and skills on a scheduled basis." (K2)
- "Our company builds and maintains virtual and physical channels for sharing and disseminating information."(K3)
- "Our company manages its own intellectual assets, e.g. patents, copy- rights, licenses."(K4)

8.5.4 Creativity and Idea Generation

- "We provide time and resources for employees to generate, share/exchange and experiment innovative ideas/solutions."(C1)
- "Employees are working in diversely skilled work groups where free and open communication among the group members is encouraged."(C2)
- "In our company, employees frequently encounter non-routine and challenging work that stimulates creativity."(C3)
- "Employees are recognized and rewarded for their creativity and innovative ideas."(C4)

8.5.5 Cultural Diversity

- "My firm has strong diversity management policy that is clearly communicated in the firm's strategy and mission and other important operational initiatives."(D1)
- "My firms upper management team is culturally diverse."(D2)
- "Senior managers are trained in managerial methods that promote and support diversity."(D3)
- "My firm's managers set and manage well communicated diversity initiatives."(D4)
- "My firm actively looks to hire new team members both locally and internationally."(D5)

8.5.6 Gender Equality

- "My firm has a well-defined gender equality initiative in terms of recruitment and promotion."(GE1)
- "My firm has a gender distribution of 33% or above women in upper management and leadership positions." (GE2)
- "My firm has strong role models and mentorship opportunities consisting of both men and women in senior positions."(GE3)

9 Appendix B – Survey Results

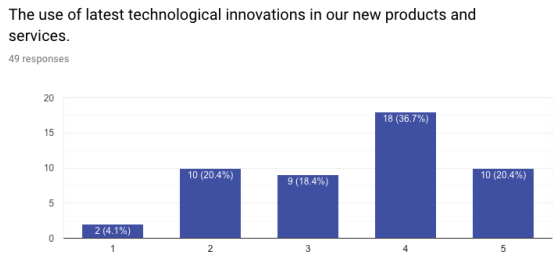
9.1 Innovation Performance

The first section of the survey focused on measuring indicators of Innovation Performance, specifically Product Innovation and Process Innovation. Here respondents answered according to their perception of their own company's performance in regard to innovation. The findings were summarized below.

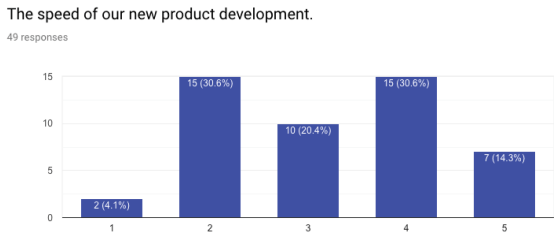
9.1.1 *Product Innovation*

This section contained five questions with had the following results:

For the level of newness question 61% of respondents were satisfied with novelty of the new products, 29.2% were neutral and 8.3% dissatisfied.

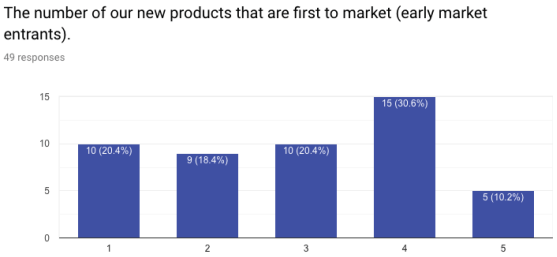


The second question showed 48% of the respondents used the latest technological innovation in new products relatively more often, as compared to 18.8% neutral and only 2.1% did not use latest technology in new products.



In terms of pace, 43% of respondents were satisfied with speed of new product development, with 21% being neutral and 38% dissatisfied.

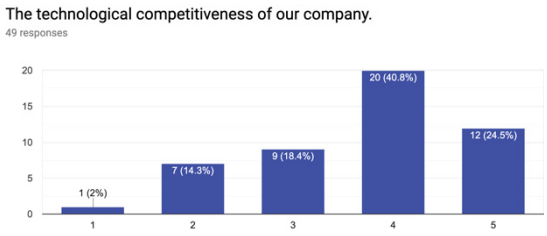
Similarly, 46% of respondents were happy with the number of new products and how this relates to the performance of their company, with 25% neutral and 32% dissatisfied.



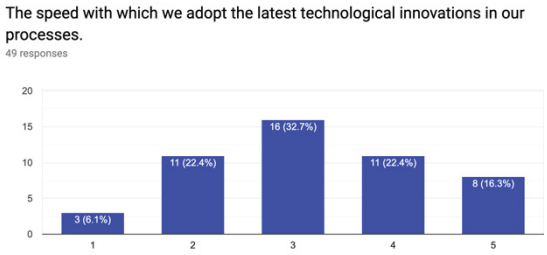
Finally, in terms of being first to market with product innovations 40.6% responded positively, 21% were neutral, 39.6% had a low perception.

9.1.2 *Process Innovation*

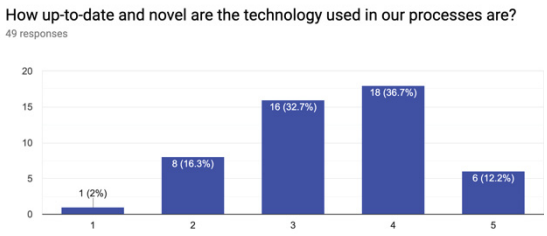
This section had four questions which was consistent with the reference study.



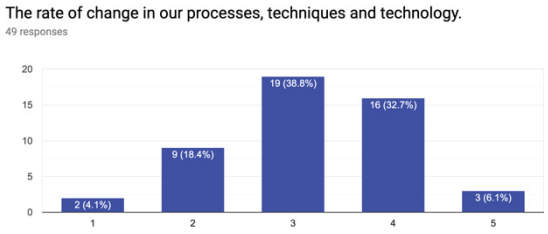
The response to technological competitiveness showed 66% being positive, and 19% neutral and 15% low.



