UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Master Degree Project in Innovation and Industrial Management

The Impact of Agility on Innovation Productivity

An empirical study

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Abstract

Purpose – Agility has been recognised as essential for firms operating in turbulent, uncertain and complex environments, in order to preserve a competitive advantage and ensure survival. However, not many organisations have considered the role of agility with respect to their innovation activities. Agility has been recently recognised as a way of dealing with innovation activities in turbulent times. Currently, there is little empirical evidence in the existing literature that links agility to innovation. Because of its critical implications for the existence and success of a business, the main purpose of this study is to gain new insights into the impact of agility on the innovation productivity of large organisations in the European Union (EU).

Approach – The concept of agility is fragmented into several agility attributes based on previous empirical works. A generally positive relationship is expected between these agility attributes and innovation productivity. This relationship is tested by considering large organisations in the EU, by using a survey methodology, by implementing a structured questionnaire as the research instrument to obtain information, and by performing three independent Negative Binomial regressions in order to analyse the data.

Findings – Different agility factors depict a significant and positive impact on the productivity of the three types of innovation.

Research limitations – It is difficult to generalise the results, due to the use of a non-probability sampling method and the final sample size.

Originality – Most of the literature on agility is concerned with agile manufacturing. Scholars have only recently started to recognise the importance of applying agility to innovation. This gap presents an interesting area of research. The study tests the effects of agility on innovation productivity in large organisations in the EU for the first time, and opens up to challenging future researches. It also seeks to address the problem of innovation processes being slow and unproductive.

Keywords – Agility, Agility Attributes, Product Innovation Productivity, Process Innovation Productivity, Business Model Innovation Productivity.

Paper type – Research paper

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Abbreviations

BM	*Business Model*
BMI	*Business Model Innovation*
CIS	*Community Innovation Survey*
EU	*European Union*
FA	*Factor Analysis*
PDI	*Product Innovation*
PCA	*Principal Component Analysis*
PRI	*Process Innovation*

1 Introduction

1.1 The Innovation Problem: "It takes too much time"

Time is considered to be a scarce resource and the demand of doing things faster is increasing in the workplace (Chakrabarti, 1996), especially considering the fast changing and highly complex industries. More and more organisations are recognising the importance of speeding up their operations, mostly to preserve their competitive advantage (Chakrabarti, 1996). It is reasonable to acknowledge that there is a need for the innovation process to be faster as a result of intense global competition, the exponential advancement in technology and the repetitively shifting nature of customer demand (Chakrabarti, 1996). Morris (2014) stated "accelerating the innovation process" as one of the three critical drivers of innovation success, however, companies have struggled to innovate fast and have to deal with some bottlenecks emerging from the innovation process (Boer and During, 2001).

Most innovations are fuzzy and involve false starts, recycling between stages, dead ends and jumps out of sequence (Tidd et al., 2005). Many firms use a Stage-Gate process to develop their projects (Cooper, 2008). However, this process can be too bloated due to the amount of documentation required, and the numerous review steps (go/kill) render the innovation process too bureaucratic (Apilo et al, 2007 as cited by Hannola et al, 2013). Furthermore, because of the complex environment inherent in the organisations, dealing with innovation is riskier than ever and companies tend to adopt a slow and safe strategy for their innovation process in order to limit financial loss. Also, due to the fast moving markets in most industries, industry clock speed can act as a moderator for innovation process success (Guimares, 2011).

The concept of Agile Innovation has been recently recognised as a way of dealing with innovation operations in these turbulent times. Scholars understand the need for faster innovation processes and acknowledge the importance of a more agile innovation process. Agile innovation was described by Morris (2014) as "*a radically new and eminently practical approach to the challenge of survival*". However, a closer look at what agile practices should be employed and what impact they may have on innovation is lacking in the current literature on this subject.

1.2 Need for Agility: The New Methodology

Nowadays, organisations are facing a turbulent, uncertain and complex environment (Tseng and Lin, 2011). Scholars, along with managers, have devoted a great deal of attention to how organisations can deal with such unstable business settings. As it becomes harder to predict the future, firms are trying to put methodologies in place in order to become more adaptive instead of predictive (Fowler, 2000). The introduction of agile practices within organisations was used to answer the complexity of the firm environment – internally and externally (Goldman et al., 1995; Shafer, 1997).

The concept of agility dates back to the early nineties (Tichy and Charan, 1989; Dove, 1999; Yusuf et al., 1999). Its origin was based on the awareness that the environment of firms started to move faster than the ability of these firms to adapt. At that time, agility was defined as "*a manufacturing system with extraordinary capabilities to meet the rapidly changing needs of the marketplace […] a system that shifts quickly among product models or product lines, ideally in real time response to customer demand*" (Youssef, 1994). In parallel, the concept of agile methods arose from the software industry. It was first introduced to tackle the bureaucratic, linear and inflexible Software Development Process. To remedy this issue, software practitioners decided to establish a new way of working, with an emphasis on effective communication, collaboration and coordination (Mishra and Mishra, 2009). The focus was put on the customers and small teams worked together in an iterative manner (Morris, 2014). The two main goals of this methodology were: i) accelerate the work processes ii) produce reliable products in line with customer needs.

Agility and agile methods have only recently been borrowed and applied to different divisions of the organisation. There is often talk about "Agile Supply Chain", "Agile Project Management" and even an "Agile Organisation" as a whole, where being agile is defined as a dynamic capability (Teece, 2009; Worley and Lawler, 2010). The primary goal of applying agility on an organisational level is to respond to change, but more specifically to "manage" it (Dove, 2001; Shafer, 1997). In present times, agility is considered as an essential ingredient for not only preserving a competitive advantage, but also for survival (Ganguly, 2009; Morris, 2014).

A number of organisations have now started to apply such methods to their innovation activities (Wilson and Doz, 2011). The current environment of accelerating change has made innovation hazardous and tricky to time as argued in the previous section. Yet, innovation is also perceived as crucial to survival (Schumpeter, 1939; Dodgson et al., 2008). Because of its critical implication for the existence and success of a business, this study will shed light on the implications of agility in the management of innovation.

1.3 Motivation

Although most of the scholars who have touched upon this area of research have acknowledged the need for adopting agility within an organisation, especially manufacturing, there is almost non-existent research on whether such agile practices have an impact on innovation in terms of productivity. This presents an important area of research because most organisations nowadays are engaged in either one or all types of innovations mentioned above. However, their innovation processes often lack productivity and may take up too much time. This study will help gain a better understanding into whether this problem can be addressed using the concept of agility.

Furthermore, no quantitative study – to the extent of the authors' knowledge – has been conducted in this field. It is therefore a great opportunity to add to the literature and suggest further studies based on this research.

Finally, this study will give a unique and collective insight into the different types of innovations within an organisation i.e. Product Innovation, Process Innovation and Business Model Innovation. It is of particular importance with regards to Process Innovation and Business Model Innovation, due to the lack of existing literature on these concepts. In fact, these two types of innovations are of great importance nowadays as they can bring a unique competitive advantage to an organisation (Teece, 2009).

1.4 Research Question

The main purpose of this study is to support the academic research with some new insights regarding the possible effects of agile practices on innovation, at the organisational level. More specifically, this research aims to detail a recurrent organisational problem i.e. the difficulty for most organisations to make their innovation processes more productive, as it is a critical factor for survival and innovation success. Consequently, the research question that will guide this study is:

To what extent can agility impact the innovation productivity of large organisations?

'Agility' is defined as the aptitude of a firm to react to change by organising in a flexible way at every level, thereby enabling the firm to prepare for change and to lead change in unforeseen circumstances.

The research question also takes into account the term 'large organisations', which for the purpose of this study depicts organisations with more than 250 employees[1]. This criterion was set in order to capture the effect on only large organisations and thereby eliminate the bias that may be caused by the size of the organisation.

The particularity of this research is its unique focus on the three types of innovations present in an organisation[2]: Product[3] Innovation (PDI), Process Innovation (PRI) and Business Model Innovation (BMI). For this reason, the term 'Innovation Productivity' refers to productivity with regards to these three types of innovations. The definitions of these three types of innovations were adapted from the Community Innovation Survey 2010. Therefore, Product Innovation refers to the market introduction of a new or significantly improved good or service; Process Innovation refers to the implementation of a new or significantly improved production process, distribution method or supporting activity; and Business Model Innovation refers to the creation of a new or significantly improved value offering, by taking into account customers, infrastructure, and the revenue model.

The Innovation Productivity definition was built starting from the definition of productivity – the rate at which goods/services (outputs) are produced from a standard set of inputs. The authors identify the outputs in terms of the number of innovations (Product, Process or

[1] A large-scale organisation employs more than 200 employees (Somers, Cain and Jeffery, 2011)
[2] Based on the Global CEO study of IBM (2006)
[3] Product takes into account both good and services

Business Model) produced by a firm during the three years 2012 - 2014. The inputs will be all activities at the organisational level that are required to carry out innovation activities. The following Figure 1.1 illustrates the role of agility as a catalyst.

Figure 1.1 Agility as a catalyst for innovation

It is expected that a generally positive relationship exists between agility and innovation productivity. The following recent industry example further elucidates this intuition.

The Volvo CarPlay Solution

When Apple released its CarPlay interface in 2013, the challenge for carmakers to be the first to adopt the technology was real. Carmakers had to deal with a completely new set of design features and figure out how to integrate the new Apple technology with their existing dashboard display systems. Volvo Cars, by employing agile practices, was able to launch the Volvo CarPlay solution in less than 50 percent of the industry standard time. In order to accelerate the innovation process, Volvo collaborated with a small engineering firm from the Silicon Valley, Symbio. Symbio brought external knowledge, promoted a fast and flexible mind-set during the brainstorming sessions, and promoted the use of iterative strategies. Such agile practices accelerated the innovation process at Volvo, and it can be implied that agility played the role of a catalyst in the innovation process (Morris, 2015).

1.5 Scope of the Research

As mentioned previously, the purpose of this study is to provide the reader with new insights regarding the potential impact of agile practices on the innovation activities of a firm in a given period of time. The focus will be on these managerial practices, and the research will not directly address other factors that could have an effect on Innovation Productivity.

Furthermore, this study does not aim to measure the degree to which an organisation is agile or has implemented agile practices. The research is designed to observe the independent impact of agility practices that will be defined as agility attributes for the purpose of this study.

It is also important to note that the research will be conducted by only taking into account organisations that are conducting activities within the European Union. The study is therefore only a reflection of the organisations present in the EU and may or may not give an accurate reflection of organisations outside the EU.

1.6 Thesis Content

This research study is structured as follows:

Section 1 – Introduction presents the research problem and introduces the research question that will guide the study.

Section 2 – Theoretical Framework clarifies the concept of agility and then defines the three types of innovations considered in this research, along with the notion of innovation productivity.

Section 3 – Methodology lays the foundation of the research by providing a detailed and argued presentation of the research approach, design and methods employed in this research. This section also offers a complete description of the data collection process, its execution and its outcomes.

Section 4 – Data Analysis summarises and models the data collected. A factor analysis will be carried out to reduce the number of variables, followed by a regression analysis in order to depict a relationship between the attributes of agility and innovation productivity (in terms of PDI, PRI and BMI).

Section 5 – Conclusion features a summary of the findings, including practical implications, limitations of the research and recommendations for future research.

The bibliography and appendices will follow Section 5.

2 Theoretical Background

2.1 Settings

2.1.1 Research Areas

In order to create a theoretical framework for this research, a systematic literature review was conducted. The literature review was broken down into two research areas: Agility and Innovation.

The literature on these two research areas was gathered through journal articles, books and dissertations. The databases used included Scopus, Science Direct, Emerald, SpringerLink and Business Source Premier *inter alia*.

The following Table 2.1 summarises the key words used to collect the relevant literature on the two research areas.

Agility

Agile		
Agility		
Agile Practices		
Agile	*and*	Organisation
Agility	*and*	Organisation
Agile Practices	*and*	Organisation
Agility	*and*	Attributes
Agility	*and*	Capabilities
Agility	*and*	Drivers

Innovation

Product Innovation		
Process Innovation		
Business Model Innovation		
Agile Innovation		
Innovation Productivity		
Innovation	*and*	Agility

Table 2.1 Key search words

2.1.2 Scope of the Theoretical Background

The first research area will be concerned with the concept of agility. It is a rather new concept and the term agility was first employed in 1991 (Dove, 1999; Yusuf et al., 1999). The literature on agility, however, is extremely broad. Scholars along with practitioners have developed several definitions and frameworks of agility from various perspectives, which renders the literature inconsistent and disjointed.

The purpose of this first part is not to question the existing theory of agility, nor to give a complete overview of agility during the last two decades. Instead the literature review will attempt to provide an overview of the most consistent views on agility.

Agility will be defined from a broad perspective i.e. embodying the concept of firm agility. In addition, this concept will be deconstructed in order to reveal three levels of agility: (1) agility attributes; (2) agility capabilities; (3) agility drivers.

It is important for the reader to note that the purpose of this research is not to measure agility. Therefore, the degree to which a firm is agile will not be approached in the theoretical background. Additionally, the reader should be aware that the literature review does not reflect the entire complexity behind the term 'agility', but instead tries to give both a simplified and exhaustive view of it.

The second research area will be concerned with the three types of innovations this research focuses on. Product Innovation (PDI), Process Innovation (PRI) and Business Model Innovation (BMI) will be defined, along with the concept of Innovation Productivity.

2.2 Agility

2.2.1 Firm Agility

Agility: *"The ability to move readily and quickly, the ability to think and understand readily and quickly; dexterity; alertness"* [4]

As straightforward as the dictionary definition may seem, the term 'agility' is multifaceted from a managerial perspective, which makes it hard to define. Indeed, the literature on agility is fragmented, heterogeneous and rather ambiguous (Sherehiy, Karwowski & Layer, 2007; Audran, 2011) and only a few scholars have considered agility in its entirety (Charbonnier, 2011). As different aspects of agility have been emphasised by different scholars, various interpretations of agility are reflected in the existing literature (Yusuf et al., 1999).

To gain a better understanding, the main definitions of agility were gathered in table 2.2. Three converging characteristics were depicted: changing environment, time and responsiveness. The following section will review these definitions in order to agree upon a definition of agility which will be used throughout this research.

[4] The Oxford English Dictionary

Authors	Definition of agility	Changing environment	Time	Responsiveness
Iacocca/Leigh (1991)	A system that shifts quickly among product models/lines, ideally in real time in order to respond to customer needs.		X	X
Goldman et al. (1995)	Capability of an organisation to operate profitably in a competitive environment comprised of continually changing customer habits.	X		X
Vokurka and Fliedner (1998)	Ability to successfully produce and market a broad range of low cost, high quality products with short lead times in varying size, which provide enhanced value to individual customers through customisation.		X	
Yusuf et al. (1999)	A successful exploration of competitive bases (speed, flexibility, innovation, proactivity, etc.) through the integration of reconfigurable resources and knowledge management, to provide customer driven products/services in a fast changing market environment.	X	X	X
Rigby et al. (2000)	The ability of an organisation to thrive in a constantly changing and unpredictable business environment.	X		
Sharifi and Zhang (1999 and 2000)	Agility is the ability of enterprises to respond to change, to cope with unexpected changes, to survive unprecedented threats from the business environment, and to take advantage of changes as opportunities.	X		X
Hooper et al. (2001)	Ability of an enterprise to develop and exploit its inter and intra-organisational capabilities to successfully compete in an uncertain and unpredictable business environment.	X		
Sharifi et al. (2001)	Two main factors: (i) responding to change (anticipated or not) in due time, (ii) exploiting changes and taking advantage of changes as opportunities.	X	X	X
Dove (1999 and 2001)	An effective integration of response ability and knowledge management in order to rapidly, efficiently and accurately adapt to unexpected changes in both proactive and reactive needs and opportunities […].	X	X	X

Nirmal (2005)	The capability to respond to new business demands and opportunities effectively and efficiently, rapidly shifting and aligning business assets to beat to competition to market.	X	X	X
Ashrafi et al. (2005)	An organisation's ability to sense environmental changes and respond effectively and efficiently to that change.	X	X	X
Sull (2009)	The capacity to identify, capture, and exploit opportunities more quickly than rivals do.	X	X	X
Tallon & Pinsonneault (2011)	Ability to detect and respond to opportunities and threats in the environment with ease, speed, and dexterity.	X	X	X

Table 2.2 Definitions of agility over time

In management literature, agility originated in 1991 based on the awareness that the environment of the firms started to move faster than the ability of the firms to adapt (Dove, 1999; Yusuf et al., 1999). At that time, a group of scholars from Iaccoca Institute at Lehigh University were discussing the new paradigm of manufacturing (Yusuf et al., 1999). They advocated "*a holistic, rather than a sub-optimal, approach to manufacturing*" and acknowledged that "*the main driving force behind agility is change*". Hence, agility was defined as "*a manufacturing system with extraordinary capabilities to meet rapid changing needs of the marketplace […] a system that shifts quickly among product models or product lines, ideally in real time response to customer demand*" (Youssef, 1994). Not so long after, the Agile Manufacturing Enterprise Forum (AMEF) was established in order to disseminate the vision of "the agile enterprise" inside organisations in the United States (Dove, 2001). Since then, scholars have refined the definition of agility, which has resulted in multiple interpretations.

Characteristic 1: Changing business environment, turbulent markets

When reviewing the different definitions of agility, the vast majority of the scholars who touched upon the topic defined agility as the aptitude of a firm to adapt quickly to external changes (Dove, 1999; Sharifi and Zhang, 1999 and 2000; Rigby et al., 2000). From the definitions gathered in table 2.2, agility is always defined as an answer to turbulent and unstable markets and business environments. As claimed by Yusuf et al. (1999), the main driving force behind agility is change. Therefore, one of the main characteristics of agility is the *Changing business environment*. These changes can be predictable (e.g. an expected new regulation affecting the industry) or unpredictable and unforeseen (e.g. market volatility caused by a disruptive innovation).

Characteristic 2: Time

A second essential characteristic of agility embedded within the definitions gathered in table 2.2 is *Time*. Yusuf et al (1999), Sharifi et al (2001), Dove (2001), Nirmal (2005), Sull (2009) and Tallon and Pinsonneault (2011) emphasised quickness and speed as a way to answer changes within the business environment of firms. One of the main perceptions of agility, as expressed by Dove (2001), is that agility is a combination of speed and flexibility (Agility = Flexibility + Speed). Vokurka and Fliedner (1998) defined flexibility as the ability of an organisation to transit between a variety of tasks as a routine and a predetermined process. However, a firm's agility does not only comprise of the ability to respond rapidly, but more importantly to respond efficiently to unexpected changes (Goldman et al., 1995; Vokurka and Fliedner, 1998). It can then be argued that in order to be agile, a firm needs to be flexible. Following the logic of Wadhwa (2003) and considering the definition given by Vokurka and Fliedner (1998) on flexibility, agility relies on flexibility by incorporating the ability to respond to unforeseen changes in the market in a quick way. Therefore, it can be understood that the concept of flexibility embeds the characteristic of time; by organising in a flexible way, a firm can cope with changes occurring in the business environment with little time penalty (Wadhwa, 2003).

Characteristic 3: Responsiveness, being reactive and proactive

Another essential characteristic of agility is *Responsiveness*. The ability of a firm to respond to changes occurring within its environment is a key characteristic as evident from table 2.2. It is interesting to understand how a firm can be responsive to changes occurring in its environment. To do so, the work of Nirmal (2005) will be focused upon.

Nirmal (2005) discerned two sides of agility: the reactive side and the proactive side. The reactive side is driven by external forces such as competition, market, customer needs etc. It comprises of two distinct approaches: the firm can either react to change – when the latter cannot be anticipated – or adopt a pre-emptive attitude i.e. by setting flexible structures. Here, a distinction can be made between the concept of adaptability and agility: adaptability is applicable when a firm deals with a predictable change, whereas agility is concerned with unforeseen changes in turbulent times. The reactive side of agility can be linked to the previous characteristic of agility i.e. being flexible.

The second side Nirmal (2005) referred to is the proactive side. This side is driven by internal forces such as the firm's vision, values and people. Nirmal put a clear emphasis on the ability of the top management to have clear insights about the future and to anticipate future trends; in fact, foresight activities such as scenario planning enhance agility (Vecchiato, 2014). The author also underlined the importance of having creative actions at all levels within the firm. The proactive side accentuates the characteristic of agility to lead change and take advantage of it. This view was also shared by Zhang & Sharifi (2000) (see Table 2.2). Dove (2001) gave a definition of agility which also stresses the two sides – proactive and reactive: "an effective integration of response ability and knowledge management in order to rapidly, efficiently and accurately adapt to any unexpected (or unpredictable) change in both proactive and reactive business/customer needs and opportunities, without compromising the cost or the quality of the product/process". Therefore, a firm is characterised as being agile when it responds to change in both a reactive and proactive manner. A McKinsey global survey dated 2006 clearly defined an organisation's agility as "its ability to change tactics or direction quickly – that is, to anticipate, adapt to and react decisively to events in the business environment".

Most of the definitions of agility as presented in the previous section have converging characteristics such as turbulent and changing environments, time, and responsiveness. For the purpose of this research, the following definition of agility was converged upon:

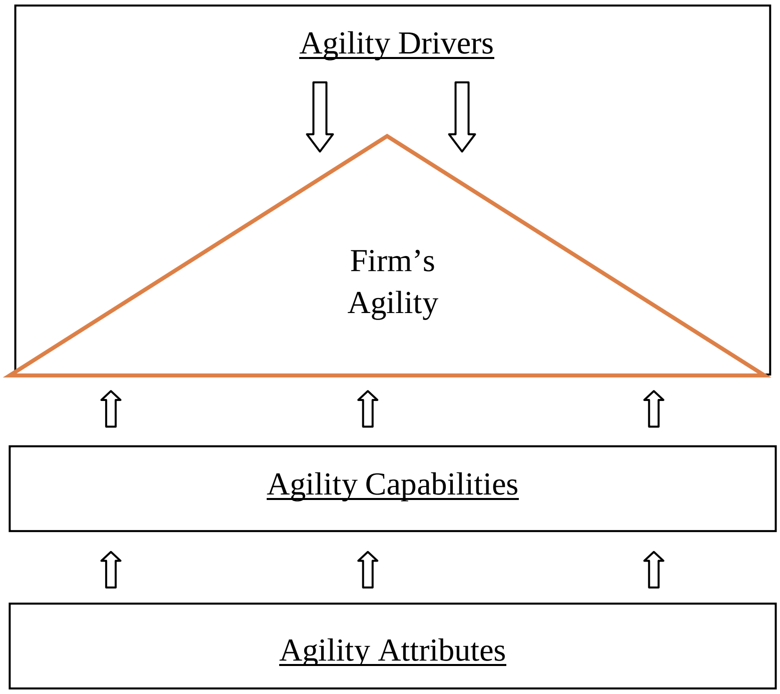
Agility is the aptitude of a firm to react to change by organising in a flexible way at every level, thereby enabling the firm to prepare for change and to lead change in unforeseen circumstances.

This definition covers the occurrence of changes within the business environment and recalls the notion of time through the concept of flexibility (it was previously discussed that a flexible firm can cope with changes within the business environment with little time penalty). Through this definition, the authors put a strong emphasis on the characteristic of being responsive to market turbulences. If a firm is agile, it will use its flexibility to react to change more effectively instead of suffering from it. But most importantly, agility is about preparing and anticipating changes and leading these changes – predictable or not – at the advantage of the firm to drive growth.

2.2.2 Achieving Firm Agility

In the previous section, different definitions of firm agility were presented and a general definition was suggested for the purpose of this research study. But what are the specific attributes i.e. indicators of an agile firm? The following section will discuss the different agility attributes found in the existing literature. These agility attributes are a way to indicate whether a company can be considered as agile or not. As the literature offers a broad range of studies that aim to measure agility and identify agility attributes, only the most commonly cited attributes will be selected. It should be noted that the majority of the studies have attempted to measure agility within the manufacturing industry; however, agility is "not industry specific" (Erande and Verma, 2008) and therefore the agility attributes reported in the following section are attributes that can be adapted or extended to organisations belonging to various industries.

The following figure, adapted from Tseng and Lin (2011), provides a better understanding of how agility may be articulated throughout an organisation.