For the speed of adaption of the latest technologies into processes, 39% responded high, 33% were neutral, and 27% being low.



50% of respondents felt their company used up-to-date technology in their processes, 33% were neutral, and 17% had a low perception.



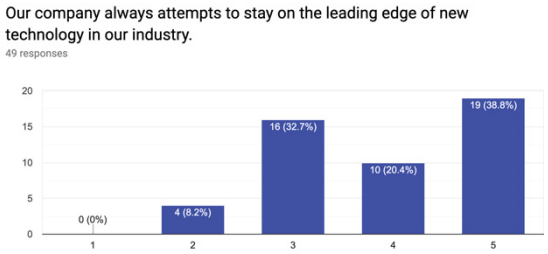
For the rate of change in process, techniques and technology 50% responded on the high side, 38% neutral, and 23% on the low side.

9.2 Innovation Capacity

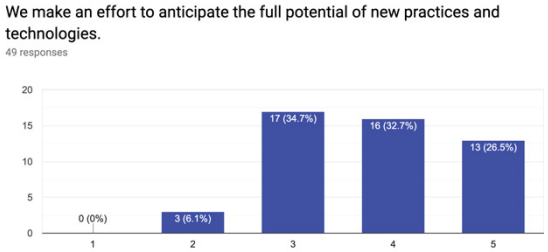
This section focused on gathering data for indicators describing the latent variable of a company's Innovation Capacity. This variable had three distinct constructs, the result of each, summarized below.

9.2.1 Technology Management

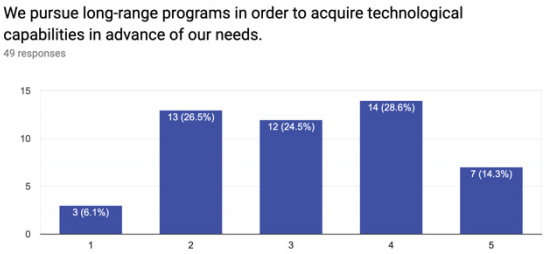
This section of the survey contained four questions and focused specifically on gathering information related to technology management. The results are shown below:



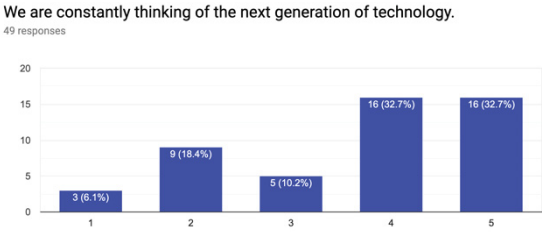
The results showed 61% of respondents always attempted to stay on leading edge technology of technology, 31% remained natural and only 8.3% did not perceive their company attempted to be on leading edge technology.



The results showed that the vast majority of respondents (59.2%) perceived that their company attempted to anticipate the potential of new practices and technologies, 34.7% being neutral, and a small group (6.1%) had a low perception.



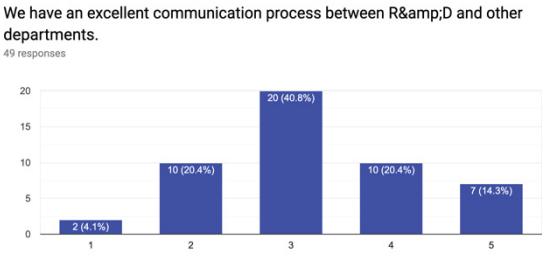
In terms of pursuing long-range programs to acquire technologies, 42.9% had a positive perception, 24.5% were neutral, and 32.6% had a low perception.



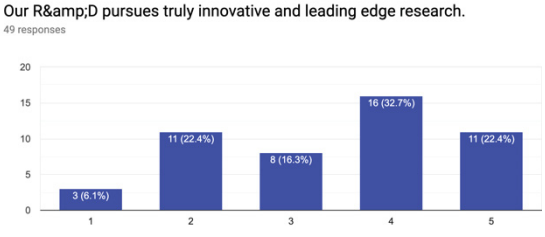
Here 65.4% had a positive perception, 10.2% neutral, and 24.5% low, to their firm's pursuit to the next generation of technology.

9.2.2 R&D Management

This section of the survey had four questions focusing on the management of R&D. The results are outlined below.

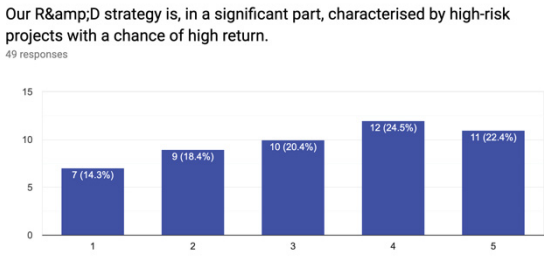


The results showed 34.8% had a positive perception, 40.8% neutral, and 24.5% negative in regard to communication between R&D and other company departments.

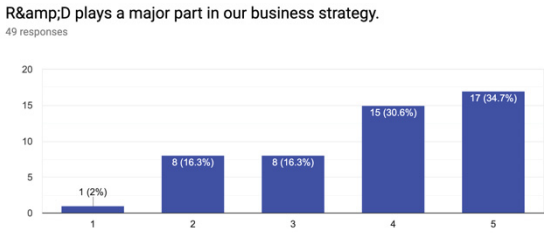


In terms of the pursuit of leading-edge technology 55.1% or respondents had a positive

perception, 16.3% neutral, and 28.5% had a low perception.



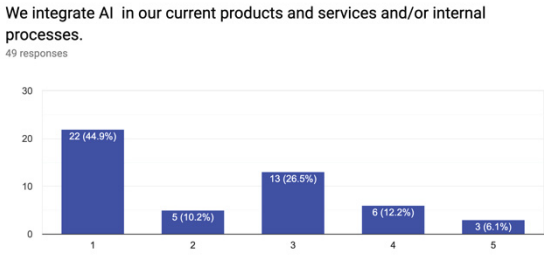
46.9% had a high perception, 20.4% neutral, and 32.7% low perception in terms of their company focusing on high risk high return projects.



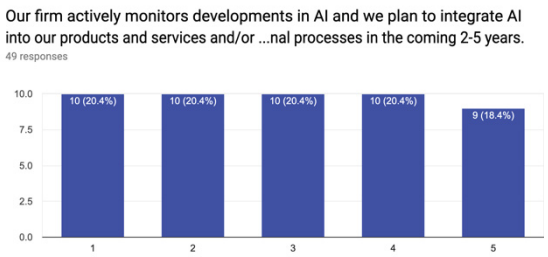
In terms of prioritizing R&D within the overall business strategy, 65.3% of respondents had a positive perception, 16.3% neutral, and 18.3% low perception.

9.2.3 Integration of AI

This section was a differentiator from the reference study as studying the effect of AI on a company's innovation performance was not included. The results are shown below.



These results show that only 18.3% of respondents perceive that their company has integrated AI into their R&D.



In terms of integrating AI into their R&D in the near term 38.8% expressed a positive, 20.4% neutral, and 40.8% negative perception.

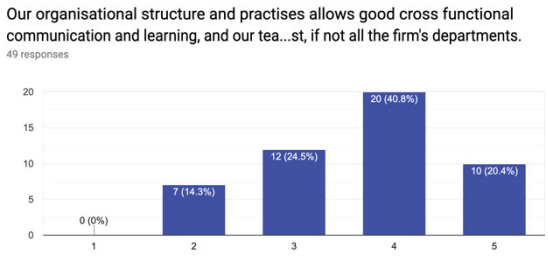
With results showing 16.3%, 20.4%, and 63.2% for positive/neutral/low respectively matches the rest of the respondents showing that most respondents don't have a strong perception that their firms are prioritizing AI as a disruptive technology.

9.3 Innovation Inhibitors

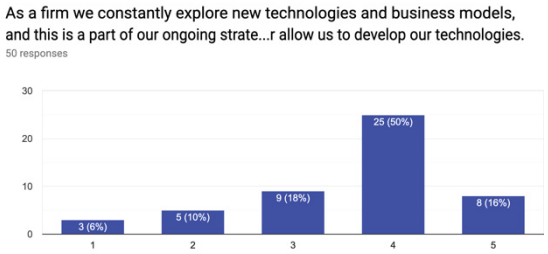
The third section of the survey focused on measuring indicators of Innovation Inhibitors, specifically Integration, Autonomy, and Strategic Gap. The summary of the respondent's answers is listed below.

9.3.1 Integration

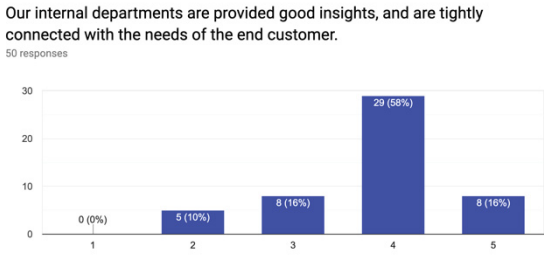
This section of the survey contained five questions focused on a company's ability to successfully integrate the outcome of innovation pursuits back into the organization. The questions are shown below.



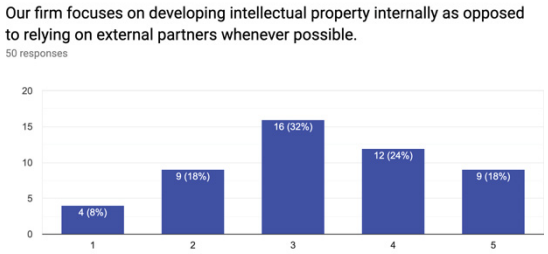
61.2% of respondents had a positive perception of their company's cross functional communication, 24.5% were neutral, and 14.3% had a negative perception.



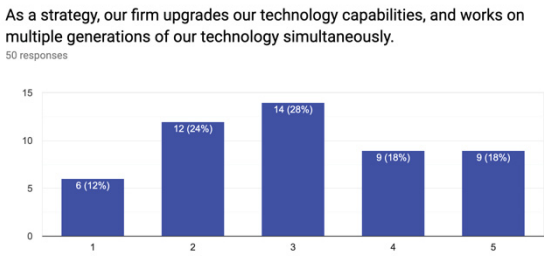
For exploring new technologies with external sources, 66% of respondents were positive, 18% neutral, and 16% had a low perception.



74% of respondents felt there was a tight connection with the needs of the end user, with 16% being neutral, and 10% negative.



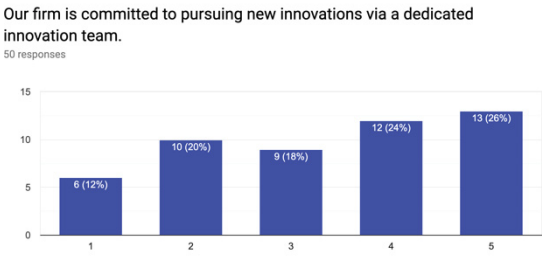
42% of all respondents had a positive perception, 16% were neutral, and 26% had a negative perception on their company's focus on developing intellectual property internally.