(Adapted from Tseng and Lin, 2011)

Figure 2.1 Conceptual model of an agile enterprise

As evident from Figure 2.1 above, agility attributes form the underlying structure of an agile organisation (Ren, Yusuf and Burns, 2003). Agility attributes must be adopted by firms attempting to cope with a turbulent business environment. In fact, the main driving force behind agility is change (Yusuf et al., 1999; Tseng and Lin, 2011). Therefore, agility attributes are required to deal with the agility drivers, i.e. changes in a business environment that pressure companies to embrace an agile strategy (Tseng and Lin, 2011). Agility attributes also determine the agility capabilities and behaviour of an enterprise; therefore, agility attributes can be understood as leading to agile capabilities. The following sections will review the agility attributes in detail and also introduce the agility capabilities and agility drivers.

2.2.2.1 Agility Attributes

Achieving agility requires the presence of various agility attributes at the organisational level. One of the first scholars who proposed the idea of agility attributes was Yusuf et al. (1999). In his article, Yusuf identified thirty-two different attributes that determine the entire behaviour of a firm. For the scope of this research paper, eleven attributes were selected based on their relevance to the research topic and on their occurrence within research papers.

Collaboration with customers

Yusuf et al. (1999) defined "*strategic relationship with customers*" and "*trust-based relation with customers*" as attributes of firm agility. Moreover, "*customer collaboration over contract negotiation*" is one of the four agile principles which can be found in the Agile Manifesto (see Appendix A).

Outsourcing and partnering activities

Goldman et al. (1995) presented "*cooperation with other companies*" as one of the main dimensions of agility. Similarly, Yusuf et al. (1999) defined "rapid partnering formation" as an attribute of firm agility. In their paper, the authors argued that in the agile paradigm, cooperating with other organisations – even with competitors – is very important. According to the authors, cooperation among enterprises can help acquire "*missing links*" within a company's main capabilities, through activities such as insourcing or alliances. Similarly, Combs (1999) argued that collaboration with other organisations is a tool for exploration; when firms are facing a turbulent and unstable business environment, accessing the knowledge of other firms improves strategic decisions. Also, networking and collaboration improve innovation and performance (Gulati and Sytch, 2007 as cited by Bock et al., 2012).

Reliance on partners

One should note that relying on partners for novel opportunities or access to information may increase coordination problems and result in survival-based learning that reduces flexibility. (Harrigan and Newman, 1990; Denrell, 2003, as cited by Bock et al., 2012). If flexibility is reduced, it can be assumed that agility will be negatively affected. Therefore, not relying on partners is an attribute of firm agility.

Efficient IT systems

Most of the authors who have attempted to measure agility, agree on the importance of having efficient IT systems within the organisation (Overby et al., 2006; Sherehiy et al., 2007; Tseng and Lin, 2011). The need for IT systems has risen from the incredible volume of information in today's global and competitive environment (Overby et al, 2006). IT systems can help process this information much faster than humans and also provide organisations with the required tools to monitor and understand changes in the business environment. One such tool is known as the Knowledge Management System, which has been acknowledged as an IT system helping organisations progress through turbulent and changing environments (Dove, 2001, Overby et al., 2006; Sherehiy et al., 2007).

Iterative strategies

Working in an iterative and incremental way within agile organisations is a concept that derives from Agile Software Development[5] (Kettunen, 2009). Abrahamsson (2002) identified Agile Software Development as being incremental (small releases and rapid cycles). Lindvall et al. (2002) recognised agile methods as being incremental and iterative. Similarly Fietz (2013) suggested that working in an iterative manner is a way to help support organisational agility

Creative climate

Promoting a creative climate has become essential for agile innovation in turbulent business environments. In fact, as the environmental turbulence increases, a creative culture facilitates innovative solutions to competitive threats (Goodstein et al., 1996; Amabile, 2008).

[5] More information in Appendix A

Fast and flexible mind-set

Being fast and flexible is at the core of the concept of agility. The promotion of a fast and flexible mind-set helps build operational dexterity (Highsmith, 2012). According to Yusuf et al. (1999), having flexible people in an organisation is an attribute of agility. Flexible thinking encourages novel approaches to value creation within an organisation (Bock, 2012).

Efficient communication

Sherehiy et al. (2007) argued that clearly communicated internal information is of great importance when thriving for firm agility. In the same paper, the authors also mention that organisations facing a turbulent environment should adopt open communication and smooth information flow. An efficient flow of information among organisational structures, people, and system components was classified as an attribute of agility by Yusuf et al. (1999) and Tseng and Lin (2011).

Decentralisation

In the traditional pyramid model, the flow of information is tightly controlled and decision making is highly centralised, which prevents big mistakes from happening (Audran, 2011). However, the pyramid organisation is slow to react i.e. the business is not agile. Agile organisations advocate a highly decentralised decision making process, in order to increase responsiveness in turbulent and uncertain environments. Hage and Dewar (1973) showed that the decentralised organisation leads to higher innovation rates. A decentralised decision making process is an attribute of agility (Yusuf et al., 1999).

Managing complexity

Simplification of operations is a process that decreases the functions or business units overseen by management via consolidation, elimination or delegation (Bock et al., 2012). By reducing design complexity of operations within an organisation, managerial attention can be devoted to solving problems or identifying opportunities stemming from turbulent, changing and complex business environments (Bock et al., 2012; Rothaermel et al., 2006; Ocasio, 2007).

Modular approach

Modularity enables an organisation to meet the customer's specifications by quickly modifying parts of a product (Yusuf et al., 1999). As argued by Worren et al. (2002), a modular structure of product and service elements has been identified to increase flexibility, which implies a higher rate of responsiveness to turbulent environments. Modular approaches help organisations to be globally efficient by using standardised components in areas such as product development and manufacturing. Modular structures are created in order to rapidly innovate and to adjust to changing market needs through reduced coordination costs (Doz and Kosonen, 2009).

2.2.2.2 Agility Capabilities

As argued previously, firm agility is concerned with an unpredictable, turbulent and complex business environment. It is critical for a firm to ensure that the attributes of firm agility can satisfy the agility capabilities – and further cope with the agility drivers (Tseng and Lin, 2011). The literature review led to various agility capabilities. The most commonly cited were the following three capabilities.

Flexibility

Flexibility is the ability of a firm to implement different processes and achieve multiple goals whilst keeping the facilities, resources and systems unchanged (Tseng and Lin, 2011). Vokurka and Fliedner (1998) referred to flexibility as *"the capability of an organisation to move from one task to another quickly and as a routine procedure, with each situation defined ahead of time so that the procedures needed to manage it are in place"*. Christopher et al. (2001) extended the notion of flexibility from the manufacturing context to a wider business context. The author encompassed organisational structures, logistics processes and in particular mind-sets as enablers of flexibility within a firm. Flexibility is often argued as being a pre-requisite to firm agility: a firm needs to first organise in a flexible way to manage change under known conditions before it can respond to unforeseen circumstances (Wadhwa, 2003).

Partnerships and Collaboration

Collaboration is the ability of a firm to effectively and efficiently collaborate and cooperate across firm boundaries, internally and externally (Yusuf et al, 1999; Sherehiy et al., 2007). Partnerships and collaboration, as a capability, can be understood as "*how well a firm can work internally and externally, between departments, with suppliers and with customers*" (Jackson and Johansson, 2003). Collaboration increases knowledge and learning (Powell et al, 1996). Therefore, it can be understood that partnerships and collaboration, by increasing the knowledge of the firm, will also enhance the dexterity of the firm.

Responsiveness

Responsiveness is the ability of a firm to respond to turbulent environments and most importantly to identify the upcoming changes in uncertain times (Tseng and Lin, 2011). This capability complements the capability of flexibility. In fact, it was earlier defined that flexibility is used to cope with known changes; responsiveness on the other hand is more about identifying future unforeseen changes and coping with them. A Knowledge Management System is often used within organisations to improve organisational knowledge and monitor changes within the business environment (Overby et al, 2005).

Intuitively, it can be argued that these three capabilities converge towards the notion of speed. It was argued in part 2.2.1 that flexibility allows to cope with changes within the business environment with little time penalty. Responsiveness was defined by Tseng and Lin (2011) as the ability to respond quickly to change. Partnering and collaboration activities speed up the learning process and the creation of knowledge. The notion of speed – or being quick – is embedded in the primary definition of agility. Some authors defined speed as being a capability, however as it was demonstrated that each capability encompasses the notion of quickness, it will not be retained as a capability for the scope of this thesis.

2.2.2.3 Agility Drivers

As defined by Zhang and Sharifi (2001), agility drivers are "the pressures from the business environment that necessitate a company to search for new ways of running its business to maintain its competitive advantage". Agility drivers would require a company to revise the current company's strategy, admit the need to become agile, and adopt an agility strategy (Sherehiy et al., 2007). This part will review the different agility drivers found in the literature. As the agility drivers are not the main focus of this research, they will be introduced briefly.

By summarising the literature on agility drivers, the most cited areas of change and turbulence in the business environment can be categorised as follows: (1) Market forces - such as the market structure, the demand, the market need, price consciousness etc.; (2) Industry competition - defined in terms of competition environment, competitors' responsiveness, substitutes for products etc.; (3) Globalisation - which makes the business environment broader and more complex; (4) Macroeconomic forces - which are unpredictable exogenous factors that affect the economy directly or indirectly; (5) Technological advancements -represented by the introduction of new technologies and their adoption; (6) Geopolitical issues - through government policies pressures, legislation pressures etc.; and finally (7) Environmental issues - caused by environmental protection pressures. (Yusuf et al., 1999; Sharifi and Zhang, 1999, 2001; Sharp et al., 1999; The IBM Innovation Study, 2006).

2.2.3 Summary on Agility

After reviewing numerous definitions of the concept of agility across time, three key characteristics were identified: changing environment, time, and responsiveness. Based on these characteristics, firm agility was defined as follow:

Agility is the aptitude of a firm to react to change by organising in a flexible way at every level, thereby enabling the firm to prepare for change and to lead change in unforeseen circumstances.

Then, the different attributes that characterise agility at the firm level were defined. These attributes represent indicators of firm agility. They are:

- Customer collaboration
- Partnering and outsourcing activities
- Reliance on partners
- Efficient IT systems
- Iterative strategies
- Creative climate
- Fast and flexible mind-set
- Efficient communication
- Decentralisation
- Managing complexity
- Modular approach

Thereafter, the agility capabilities that stem from the agility attributes were presented. The three agility capabilities identified are:

- Flexibility
- Partnerships and Collaboration
- Responsiveness

Finally, the most cited agility drivers were presented. They are:

- Market forces
- Industry competition
- Globalisation
- Macroeconomic forces
- Technological advancements
- Geopolitical issues
- Environmental issues

The information presented above will now be used to fill up the organisational agility framework that was presented earlier. The completed framework is represented in figure 2.2.

Previously, it was stated that agility attributes determine the agility capabilities i.e. agility attributes can be understood as leading to agile capabilities (Tseng and Lin, 2011). But which attributes lead to what capability? Instinctively, it can be claimed that the attributes “Customer collaboration”, “Partnering and outsourcing activities” and “Reliance on partners” will belong to the capability “Partnerships and collaboration”. The capability “Responsiveness” was defined as the ability to identify future changes and cope with it when unforeseen. A good Knowledge Management System was identified as an IT tool used to increase responsiveness. Adopting a modular approach towards products and/or services, as well as smooth communication flow allow for greater responsiveness as well. Therefore, the attributes “Efficient IT systems”, “Efficient communication” and “Modular approach” are expected to belong to the capability “Responsiveness”. The remaining attributes “Creative climate”, “Iterative strategies”, “Fast and flexible mind-set”, “Decentralisation” and “Managing complexity” all present cultural values that are close to the natural values of start-ups (Audran, 2011). Most of the time, start-ups and young firms are classified as being highly flexible (Knight, 2004). Therefore, it is expected that these attributes belong to the capability “Flexibility”. These intuitions are summarised below in the form of propositions. These propositions will in turn be tested in part 4 – Analysis.