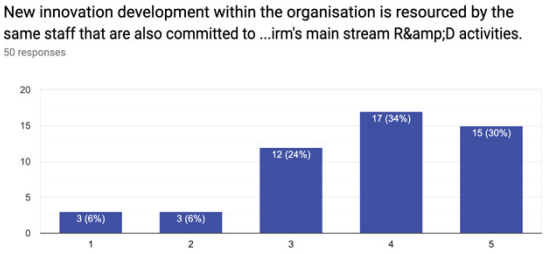
36% responded with a positive perception, 28% were neutral, and 36% had a negative perception on their firm's ability to focus on multiple generations of technology.

9.3.2 Autonomy

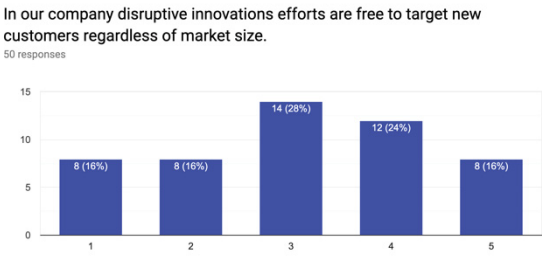
This section of the survey consisted of four questions focusing on a whether companies provided adequate operational and strategic autonomy to innovation teams as prescribed by the theory discussed earlier.



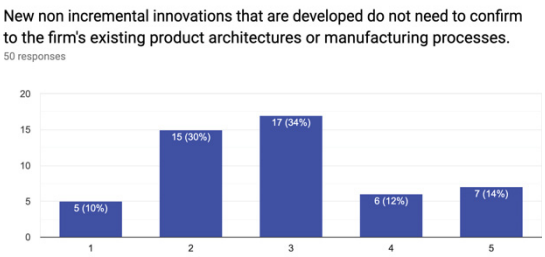
50% responded positively, 18% neutral, and 32% negatively in regard to their company pursuing innovation via a dedicated team.



For autonomy of resources 64% of respondents were positive, 24% neutral, and 12% had a low perception.



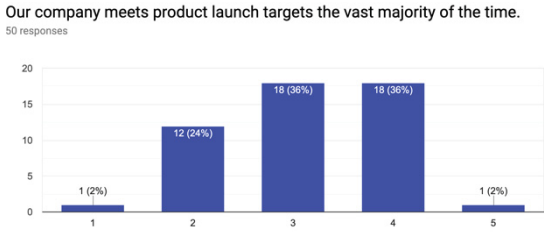
In terms of business model autonomy 40% expressed a positive perception, 28% were neutral, and 32% a negative perception.



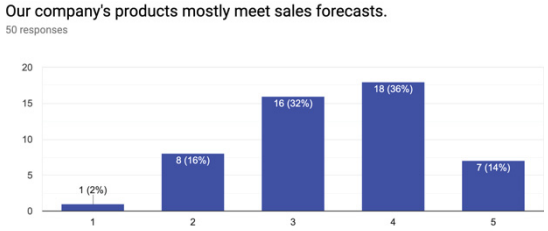
For operational autonomy 26% of respondents were positive, 34% neutral, and 40% had a low perception.

9.3.3 Strategic Gap

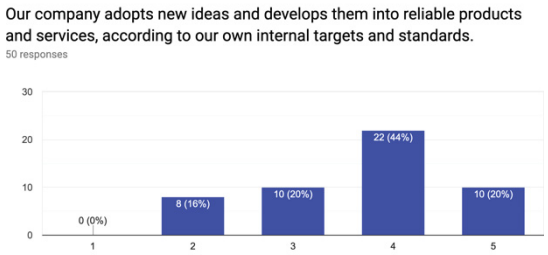
This section contained three questions focusing on gathering data related to the strategic gap.



For product launch targets 38% expressed a positive perception, 36% were neutral, and 26% had a negative perception.



50% responded positively, 32% neutral, and 18% negatively in regard to their company mostly meeting sales forecasts.



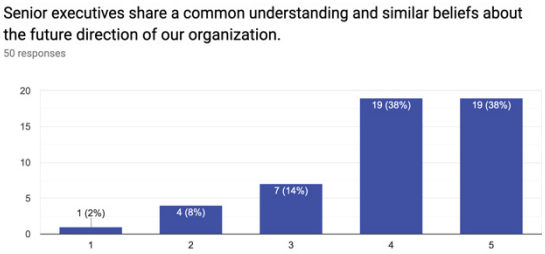
For autonomy of resources 66% of respondents were positive, 20% neutral, and 16% had a low perception of their company's ability to mobilize ideas into reliable products and services.

9.4 Human Factors

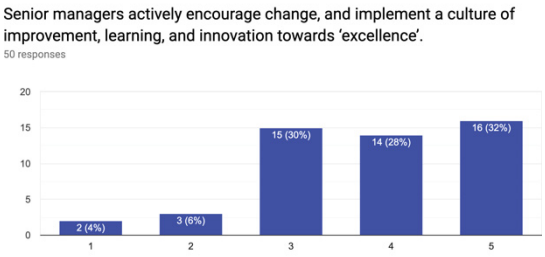
This part of the survey was the longest and consisted of six sub headings summarized below.

9.4.1 Leadership

There were four questions in this section which are outlined below.

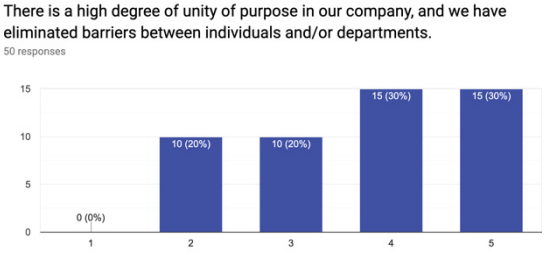


76% of respondents were positive about the alignment of their company's leadership, 14% neutral, and 10% low.



60% expressed a positive perception in regard to management culture, 30% were neutral, and 10% had a negative perception.

78% expressed a positive perception, 36% were neutral, and 26% had a negative perception of employee's ability to encourage change to the company or products.