Proposition 1	- Customer collaboration - Partnering and outsourcing activities - Reliance on partners	⇨	**Partnerships and Collaboration**
Proposition 2	- Efficient IT systems - Efficient communication - Modular approach	⇨	**Responsiveness**
Proposition 3	- Creative climate - Iterative strategies - Fast and flexible mind-sets - Decentralisation - Managing complexity	⇨	**Flexibility**

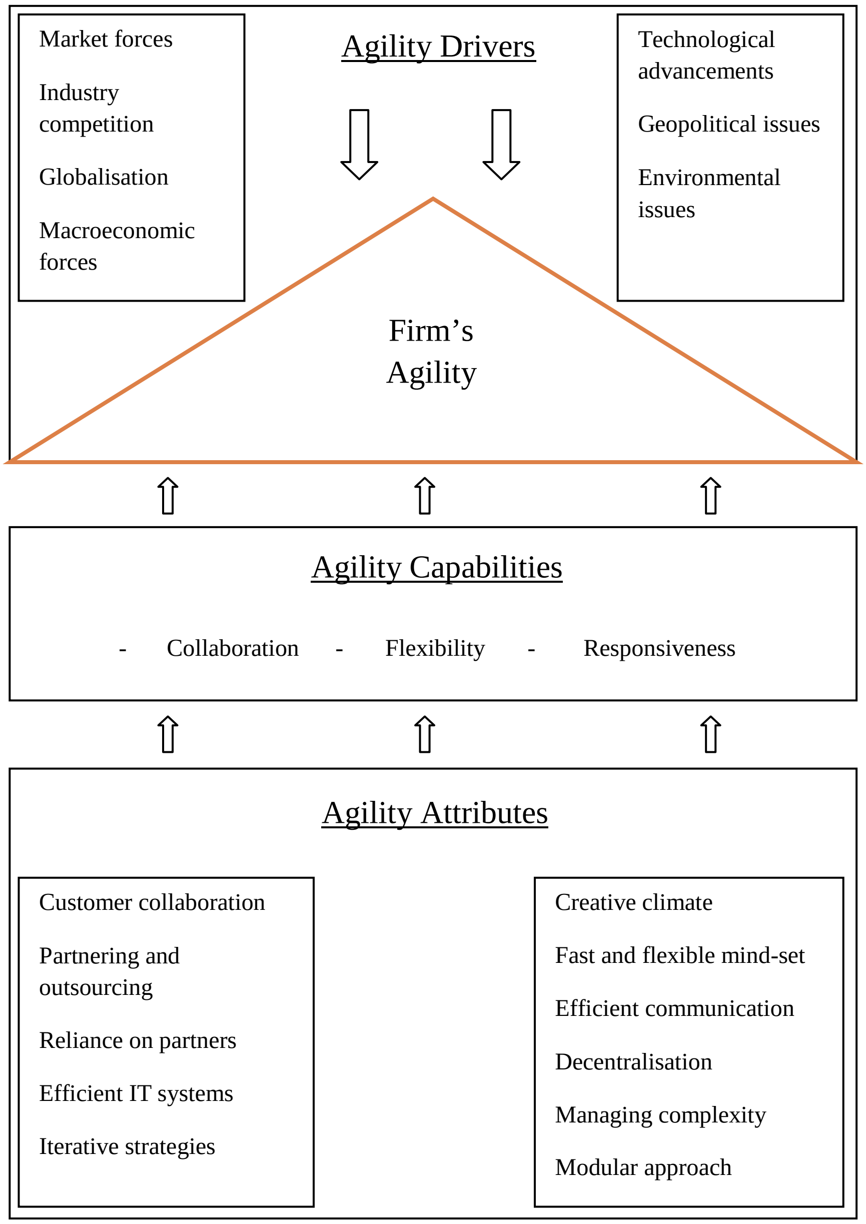


Figure 2.2 Conceptual model of an agile enterprise – Complete

2.3 Innovation

Innovation is a complex activity (Trott, 2005) and therefore it is difficult to converge upon a universal definition. As described by Schumpeter in his seminal work (1942), innovation encompasses the creation and introduction of a new product/service, new or improved production processes, materials and intermediate inputs, and management methods (Schumpeter, 1942).

For the scope of this thesis, the definition by Hartley (2006) will be used. Hartley suggests that innovation is the successful development, implementation and use of new or structurally improved products, services, processes or business models (Hartley, 2006). This definition is interesting as it covers the dimension of novelty (which can be associated with radical innovation), the concept of improvement (which can be associated with incremental innovation), emphasises that innovation is a process (development, implementation and use), and most importantly it highlights the three types of innovation that will be addressed in this study: Product Innovation, Process Innovation, and Business Model Innovation.

2.3.1 Product Innovation

Product Innovation (PDI) can be defined as new or significantly improved goods and services, which generate value for the final consumer. Product innovation is strategically important to industrial firms. The design of a new product is not an isolated activity. Apart from the product design, plans have to be drawn up for the manufacturing process, the layout of the factory, the distribution, the sale, as well as the whole production and sales unit. While it can be complex and costly, product innovation is also a major source of future income and competitive advantage for companies (e.g. Brown and Eisenhardt, 1995; Clark and Fujimoto, 1991). A firm's ability to generate a continuous stream of product innovations may be more important than ever in allowing a firm to improve business performance, because of increasing levels of competition and decreasing product life cycles. Therefore, a major concern for product innovation managers is managing the complexity of product innovation, whilst keeping in mind the link between product innovation and business performance.

2.3.2 Process Innovation

Process Innovation (PRI) is concerned with identifying new and more effective internal operations (Cohen and Levin (1989) as cited by Martinez and Labeaga, 2009), and also with introducing new elements into an organisation's operations such as input materials, task specifications, work and information flow mechanisms, and equipment used to produce a product or render a service (Afuah, 1998). These new materials, tools, task specifications, etc. help reduce production costs, which in turn help strengthen the firm's competitive advantage (Freeman (1987) as cited by Martinez and Labeaga, 2009).

2.3.3 Business Model Innovation

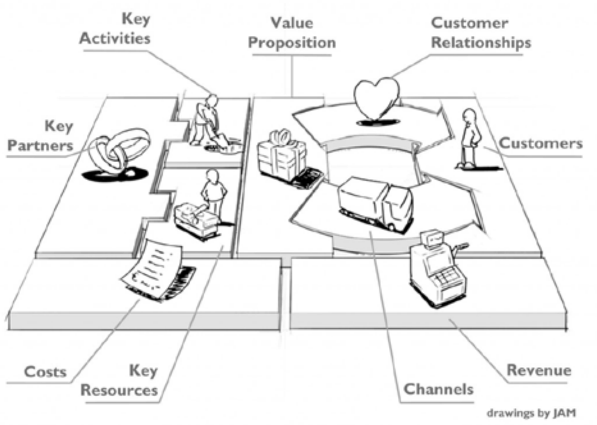
The notion of a *Business Model* (BM) can be understood as being the mechanism and the structural design by which a firm creates margins and/or growth. Osterwalder and Pigneur (2010) define BM as "*the rationale of how an organisation creates, delivers and captures value*". However, due to the competitive environment in constant change, business models are not static; rather they need to be adapted and strengthened (Ganguly, Euchner 2014).

Business Model Innovation (BMI) has been defined in various ways. It is defined by Markides (2006) as "*the discovery of a fundamental different business-model in an existing business*". It is concerned with the search of new logics and new ways to create and capture value (Casadeus-Masanell and Zhu, 2012). BMI also refers to the situation when a firm adopts a novel approach to commercialising its underlying assets (Gambardella and McGahan, 2010). BMI is about changing the current business model; however the extent to which the current business model has to change in order to classify it as an innovation remains uncertain.

Markides (2006) argues that PDI and PRI solely do not lead to BMI. Markides claims that BMI emphasises the creation of new value sources and new markets, by modifying existing systems. Ganguly and Euchner (2014) add on the notion of creating new markets by stating that BMI is any innovation that disrupts the competitive advantage of key competitors. Consequently, firms can compete through their BMs (Casadesus-Masanell, 2007). Novel BMs may be a source of disruption (Christensen, 1997), by changing the logic of entire industries and replacing the old ways of doing things to become the standard for the next generation of entrepreneurs to beat (Magretta, 2002). According to Chesbrough (2007), BMI may have more important strategic implications than other forms of innovation. This view was sustained by a recent IBM global CEO survey (2006), which revealed that organisations that have grown their operating margins faster than their competitors were putting *twice* as much emphasis on BMI as the underperformers.

Osterwalder and Pigneur (2010) defined BMs with the help of the business model canvas (figure 2.3). It can be instinctively assessed that if a firm changes at least one of the key elements of the business model canvas (i.e. "who", "what", "why", "where", "how" and "how much"), and by doing so create a new market, generate a new value source, or disrupt the competitive advantage of key competitors, then the firm has successfully engaged in BMI.

Zott and Amit (2012) suggested that managers can innovate a BM in three ways: by adding new activities, linking activities in novel ways, and changing which parties perform an activity. In other words, BMI consists of innovating the content (i.e. the nature of the activities), the structure (i.e. linkages and sequencing of activities) or the governance (the control/responsibility over an activity) of the activity system between a firm and its network.



Source: Alex Osterwalder and Yves Pigneur (2010)

Figure 2.3 Business model canvas

2.3.4 Innovation Productivity

The Innovation Productivity definition was built starting from the definition of productivity – the rate at which goods/services (outputs) are produced from a standard set of inputs. Outputs were identified in terms of the number of innovations (i.e. number of PDIs; number of PRIs; and number of BMIs) produced by a firm, during a certain time period. The inputs will be all activities at the organisational level that may affect the innovation process. These activities could include R&D effort, hiring innovation talents, organising to enhance a creative climate, promotion of individual projects, investments etc. The inputs of Innovation Productivity are beyond the scope of this study and will not be considered. Instead, the outputs and the facilitating attributes of agility are the critical measures.

The following Figure 2.4 depicts the definition of Innovation Productivity that has been formulated for this study. In this process, agility will be defined as a catalyst.

Figure 2.4 Agility as a catalyst for innovation

3 Methodology

3.1 Research Approach

3.1.1 Goal

The overall purpose of this research study was to test if there exists a relationship between a set of defined agility attributes and innovation productivity. Innovation was broken down into three dependent variables: Product Innovation (PDI), Process Innovation (PRI) and Business Model Innovation (BMI). All these three dependent variables depict the 'number' of respective innovations during the three years 2012 - 2014. This has helped define them as Product, Process and Business Model Innovation productivity.

The literature review laid down the foundation of the theoretical framework by providing an exploratory dimension through the review of academic articles, management journals, books, and dissertations within the field of agility and the three types of innovation. The literature review helped uncover the variables of agility that could have an effect on the innovation process.

3.1.2 Strategy

As the research aimed at testing the existence of a relationship between the attributes of agility and innovation productivity, the primary research was therefore quantitative in nature. The research has assessed various organisations and multiple industries across the EU. The explanatory or independent variables were the agility attributes employed by these organisations, along with a number of control variables to make the study more reliable.

A quantitative study was opted for due to multiple reasons. Firstly, it allowed for a broader study, with a greater number of observations as compared to a qualitative study. Second, through a quantitative study it was possible to collect a large amount of data across numerous cases, which can then help produce generalised results. Third, as the goal of this research work was to measure the extent of the impact of agility attributes on innovation productivity, a quantitative study was best suited for it (Bryman and Bell, 2011). Finally, a quantitative study allowed for more objectivity in the results, as the findings are not based on the subjective thoughts, opinions or interpretations of the respondent (Bryman and Bell, 2011).

Nonetheless, a quantitative study presented some shortcomings as well. It is rather inflexible, as the data collected through surveys makes it is quasi impossible to modify the survey or adapt it along the way. Moreover, if the questions in a survey were not presented in a clear and easy to understand way, a bias could arise as some of the questions may be interpreted in a subjective manner. For this reason, understanding the underlying causes of reality is a prerequisite in order to interpret the results correctly and without engendering a bias. Therefore, it is important that the questions are presented in a standard way along with multiple controls, and that the respondents have a common understanding of the underlying concepts.

Figure 3.1 below gives a summary of the research approach and the subsequent deliverables. In the following parts, the research design and the methodology adopted to answer the proposed problem will be addressed in detail.