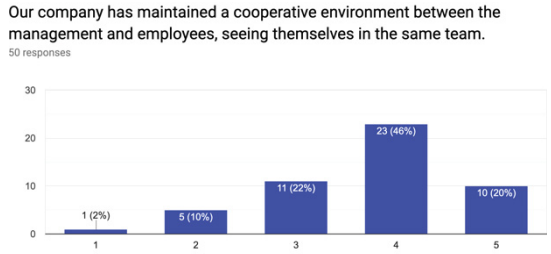


For overall company unity 60% expressed a positive perception, 20% were neutral, and 20% had a negative perception.

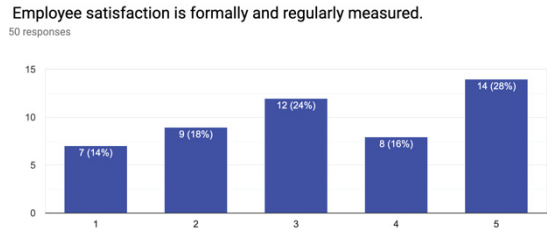
9.4.2 *People Management*

This section of the survey had five questions, the results of which are listed below.

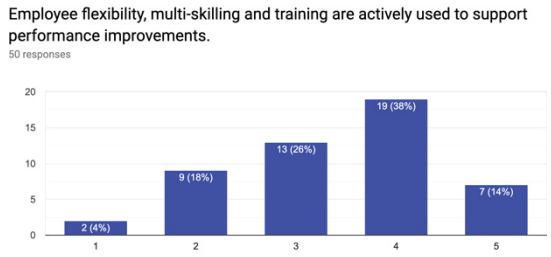
In terms of staff development 42% expressed a positive perception, 28% were neutral, and 30% had a negative perception.



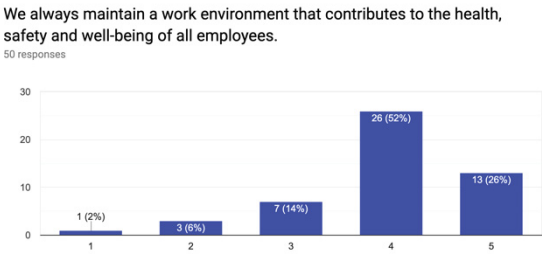
66% expressed a positive perception in regard to their company's cooperative environment, 22% were neutral, and 12% had a negative perception.



For measurement of employee satisfaction 44% expressed a positive perception, 24% were neutral, and 32% had a negative perception.



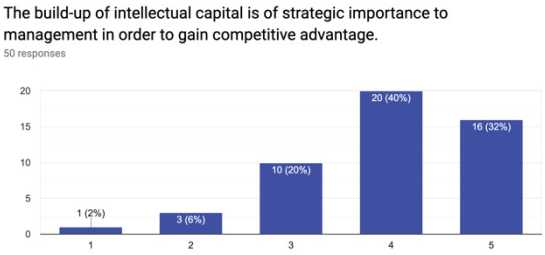
52% expressed a positive perception in regard to their company's support of employee performance improvements, 26% were neutral, and 22% had a negative perception.



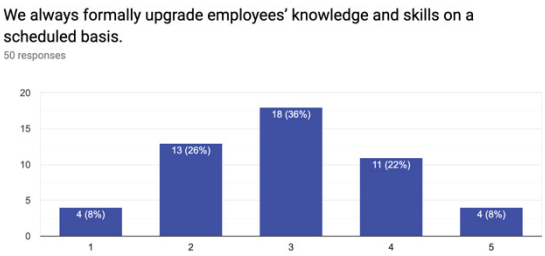
In regard to a working environment that promoted wellbeing, 78% expressed a positive perception, 14% were neutral, and 8% had a negative perception.

9.4.3 *Knowledge Management*

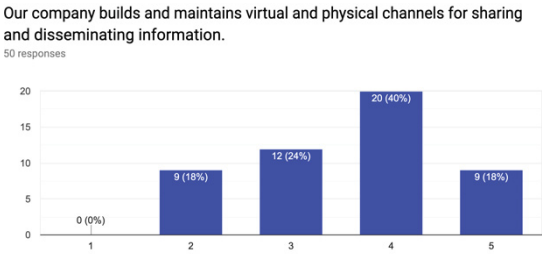
Here the survey contained four questions listed below.



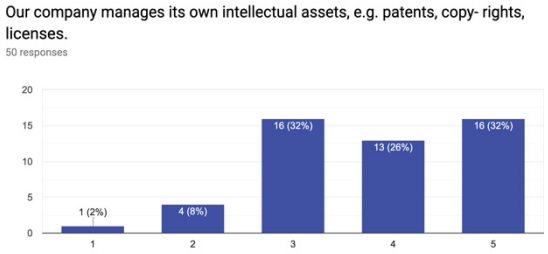
72% expressed a positive perception in regard to their company prioritizing the buildup of intellectual capital, 20% were neutral, and 8% had a negative perception.



In regard to upgrading employee skills, 30% expressed a positive perception, 36% were neutral, and 34% had a negative perception.



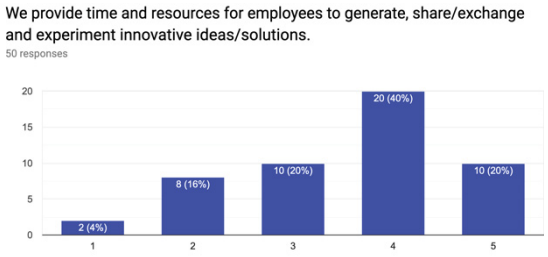
58% expressed a positive perception in regard to their company maintaining virtual communication to promote information sharing, 24% were neutral, and 18% had a negative perception.