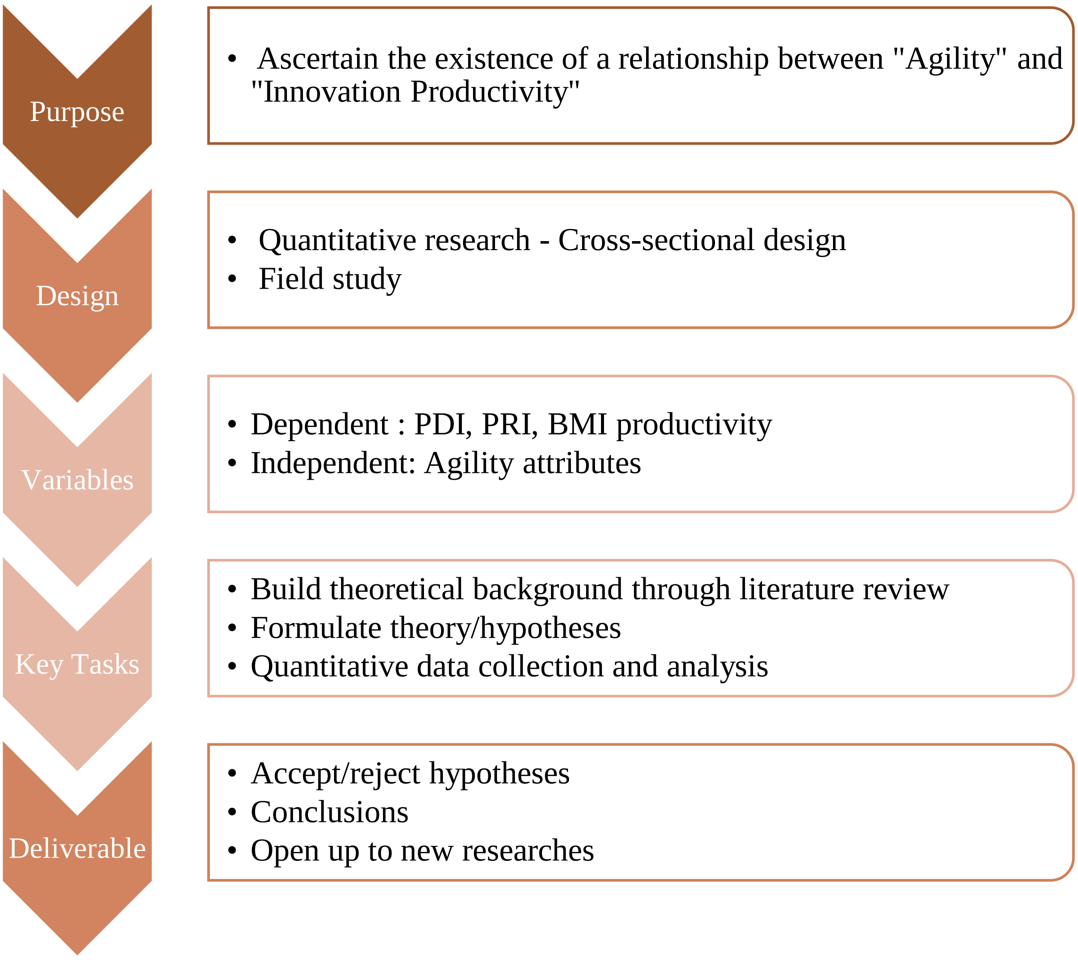


Figure 3.1 Research approach

3.2 Research Design

3.2.1 Field Study

The design of the primary research was aimed towards simulating a field study by sending out questionnaires to individuals working with innovation all over the EU. A field study was opted for because the study needs to observe the “real world” in order to assess the impact of agility attributes on innovation productivity.

3.2.2 Cross-sectional Design

A cross-sectional design was chosen as the research aims at collecting a body of quantitative data on numerous cases, at a single point in time, in order to detect a potential relationship between the agility attributes and innovation productivity.

In order to collect a body of quantitative data on numerous cases, a survey research method was used. The research instrument that was opted for was a questionnaire. The answers were collected more or less simultaneously (over a four-week period), which is a characteristic of the cross-sectional design. However, as there is no time ordering with regards to the variables (caused by the simultaneity of the collection of data), it might create a problem when establishing the direction of the causal relationship (Bryman and Bell, 2011). Consequently, careful attention is required during the interpretation of the results. It is possible to draw certain inferences regarding causality, however, cross-sectional design lacks internal validity and the inferences could also lack the credibility that can be found in most experimental studies (Bryman and Bell, 2011).

Table 3.1 depicts the structure of the cross-sectional design. Such a design includes the collection of a body of quantitative data on many variables (Variable$_1$; Variable$_2$, Variable$_3$ … Variable$_n$), at a single point in time whilst considering multiple cases. For each observation (in this study each observation will be one organisation), data is available for all variables. All these variables will be collected at time T_1, through a questionnaire – the research instrument.

	Variable$_1$	Variable$_2$	Variable$_3$	…	Variable$_n$
Obs$_1$					
Obs$_2$					
Obs$_3$					
…					
Obs$_n$					

Source: Marsh, 1982

Table 3.1 The data rectangle in cross-sectional design

For the purpose of this study, a regression analysis was chosen as a quantitative research method, in order to analyse the data from the multiple variables. The regressions were used to conduct a statistical analysis and thereby determine the nature of relationships, if any. Such an analysis was required for each type of innovation in order to test the proposed hypotheses. The details of the regressions and the acceptance or rejection of the hypotheses were examined in Section 4 of this report.

3.3 Research Methods

3.3.1 Survey Methodology

In order to collect the data necessary for the research, a survey methodology was formulated. Generally, surveys can be divided into two broad categories: interviews and questionnaires. One of the main objectives of this research was to collect as many observations as possible in the given time frame for this study, in order to build statistical inferences. For this reason, the choice to use a questionnaire as the instrument to collect data seemed to be the optimal course of action. The questionnaire took the shape of an online form and was sent out via e-mail in order to garner maximum reach.

Although an online questionnaire will assist in reaching out to more respondents in the limited timeframe, several issues may arise and these potential issues should be considered during the design of the questionnaire. One such issue is related to the formulation of questions. As the contact with the potential respondents will be initiated indirectly through e-mail, it will be almost impossible to verify if the questions were understood and interpreted in the right manner. This in turn could lead to biased answers and affect the results of the research. Therefore, the questions need to be designed in a standard way, using standard definitions.

Another potential issue is concerning the collection of data. The design of the questionnaire needed to ensure that data regarding all questions can be quantified across the defined variables. Finally, conveying the usefulness of this research to the potential respondents and gaining their interest will be a major challenge. Therefore, it is essential to incorporate a short argumentation communicating the value of the defined research area to not only the given field, but to the respondents as well. A detailed description of the questionnaire design can be found in Section 3.4.2.

3.3.2 Questionnaire

The question addressed in this research is: To what extent can agility improve innovation productivity inside large organisations? The data required in this study can be broken down into three sets of variables. The questionnaire was designed in such way that it was possible to collect data on each of the three sets of variables.

Dependent variables: These variables correspond to the three types of innovations, in terms of their productivity.

Independent variables: These variables correspond to the agility attributes. These attributes can be summarised under four categories, as done in the literature review. However, in section 3.4

(Data Collection), these categories will be broken down into the eleven attributes of agility contained in these four categories.

Control variables: These variables correspond to the factors that may have a confounding effect on the results, and their inclusion is critical in order to measure the unbiased effect of the given independent variables on the dependent variables. The controls usually take into account an observation's characteristic and environment.

3.3.3 Regression Analysis Methodology

In order to analyse the collected data, a regression analysis method was used. An empirical analysis was carried out in order to estimate the relationship to be tested (i.e. possible relationship between agility and innovation productivity).

The models that were tested took the following generic forms:

PDI Productivity = $\beta_0 + \beta_1$ * Agility Attribute$_1$ + β_2 * Agility Attribute$_2$ + …+ $\beta_{control}$ * Control Variable + … + ε

PRI Productivity = $\beta_0 + \beta_1$ * Agility Attribute$_1$ + β_2 * Agility Attribute$_2$ + …+ $\beta_{control}$ * Control Variable + … + ε

BMI Productivity = $\beta_0 + \beta_1$ * Agility Attribute$_1$ + β_2 * Agility Attribute$_2$ + …+ $\beta_{control}$ * Control Variable + … + ε

The above econometric models represent the generic equations that will be used in order to test the effect of different agile attributes on the productivity of product, process and business model innovations. The β values are the coefficients of the independent and control variables that will reflect the change in the dependent variable given a unit change in the independent variable. Different models will be created using different variables, along with any interaction variables if relevant.

As the dependent variables can contain any whole number value from 0 to infinity, depending on the number of innovations listed, they are count variables and a Poisson or Negative Binomial regression model will be used. In these equations, the agility attributes are the independent variables or predictors. Depending on the nature of the variables, they will be expressed as ranked values, dummy variables or numerical variables. Finally, the regressions also include control variables in order to ensure that any potential bias in study has been accounted for.

In order to build these regression models and conduct the subsequent data analysis, the statistical tool STATA was used. Using STATA made it possible to run and test the model.

A number of measures had to be considered to ensure that the model was not biased. Firstly, through exploratory data analysis, the presence of outliers was controlled and it was assessed whether the outliers were to be kept as part of the analysis or not. They were not deleted if they were not considered as typos or if the value was extremely abnormal; it was however important to be aware of their presence in the data set. Second, multicollinearity was also accounted for in order to ensure that the effect of a given variable was not overestimated. The problem of multicollinearity may arise if two variables having a strongly similar effect are both used as independent variables in the regression equation.

Once the regressions were performed, the attention was put on the β values, their statistical significance, the number of observations taken into account, and the robustness check to account for the good fit of the model. Finally, it was possible to determine if there exists a relationship and if so what the nature of it is. The data analysis can be found in Section 4.

3.4 Data Collection

3.4.1 Sampling

This part will address the sampling methodology formulated, in order to obtain a representative sample of the population under observation. In order to define a sample that ought to match the requirements of the study, certain filters were applied whilst selecting the respondents. It was defined that the respondents must work for an organisation with more than 250 employees, in the EU, and occupy an influential position in an innovation role.

Given the limited timeframe to conduct this study, the population under observation corresponded to members belonging to the three LinkedIn groups: Innovation Management Group, Innovation Excellence Group, and Open Innovation Network Group. In total, these groups comprise of more than 75,000 members. However, this number should be interpreted carefully as some members may be present in more than one, or all three groups. Also, not all of the members were working with innovation in the European Union. After attaining membership of these groups, it was possible to contact the members through a personalised e-mail.

The members that were considered for this research comprised of Innovation Managers, Innovation Directors, Heads of Innovation, and Vice President Innovation. The main reason behind reaching these type of positions was to increase the reliability of the answers. In fact, it was assumed that high positions were more inclined towards knowing the overall activities of their respective organisations. Other positions were also considered, but to a smaller extent. The selected members represented their respective organisations while responding to the questionnaire. Therefore, the chosen unit of analysis was the organisation, even though the observation was collected on an individual level.

Overall, the sampling method employed corresponded to that of a non-probability sample. As the sample was subject to additional filters, randomisation could not be accounted for. However, in order to strengthen this technique it was decided to include all possible observations that fit the selection criteria, in order to obtain a consecutive sampling.

3.4.2 Questionnaire Design

In order to carry out this quantitative research, a questionnaire was created through the online tool Qualtrics, with closed-ended questions to quantitatively assess the responses of the observed sample. Some definitions and questions were adapted from the Community Innovation Survey (CIS) 2010; it was used as a guideline to formulate questions pertaining to product innovation and process innovation. The definitions of these two types of innovations were also incorporated in the survey for this study as they were deemed to be representative of the broad industry wide understanding of these terms. Other definitions stem from the literature review that was conducted before.

The average time to complete the questionnaire was estimated to be 10 minutes. It consisted of both the core research questions and the control questions. The full questionnaire can be found in Appendix C. The following section builds on the introduction to the questionnaire presented in the research methods Section 3.3 by providing greater details about each variable.

3.4.2.1 Variables

a) Dependent Variables

***Product Innovation Productivity*:** The questionnaire included a standard definition of product innovation, defined as being a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems. The respondents were then asked if their organisation introduced any new or significantly improved goods or services during the three years 2012 – 2014. These two were contingency questions, and if the respondents answered yes to any of the two, they were required to answer a follow up question. This follow up question asked them how many new goods/services, as well as significant improvements to existing goods/services, had their organisation introduced from 2012 to 2014. The respondents were given a range of numerical choices to answer this question.

***Process Innovation Productivity*:** A standard definition of process innovation was presented, where process innovation was defined as the implementation of a new or significantly improved production process, distribution method, or supporting activity. The respondents were then asked if their organisation introduced any new or significantly improved methods of manufacturing or producing goods or services; new or significantly improved logistics, delivery or distribution methods for their inputs, goods or services; and new or significantly improved supporting activities for their processes, such as maintenance systems or operations for purchasing, accounting, or computing - during the three years 2012-2014. These three were contingency questions, and if the respondents answered yes to any of them, they were required to answer a follow up question. This follow up question asked them how many processes, as well as improvements to existing processes, had their organisation introduced from 2012 to 2014. The respondents were given a range of numerical choices to answer this question.