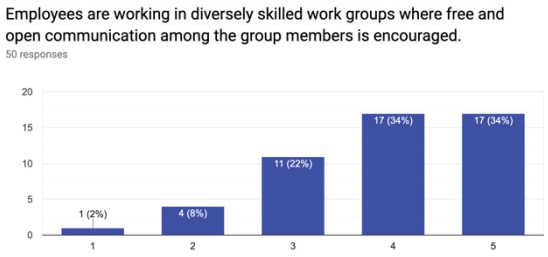
In regard to the company managing its own intellectual assets 58% expressed a positive perception, 32% were neutral, and 10% had a negative perception.

9.4.4 Creativity and Idea Generation

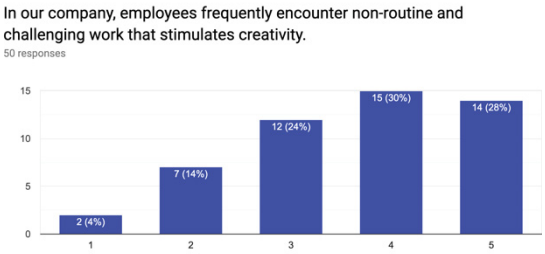
The results of the four questions from this section are listed below.



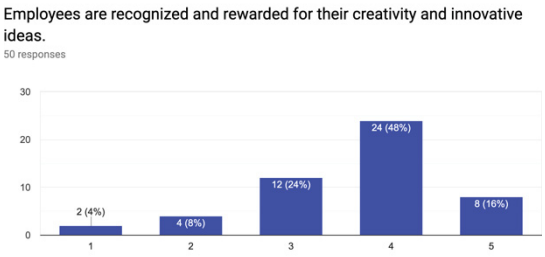
60% expressed a positive perception in regard to their company prioritizing creative collaboration, 20% were neutral, and 20% had a negative perception.



69% expressed a positive perception in regard to the opportunity of cross functional collaboration within their company, 22% were neutral, and 10% had a negative perception.



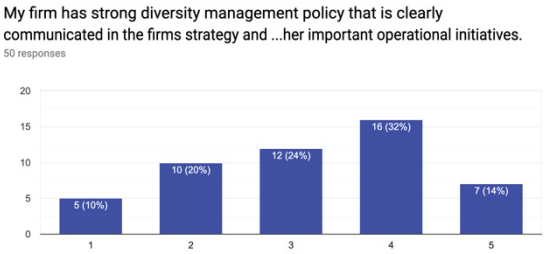
58% expressed a positive perception of the creativity level of their daily work, 24% were neutral, and 18% had a negative perception.



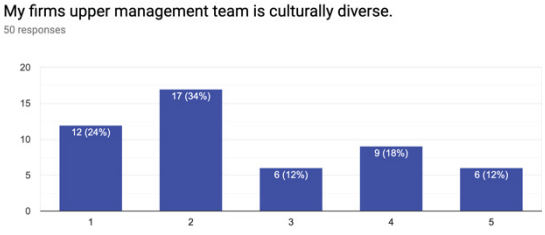
64% expressed a positive perception towards the idea that employees receive recognition for creative ideas, 24% were neutral, and 12% had a negative perception.

9.4.5 Cultural Diversity

There were five questions to this section of the survey.

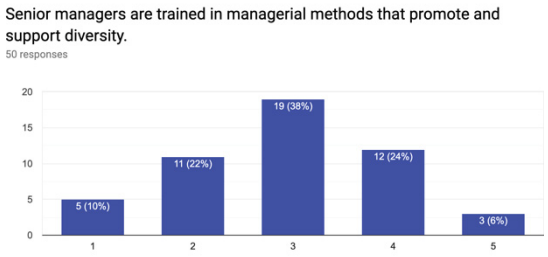


In regard to a clearly communicated diversity management policy 46% expressed a positive perception, 24% were neutral, and 30% had a negative perception.

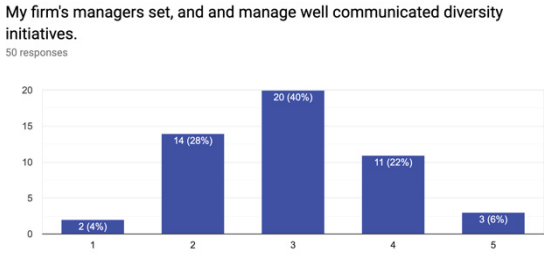


The majority had a negative perception towards the diversity of their upper management team

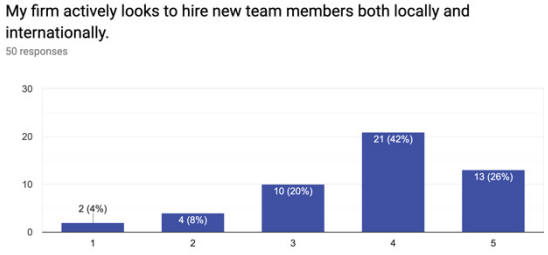
with 30% being positive, 12% neutral, and 58% negative.



In terms of appropriate diversity management 30% expressed a positive perception, 38% were neutral, and 32% had a negative perception.



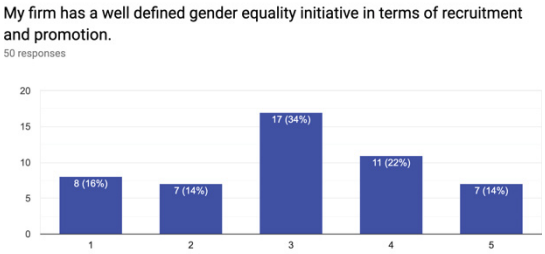
28% expressed a positive perception towards management and communication of diversity initiatives within their company, 40% were neutral, and 32% had a negative perception.