***Business Model Innovation Productivity*:** Business model innovation was defined as the creation of new or significantly improved value offering, by taking into account the customers, infrastructure, and revenue model. The respondents were then asked if their organisation introduced any new or significantly improved value offering to customers; new or significantly improved customer relationships, customer segments, or distribution channels; new or significantly improved key partners, key activities, or key resources; and new or significantly improved cost structures or revenue streams - during the three years 2012-2014. These four were contingency questions, and if the respondents answered yes to any of them, they were required to answer a follow up question. This follow up question asked them how many times their organisation had re-invented its business model from 2012 to 2014. The respondents were given a range of numerical choices to answer this question.

b) Independent Variables

***Agility and Organisational Behaviour*:** The respondents were asked to rate a number of agility attributes on a 7-point likert scale, where 1 meant that the factor had no presence within the organisation and 7 meant that it had an extremely strong presence within the organisation. 4 meant the factor had a moderate presence. According to the literature review, the agility attributes incorporated in the questionnaire included the following:

- Presence of a creative climate
- Simplification of products and operations to manage complexity
- Delegation of power and decentralised decision making
- Use of iterative strategies relying on quick and speedy decisions
- Outsourcing and partnering activities
- Reliance on partners
- Customer collaboration
- Modular approach towards products/services
- Efficient IT system (knowledge management)
- Effective communication (both internal and external)
- Promotion of a fast and flexible mind-set.

These independent variables were then used to create a regression model in order to assess the impact on the dependent variables and by doing so, test the proposed hypotheses.

c) Initial Controls

A number of control questions were included in the questionnaire that took into account variables relative to location of the organisation's headquarters, geographic markets the organisation is involved in, type of industry, size of the organisation, exogenous factors, and technological integration with business processes.

***Location of Headquarters*:** This variable was used in order to ascertain whether the headquarters of the organisation were located within the EU. A binary (dummy) variable was introduced if the organisation's headquarter was inside the EU. Organisations in the EU operate in a common market but with socio-culturally diverse facilities, with the potential to affect innovation and change (Bock et al., 2012).

Geographic Markets**:** The geographic markets in which the organisation is involved in were used to determine the extent of the organisation's operations and control for the scale of their products or services. Four separate choices were introduced, which represented an increasing subset of each other. All four choices were binary (dummy) variables representing a particular type of geographic market.

Type of Industry**:** As the research is a cross-industry research, this variable was used to identify the respective industry of an organisation and control for the effect it may have on the number and kind of products/services. Multiple choices were included along with an 'Other' option. All industry choices were introduced as binary (dummy) variables representing a particular type of industry. Manufacturing, Fast Moving Consumer Goods, and Luxury organisations were grouped under the Manufacturing industry variable. In addition, service, banking/financial and consulting organisations were grouped under the Service industry variable.

Size of the Organisation**:** The variable 'size of the organisation' was used to control for the minimum number of employees required to deem an organisation as being 'large'. The organisation was considered 'large' if and only if it had equal to or greater than 250 employees, according to the initial definition of a large organisation. In case the employees were stated to be less than 250, the responses were not considered suitable for the study. The intuition behind including this variable was the fact that size of the organisation may affect innovation efforts (Damanpour, 1992), and therefore the size of the organisation was aggregated into six categories. The categories were: less than 250 employees, between 251 and 500 employees, between 501 and 1,000 employees, between 1,001 and 5,000 employees, between 5,001 and 10,000 employees and greater than 10,000 employees.

Exogenous Threats**:** The variable concerning potential exogenous threats to the organisation was controlled for in order to assess whether the organisation's innovation activities were affected by the perceived macroclimate of the future. All choices were introduced as binary (dummy) variables representing a particular type of exogenous factor. The most important exogenous factors for this study were considered to be technological advancements and macroeconomic factors.

Technological Integration**:** Technological integration with business processes was controlled for the fact that a non-random sample may associate innovation with efforts to improve integration of technology with business processes (Bock, et.al, 2012). A five-point Likert scale was introduced, where 1 represented 'least important' and 5 represented 'most important'.

d) Core Controls

Innovation Objectives**:** In order to control for the reasons behind an organisation's intention to engage in product, process, or business model innovation; a set of questions regarding each category were introduced using a 7-point likert scale. Under each category, the respondents were asked how important were each of the given objectives for their organisation's product/service, process, business model, or organisational innovations introduced during the three years 2012 to 2014. With respect to the 7-point likert scale, 1 meant that the objective was not important at all and 7 meant that the objective was of critical importance. 4 meant that the objective held average importance. The reason for introducing these core controls was to account for the confounding effect of these innovation objectives.

The following table summarises all three sets of variables:

<table>
<tr><th>Dependent Variables</th><th colspan="2">Independent Variables</th><th>Control Variables</th></tr>
<tr>
<td>• PDI Productivity
• PRI Productivity
• BMI Productivity</td>
<td>• Presence of a creative climate
• Simplification of products and operations to manage complexity
• Delegation of power and decentralised decision making
• Use of iterative strategies relying on quick and speedy decisions
• Outsourcing and partnering activities</td>
<td>• Customer collaboration
• Reliance on partners
• Modular approach towards products/services
• Efficient IT system (knowledge management)
• Effective communication (both internal and external)
• Promotion of a fast and flexible mind-set.</td>
<td>• Location of Headquarters
• Geographic Markets
• Type of Industry
• Size of the Organisation
• Exogenous Factors
• Technological Integration
• Innovation Objectives</td>
</tr>
</table>

Table 3.2 List of dependent, independent and control variables

3.5 Research Criteria

3.5.1 Replicability

The procedure for selecting the respondents, designing the variables to be measured, and administrating the questionnaire has been detailed in the previous sections. Similarly, in section 4, the process used to carry out the data analysis will be explained in detail as well. This process will ensure that this study is replicable. It is important to ascertain the replicability of this research, as it is a pre-requisite to ensure the reliability of the study.

3.5.2 Reliability

In this study, reliability is concerned with the consistency of the measures of agility (Bryman and Bell, 2011). As the attributes of agility were taken from existing research during the literature review, it can be argued that the stability of the measures was accounted for. Similarly, the different definitions of innovation were borrowed from the Community Innovation Survey which therefore ensure the reliability of this concept

Internal reliability, on the other hand, will be tested in Section 4 through the use of Cronbach's Alpha after the Principal Component Analysis.

3.5.3 Validity

Validity is concerned with the integrity of the measures employed in the research. The attributes of agility were borrowed from the literature and have already been validated in terms of measuring agility. Therefore, content validity was accounted for and all of the attributes of agility are considered to be valid.

On the other hand, bearing in mind the cross sectional design of the research, internal validity might be impeded. This is mainly due to the fact that there is no time ordering with respect to the variables and also, there is no manipulation present. In case a relationship is depicted, the confidence for drawing a causal relationship and statistical inferences will generally lack the credibility of the findings derived from an experimental design.

External validity can be questioned due to the non-probability sampling method. However, the consecutive sampling technique employed strengthens this criterion. Nevertheless, it will be necessary to take into account the non-randomisation of the sampling while interpreting the results. This also suggests that any generalisations should be treated carefully.

3.6 Execution

3.6.1 Survey Administration

Before starting the survey, the questionnaire was tested on two individuals in order to assess whether the questions were understood in the right context and to calculate the average time needed to complete the questionnaire. The questionnaire was deemed comprehensible and the average time to complete the questionnaire was determined to be 10 minutes. Following this, the survey was initiated.

317 questionnaires were sent out to Innovation Managers, Innovation Leaders, Innovation Directors, and Heads of Innovation, working for organisations within the European Union. These 317 questionnaires corresponded to all possible observations that matched the control criteria and could be associated with the sampling population (the sampling methodology can be found in section 3.4.1). In order to create awareness, arouse interest and increase the response rate, all correspondence was conducted on an individual level through personalised e-

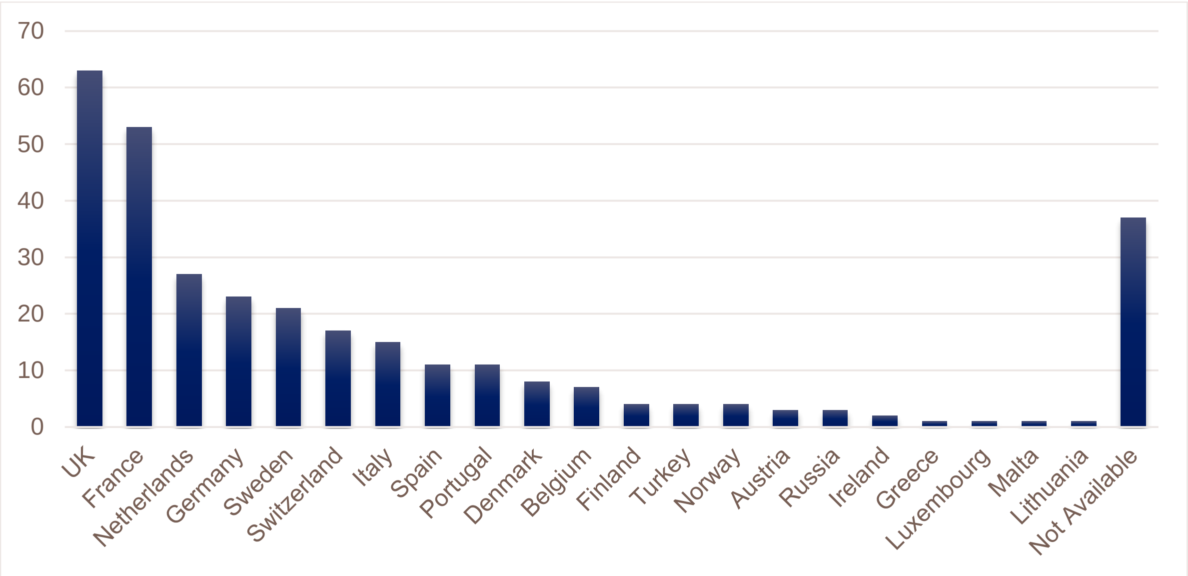
mails sent out to the filtered members of the three LinkedIn groups. After the initial round of emails in early March, follow up e-mails were sent out after ten days to those individuals who did not respond to the initial correspondence. This strategy helped increase the response rate by over 100%. The personalised e-mails can be found in Appendix B.

Table 3.3 shows the practical details of the survey methodology and the survey administration results.

Population under study	Organisations with more than 250 employees
Geographical area	European Union
Data collection method	Structured survey administered through an online questionnaire via e-mail
Sample size	103 returned questionnaires
Response rate	32.49%
Time frame	1st March 2015 – 31st March 2015
Respondent profiles	Innovation Manager, Innovation Director, Head of Innovation, VP Innovation

Table 3.3 Survey data

Figure 3.2 shows the geographic locations of the organisations that were approached. Where it was not possible to determine the geographic location of an organisation through the target profile, it was categorised under “Not Available”.