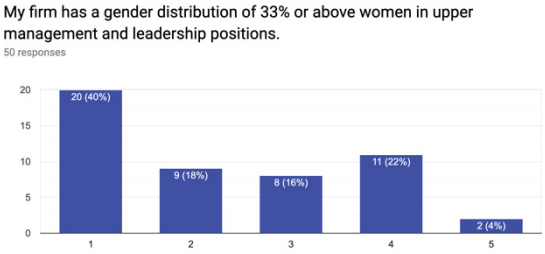
The majority felt their firm looked to hire internationally with 68% expressing a positive perception, 20% were neutral, and 12% had a negative perception.

9.4.6 Gender Equality

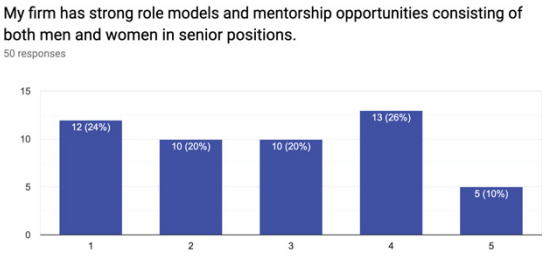
This final section contained three questions which are shown below.



In regard to having a well-defined gender equality initiative, 36% expressing a positive perception, 34% were neutral, and 30% had a negative perception.



The majority felt their firm was below the 33% threshold of female representation in upper management, with 26% expressing a positive perception, 16% were neutral, and 58% had a negative perception.



36% expressed a positive perception towards the proposition that there were strong role models for both men and women within their firm, 20% were neutral, and 44% had a negative perception.

10 Appendix C

This appendix lists complimentary diagrams and tables discussed in from *Chapter 4 Results*.

Figure 10-1 Original Path Diagram Prior To Data Reduction

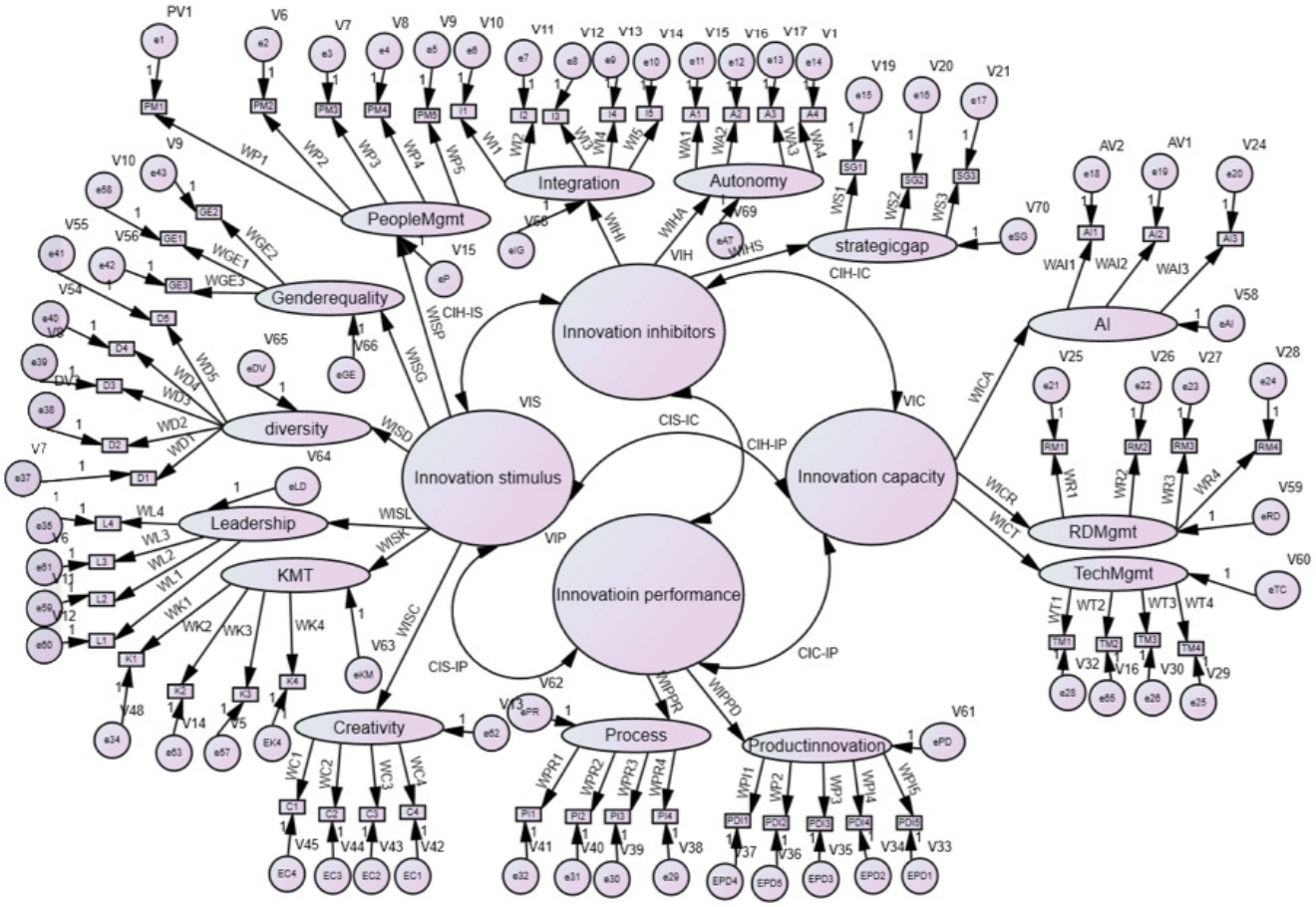


Table 10-1 Total Variance Explained

Component	Cumulative %	Total	% of Variance	Cumulative %
1	38.172	4.590	27.000	27.000
2	51.508	3.706	21.800	48.800
3	59.573	1.589	9.348	58.148
4	65.971	1.191	7.007	65.156
5	72.026	1.168	6.871	72.026

Table 10-2 Component Matrix

	Component												
	1	2	3	4	5	6	7	8	9	10	11	12	13
TM1	0.747	-0.321		-0.267							-0.102	-0.150	
I5	0.717		0.108			-0.147	0.117	0.301	-0.123		0.131	0.196	
L2	0.717	0.129	-0.383	-0.102				0.127				-0.183	0.130
AI1	0.688		0.324	-0.153		0.130	0.221			-0.289		0.204	0.177
TM2	0.683	-0.231		-0.323		-0.187		-0.138					
PI1	0.681	-0.251	0.125	-0.136	0.108	-0.180	-0.169		0.111	0.157	0.233		
TM4	0.675	-0.390						-0.136					
I2	0.675		-0.115			-0.239	0.254	0.156	-0.151	0.112	-0.147	0.166	
C1	0.674	0.201	-0.208	0.106	-0.368					-0.121			
PDI1	0.669	-0.407					-0.221		-0.181				
PI2	0.661	-0.315		-0.281		0.173		-0.136	0.104		0.224	0.176	
AI2	0.657		0.204	-0.295		0.117	0.291			-0.350		0.194	0.121
PI3	0.654	-0.403	0.124	-0.204					0.205				
RM1	0.648		-0.231	0.337	0.155	0.121							-0.227
PDI2	0.641	-0.395	0.240	-0.226		0.122	-0.109	-0.108					
RM2	0.635	-0.349	0.278	0.191		-0.114						-0.192	
K1	0.625		-0.114		-0.255	-0.165	-0.148		-0.102			0.122	-0.369
L3	0.611	0.155	-0.472	-0.175	-0.146		0.194	0.171	-0.146			-0.134	
K2	0.610	0.412	0.143			-0.227	0.228	-0.115			0.119		
PM2	0.609	0.190	-0.346	-0.160	-0.263					0.104			0.192
SG3	0.607		-0.202		0.318	0.318	-0.140			-0.117	-0.161		
PI4	0.605	-0.336	-0.128	-0.102	0.166	0.147	0.170		0.133			0.179	-0.147
RM4	0.600	-0.465		0.153		-0.150				0.157	-0.253		
TM3	0.594		0.276		0.139	-0.349	0.219		-0.105				-0.140
PDI3	0.586	-0.229	-0.126		0.166	0.269		-0.187	-0.172	0.311		-0.201	
RM3	0.581	-0.347		0.427	-0.198						-0.258	0.129	
L4	0.579	0.163	-0.577										0.193
I1	0.575	0.157	-0.524		0.228	0.105							
PM4	0.573	0.405	-0.106	-0.217	-0.162		-0.196		0.344		0.101		0.159
L1	0.570	0.194	-0.363		0.241			0.196	0.167	-0.216	-0.172	-0.184	-0.110
C4	0.569	0.225	-0.300	0.115	-0.288			-0.194			0.149	0.251	0.117
I4	0.551	-0.102	0.144	0.106		-0.151	-0.140	0.411		-0.177	0.101		
D4	0.548	0.419	0.275				-0.342		0.343		0.140		
I3	0.539		-0.209		0.257	-0.117	-0.201	-0.204		0.154	-0.202	0.181	-0.297
K3	0.532	0.130		-0.290			0.118	0.389			0.253	-0.236	-0.180
C3	0.530		-0.395		-0.428	0.256	-0.157						
PM5	0.524	0.318	-0.123	-0.102	0.169	-0.205			-0.264	0.117		-0.176	
D1	0.520	0.204	0.342	0.196		-0.178	-0.145	0.139	0.213		0.156		-0.180
C2	0.513	0.140	-0.273	0.253	-0.247		-0.232		-0.188	-0.178		-0.107	-0.178
D3	0.489	0.370	0.420	0.229	-0.122		-0.331		0.174				
D2	0.489		0.356			0.250	-0.389		-0.129	0.141	-0.113	0.101	
A1	0.482		0.174	0.315	0.125	-0.199	0.255	0.112			-0.337	-0.197	0.221
PDI4	0.454		0.165	0.224	0.308				-0.221	0.210	0.213	-0.172	0.217
PDI5	0.443	-0.281	0.280	0.213	-0.134	0.194		-0.169	-0.237	0.150		-0.195	0.172
PM1	0.515	0.551	0.173			-0.196	0.192	-0.185		0.189			
GE2	0.244	0.504	0.325	-0.119		0.317	0.112	0.149	-0.112		-0.322	0.113	
PM3	0.460	0.483	0.180			-0.327	0.170	-0.307				-0.217	
GE1	0.352	0.460	0.393			0.401		0.142					-0.173
GE3	0.412	0.451	0.369	-0.122	-0.120	0.317	0.124		-0.199		-0.190		0.102
A2	0.318	-0.244	-0.123	0.461	0.171	0.192			0.277	-0.298		-0.168	
K4	0.338			0.425	0.110	-0.307	-0.220	0.210	-0.187	-0.121	0.230	0.277	0.238
A4	0.326			0.410	-0.244	0.333	0.300		-0.260	0.101	0.185		-0.303
SG1	0.364	0.240		0.132	0.520	0.273				-0.110	0.280		
SG2	0.465	0.338			0.487	0.109	-0.137	-0.200	-0.109			0.103	-0.110
A3	0.185			0.366	-0.216	0.225	0.502	-0.244	0.335		0.136		
D5	0.369	-0.319	0.273	-0.214	-0.286			0.392	0.160	0.134		-0.144	-0.118
AI3			-0.272	0.154			0.204	0.454	0.327	0.563		0.182	

Extraction Method: Principal Component Analysis.
a. 13 components extracted.