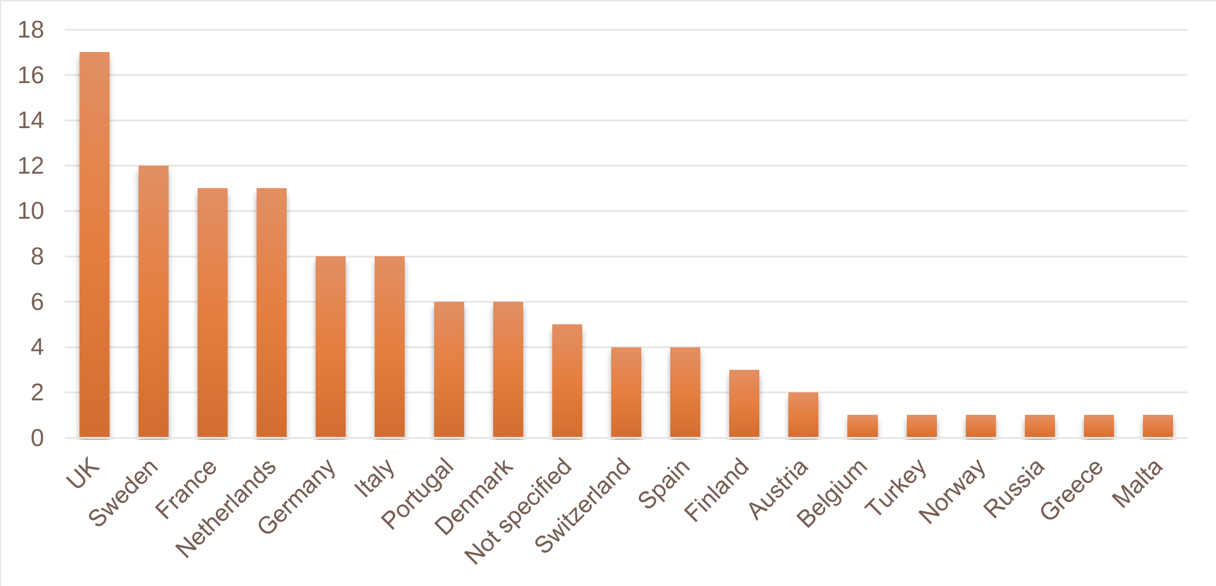


(Total: 317 surveys administrated)

Figure 3.2 Survey administration across geographic area

3.6.2 Final Sample

Out of a possible 317 responses, 103 responses were gathered over a period of four weeks. This suggests a response rate of 32.49%. The base line target to ensure the reliability of the study was set at minimum of 40 responses. This target was surpassed by approximately 158%, which accounted for a significant increase in the reliability of the study. Figure 3.3 shows the geographic locations of the organisations that responded to the survey questionnaire. Where the geographic location of an organisation was not specified, it was categorised under "Not Specified".



(Total: 103 questionnaires collected)

Figure 3.3 Responses across geographic area

Figure 3.3 illustrates that the most number of respondents belong to the UK, France, Sweden and Netherlands. Out of these four countries, Sweden had the highest response rate of 60%. A cursory look at both figure 3.2 and 3.3 suggests that Sweden may represent a response bias, as the response rate in Sweden is significantly higher than the other countries. It may be the case that Sweden is overweight in the final sample, but as the number of responses from Sweden account for only 12% of the total responses, the effect can be considered to be insignificant.

Out of the 103 responses collected, 28.2% were completed by Directors of Innovation, Strategy or R&D, 20.4% were completed by Heads of Innovation, 24.3% were completed by Managers in Innovation, 7.8% were by Innovation Vice Presidents, and 19.4% were completed by other positions within innovation or non-specified positions. Figure 3.4 gives a graphical representation of this distribution.

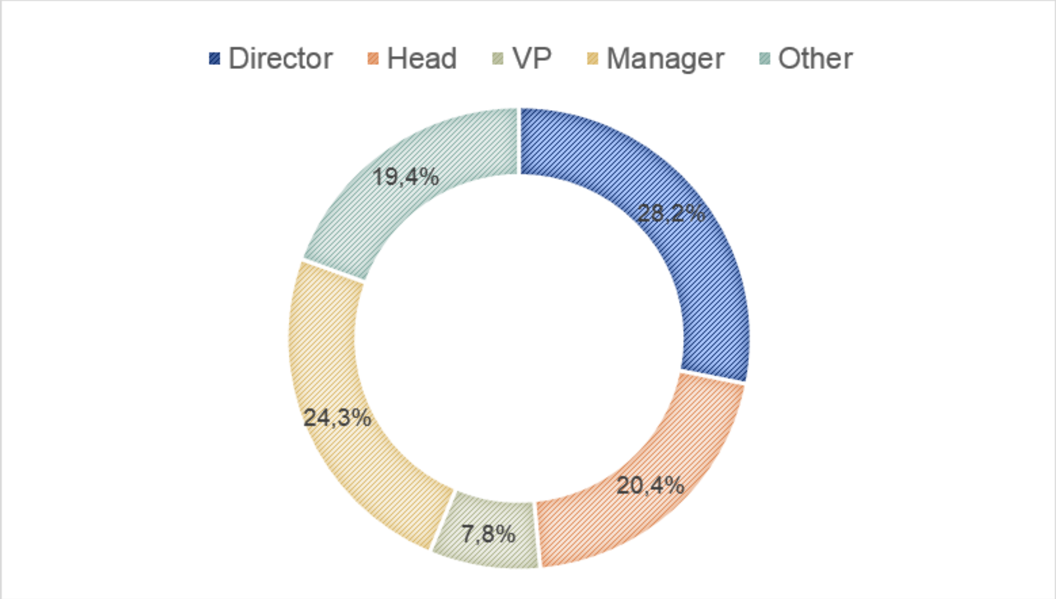


Figure 3.4 Distribution of respondents across positions

Over 50% of the respondents occupy very high position within innovation (VP, Director or Head of Innovation). This ensures the reliability of the data collected as it was assumed that people occupying these types of position have a better understanding and overall view of the activities conducted within their respective organisations. Other positions related in general to positions within R&D or Marketing.

4 Data Analysis

4.1 Data selection

Only people working with Innovation within the EU were kept as part of the sample selection. Responses that indicated the HQ of the organisation in question was outside the EU were not considered. Also, responses that indicated the organisation size to be less than 250 employees were discarded, as the study only takes into account large organisations with at least 250 employees.

In total, 19 observations with less than 250 employees were present in the dataset and were thus deleted from the dataset. This reduced the number of valid observations from 103 to 84. In addition, two further observations were dropped from the dataset. One of these observations contained missing values across all variables and the other observation was assumed to be a case of wrong data entry due to the presence of an abnormal outlier.

Therefore, a total of **82 valid observations** were used in this study.

4.2 Variables

4.2.1 Variable Names and Description

Table 4.1 presents all the variables used in this study along with their descriptions:

Type of Variable	Variable	Description
DEPENDENT VARIABLES	Num_PDI	Number of Product Innovations 2012-2014
	Num_PRI	Number of Process Innovations 2012-2014
	Num_BMI	Number of Business Model Innovations 2012-2014
INDEPENDENT VARIABLES	Agility_CC	Creative Climate *(=1 if not present, 7 if high)*
	Agility_IS	Iterative Strategies *(=1 if not used, 7 if high)*
	Agility_FM	Promotion of a Fast, Flexible Mind-set *(=1 if not promoted, 7 if high)*
	Agility_MC	Manage Complexity *(=1 if not simplified, 7 if high)*
	Agility_DM	Delegation of Power / Decentralised Decision Making *(=1 if low delegation, 7 if high)*
	Agility_MA	Modular Approach *(=1 if not used, 7 if high)*
	Agility_IT	Efficient IT System *(=1 if not efficient, 7 if high)*
	Agility_Comm	Efficient Communication *(=1 if not efficient, 7 if high)*
	Agility_PR	Reliance on Partners *(=1 if low reliance, 7 if high)*
	Agility_CCOL	Customer Collaboration *(=1 if low collaboration, 7 if high)*
	Agility_OP	Outsourcing and Partnering Activities *(=1 if low, 7 if high)*
INDUSTRY, LOCATION	EU	Headquarters in the EU *(=1 if located in the EU, 0 if not)*
	Geo_EU	Goods/Services sold across Europe *(=1 if yes, 0 if not)*

AND EXOGENOUS CONTROLS	Ind_MANU	Firms from Manufacturing Industry *(=1 if yes, 0 if not)*
	Ind_SERV	Firms from Service Industry *(=1 if yes, 0 if not)*
	Ind_Tech	Firms from Technology Industry *(=1 if yes, 0 if not)*
	Org_Size	Size of the organisation
	Tech_Int	Importance of technological integration to the firm *(1 if no value to business, 5 if very important)*
	Exo_Tech	Technological advancements *(1 if small impact on business, 5 if high)*
	Exo_Macro	Macroeconomic factors *(1 if small impact on business, 5 if high)*
PRODUCT INNOVATION CONTROLS	PDI_CONT_1	Penetration of current market *(1 if weak importance on Innovation Strategy, 7 if high)*
	PDI_CONT_2	Improvements to current products/services *(1 if weak importance on Innovation Strategy, 7 if high)*
PROCESS INNOVATION CONTROLS	PRI_CONT_1	Improvement in operations responsiveness *(1 if weak importance on Innovation Strategy, 7 if high)*
	PRI_CONT_2	Application of technology to core processes *(1 if weak importance on Innovation Strategy, 7 if high)*
	PRI_CONT_3	New IT to automate processes *(1 if weak importance on Innovation Strategy, 7 if high)*
	PRI_CONT_4	Optimisation of core processes *(1 if weak importance on Innovation Strategy, 7 if high)*
	PRI_CONT_5	Reduction in cycle time/complexity *(1 if weak importance on Innovation Strategy, 7 if high)*
BUSINESS MODEL INNOVATION CONTROLS	BMI_CONT_1	Organisational structure changes *(1 if weak importance on Innovation Strategy, 7 if high)*
	BMI_CONT_2	Strategic partnerships *(1 if weak importance on Innovation Strategy, 7 if high)*
	BMI_CONT_3	Use of a third party operating utility *(1 if weak importance on Innovation Strategy, 7 if high)*

Table 4.1 Variable names and description

4.2.2 Descriptive Statistics and Correlations

The descriptive statistics of the variables used in this study can be found in table 4.2. The statistics show the number of observations, mean, standard deviation and minimum/maximum values of the given variables. A cursory look at the means of Num_PDI, Num_PRI and Num_BMI suggests that during 2012-2014, the number of product innovations were considerably greater than the number of process or business model innovations.

Variable	Obs	Mean	Std. Dev.	Min	Max
Num_PDI	82	13.45122	23.82247	0	100
Num_PRI	80	5.3375	7.929984	0	50
Num_BMI	74	3.378378	3.095302	0	20
Agility_CC	80	4.85	1.623405	2	7
Agility_MC	80	4.35	1.26391	2	7
Agility_DM	78	4.141026	1.763441	1	7
Agility_IS	80	4.2875	1.56863	1	7
Agility_OP	80	4.4875	1.591065	1	7
Agility_PR	80	4.5	1.606947	1	7

Agility_CCOL	80	4.85	1.661934	1	7
Agility_MA	80	4.475	1.792919	1	7
Agility_IT	79	4.088608	1.594782	1	7
Agility_Comm	79	4.556962	1.516971	1	7
Agility_FM	79	4.582278	1.661075	1	7
EU	81	.8148148	.390868	0	1
Geo_EU	82	.6097561	.4908068	0	1
Ind_SERV	82	.4146341	.4956906	0	1
Ind_MANU	82	.5487805	.500677	0	1
Ind_Tech	82	.3536585	.481047	0	1
Org_Size	82	4.95122	1.430725	2	6
Exo_Macro	82	.4268293	.4976609	0	1
Exo_Tech	82	.7560976	.4320773	0	1
Tech_Int	82	3.865854	.8128929	2	5
PDI_CONT_1	81	5.45679	1.351382	1	7
PDI_CONT_2	81	5.666667	1.360147	1	7
PRI_CONT_1	81	5.407407	1.272574	2	7
PRI_CONT_2	81	5.049383	1.650009	1	7
PRI_CONT_3	81	4.901235	1.585914	1	7
PRI_CONT_4	81	5.234568	1.217288	1	7
PRI_CONT_5	81	5.222222	1.431782	2	7
BMI_CONT_1	80	5.1875	1.567823	1	7
BMI_CONT_2	80	5.2625	1.490423	1	7
BMI_CONT_3	79	3.658228	1.745956	1	7

Table 4.2 Descriptive statistics

In addition to the descriptive statistics, it was also interesting to see the existing correlation trend between the agility attributes. Table 4.3 below depicts that most of the variables are correlated with each other to a certain extent, however, the correlation is not high. The only exception seems to be Agility_PR and Agility_OP with a correlation of 0.8068. All other variables possess a correlation of less than 0.7.

	Agili~CC	Agili~MC	Agili~DM	Agilit~S	Agilit~P	Agilit~R	Agilit~A	Agilit~L	Agilit~T	Agilit~m	Agili~FM
Agility_CC	1.0000										
Agility_MC	0.6993	1.0000									
Agility_DM	0.6567	0.4240	1.0000								
Agility_IS	0.5528	0.4445	0.6651	1.0000							
Agility_OP	0.3153	0.2662	0.2925	0.3520	1.0000						
Agility_PR	0.4204	0.4086	0.3512	0.5008	0.8068	1.0000					
Agility_MA	0.5094	0.4030	0.3193	0.3845	0.3367	0.4679	1.0000				
Agility_CCOL	0.6047	0.4407	0.3785	0.4236	0.4516	0.5787	0.5333	1.0000			
Agility_IT	0.3617	0.3165	0.1768	0.2796	0.1409	0.3463	0.4790	0.3659	1.0000		
Agility_Comm	0.5257	0.5089	0.4842	0.5049	0.2203	0.3464	0.5148	0.4365	0.5597	1.0000	
Agility_FM	0.6562	0.4443	0.5715	0.5944	0.2894	0.4565	0.4965	0.5779	0.4452	0.6605	1.0000

Table 4.3 Correlation matrix

4.3 Principal Component Analysis

4.3.1 Purpose

For the purpose of the analysis, the 11 agility attributes (independent variables) needed to be reduced to a smaller number of composite variables due to two main reasons:

i) The total number of observations (N = 82) were not considered sufficient enough to depict the individual unbiased impact of each variable.

ii) The correlated observed variables could potentially lead to multicollinearity and thereby give biased results.

In order to achieve this, two methods were considered i.e. Principal Component Analysis (PCA) that would give the principal component factors, and Factor Analysis (FA) that would give the iterated principal factors. As the aim of this analysis was to only reduce the independent variables into a smaller set of composite variables, the PCA was preferred. The FA would have been preferred if the aim was to test a theoretical model of latent factors causing observed variables.

4.3.2 Analysis

The command for the PCA was run in STATA in order to extract the principal component factors using the eigenvalues. As a default rule of thumb derived using the Kaiser criterion, eigenvalues above 1 were used to create the composite factors (Kaiser, 1960). Table 4.4 shows the eigenvalues as well as the factor loadings acquired in STATA. The variables displayed in table 4.5 represent the independent variables i.e. the agility attributes.

Factor analysis/correlation   Number of obs = 78
Method: principal-component factors   Retained factors = 3
Rotation: (unrotated)   Number of params = 30

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	5.56472	4.26146	0.5059	0.5059
Factor2	1.30326	0.23042	0.1185	0.6244
Factor3	1.07285	0.36754	0.0975	0.7219
Factor4	0.70530	0.13968	0.0641	0.7860
Factor5	0.56562	0.10225	0.0514	0.8374
Factor6	0.46338	0.07678	0.0421	0.8796
Factor7	0.38659	0.03433	0.0351	0.9147
Factor8	0.35226	0.06866	0.0320	0.9467
Factor9	0.28360	0.10595	0.0258	0.9725
Factor10	0.17765	0.05289	0.0162	0.9887
Factor11	0.12476	.	0.0113	1.0000

LR test: independent vs. saturated: chi2(55) = 492.43 Prob>chi2 = 0.0000

Table 4.4 Factor analysis

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness
Agility_CC	0.8224	-0.1938	-0.2008	0.2458
Agility_MC	0.6927	-0.1603	-0.1046	0.4836
Agility_DM	0.6933	-0.1811	-0.5318	0.2038
Agility_IS	0.7391	-0.0515	-0.3600	0.3215
Agility_OP	0.5548	0.7583	-0.0378	0.1159
Agility_PR	0.7159	0.6093	0.0720	0.1110
Agility_CCOL	0.7471	0.1865	0.1305	0.3901
Agility_MA	0.6958	0.0018	0.3833	0.3689
Agility_IT	0.5597	-0.2348	0.6346	0.2289
Agility_Comm	0.7438	-0.3526	0.1882	0.2871
Agility_FM	0.8079	-0.2101	-0.0218	0.3027

Table 4.5 Factor loadings

The three eigenvalues highlighted in red in table 4.4 represent the optimal number of factors or components that can be generated using the 11 independent variables. Figure 4.1 gives a visual representation. It is important to note that even though the final sample included 82 valid observations, there are some missing values that reduce the number of observations used in the factor analysis to 78 (see table 4.4).

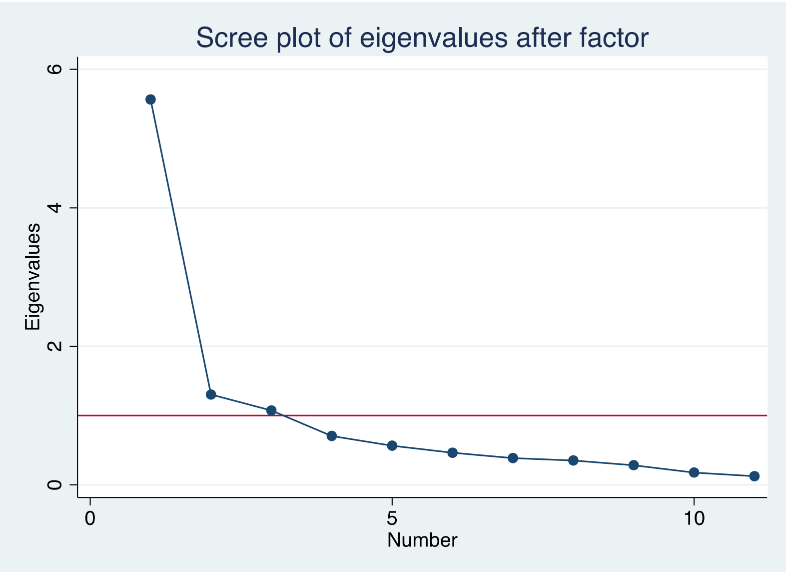


Figure 4.1 Visual representation of optimal number of factors

The factor loadings were then given an orthogonal varimax rotation (Kaiser on) in order to ensure that the factors are not correlated with each other and to also assign all rows the same weight (Horst, 1965).

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Uniqueness
Agility_CC	0.7687	0.3496		0.2458
Agility_MC	0.6061	0.3438		0.4836
Agility_DM	0.8809			0.2038
Agility_IS	0.7614			0.3215
Agility_OP			0.9270	0.1159
Agility_PR			0.8743	0.1110
Agility_CCOL	0.3789	0.4464	0.5168	0.3901
Agility_MA		0.6742	0.3394	0.3689
Agility_IT		0.8715		0.2289
Agility_Comm	0.5243	0.6606		0.2871
Agility_FM	0.6521	0.4864		0.3027

(Blanks represent abs(loading)<.3)

Table 4.6 Rotated factor loadings

The rotated factor loadings that represented a correlation of < 0.3 with the generated factors were then removed in order to present a less noisy table. Table 4.6 shows the rotated factor loadings i.e. the correlation between the independent variables and the principal component factors.

All variables show a low uniqueness of < 0.5, which suggests that all variables belong to at least one of the factors uniquely and the relevance of the variables is higher for a given factor model. A very high uniqueness would have suggested that a given variable does not uniquely belong to any of the factors listed.

Table 4.7 shows how the 11 independent variables are classified into the three factor loadings, in accordance with Table 4.6. After conducting the literature review, three propositions were formulated on how the agility attributes can be classified under the agility capabilities (see Figure 2.2). The factor analysis confirmed the intuition formulated through these propositions. In fact, all three factors contain the same set of agility attributes as proposed in Figure 2.2. Therefore, the composite factors containing the independent variables were named as Flexibility, Responsiveness, and Partnerships and Collaboration based on the understanding gained through the literature review. These three composite factors, consequently, are identified as capabilities of agility containing the specific agility attributes.

FLEXIBILITY *(Factor 1)*	- Creative Climate (Agility_CC) - Iterative Strategies (Agility_IS) - Promotion of a Fast and Flexible mind-set (Agility_FM) - Simplification of Products/Operations to Manage Complexity (Agility_MC) - Delegation of Power and Decentralised Decision Making (Agility_DM)

RESPONSIVENESS *(Factor 2)*	- Modular Approach (Agility_MA) - Efficient IT System (Agility_IT) - Efficient Communication (Agility_Comm)
PARTNERSHIPS AND COLLABORATION *(Factor 3)*	- Reliance on Partners (Agility_PR) - Customer Collaboration (Agility_CCOL) - Outsourcing and Partnering Activities (Agility_OP)

Table 4.7 Classification of independent variables into factor loadings

The three factors Flexibility, Responsiveness and Partnerships and Collaboration were then used in three independent regression models as independent variables to assess the impact on the dependent variables Num_PDI, Num_PRI and Num_BMI.

4.3.3 Reliability and Validity of PCA

In order to assess the reliability of the factors formed using the PCA, the Cronbach's alpha test was run in STATA to check the internal consistency of the factors (Nunally, 1978). The following table shows the results:

	Flexibility *(Agility_CC, Agility_IS, Agility_FM, Agility_MC, Agility_DM)*	***Responsiveness*** *(Agility_MA, Agility_IT, Agility_Comm)*	***Partnerships and Collaboration*** *(Agility_PR, Agility_OP, Agility_CCOL,)*
Cronbach's alpha (α)	0.8752	0.6537	0.8484

Table 4.8 Reliability of PCA

A Cronbach's alpha value of > 0.7 depicts strict internal consistency within the factors (Nunally, 1978), whereas a value of > 0.6 is considered to be the composite reliability coefficient (Bagozzi and Yi, 1988). In the table above, Flexibility and Partnerships and Collaboration have a value of > 0.7, thereby depicting strict internal consistency. Responsiveness on the other hand has an alpha value of < 0.7, however, the value is > 0.6 and the factor can therefore be considered as reliable.

4.4 Regression Analysis

4.4.1 Poisson Regression vs. Negative Binomial Regression

Before conducting the respective regressions, there was a need to identify whether a Poisson regression was more appropriate or a Negative Binomial regression. In order to ascertain this, the descriptive statistics of Num_PDI, Num_PRI and Num_BMI were analysed in order to compare the means and the variances of the dependent variables. Table X shows the results.

	Num_PDI	Num_PRI	Num_BMI
Obs	82	80	74
Mean	13.45122	5.3375	3.378378
Std. Dev.	23.82247	7.929984	3.095302
Min	0	0	0
Max	100	50	20

Table 4.9 Mean and variances of dependent variables

The rule of thumb suggests that if the Mean < Variance, the data is over dispersed and a Negative Binomial regression is the appropriate choice as the Poisson assumption is violated.

The table above shows that in all three cases the Mean < Variance, therefore indicating that a Negative Binomial regression is the optimal choice in all three cases. Another method to choose the right model is to look at the Pearson goodness-of-fit test results. If the Prob > chi2 value lies below the threshold of 0.05, it is more appropriate to use a Negative Binomial regression. The following table shows the Pearson goodness-of-fit test results, all of which indicated a Prob > chi2 value of < 0.005.

Poisson = Num_PDI

Pearson goodness-of-fit = 2669.014

Prob > chi2(74) = 0.0000

Poisson = Num_PRI

Pearson goodness-of-fit = 740.6172

Prob > chi2(72) = 0.0000

Poisson = Num_BMI

Pearson goodness-of-fit = 174.9379

Prob > chi2(66) = 0.0000

Table 4.10 Comparison mean / variances

4.4.2 Hypotheses

The factors created using the PCA were then used to generate the hypotheses to be tested using the Negative Binomial regression models. As the agility attributes needed to be grouped before proceeding with the regression analysis, the hypotheses were formulated after the PCA. The following hypotheses will be tested:

H1: Flexibility increases product innovation productivity

H2: Responsiveness increases product innovation productivity

H3: Partnerships and Collaboration increase product innovation productivity

H4: Flexibility increases process innovation productivity

H5: Responsiveness increases process innovation productivity

H6: Partnerships and Collaboration increase process innovation productivity

H7: Flexibility increases business model innovation productivity

H8: Responsiveness increases business model innovation productivity

H9: Partnerships and Collaboration increase business model innovation productivity

4.4.3 Analysis

Three independent regressions were run for the three dependent variables Num_PDI, Num_PRI and Num_BMI using the three composite factors of Flexibility, Responsiveness, and Partner_Collab as independent variables.

All regressions also included controls such as EU, Geo_EU, Ind_MANU, Ind_SERV, Ind_Tech, Org_Size, Tech_Int, Exo_Tech, and Exo_Macro.

In addition, the regression concerning Num_PDI included the controls PDI_CONT_1 and PDI_CONT_2; the regression concerning Num_PRI included the controls PRI_CONT_1, PRI_CONT_2, PRI_CONT_3, PRI_CONT_4, and PRI_CONT_5; and the regression concerning Num_BMI included the controls BMI_CONT_1, BMI_CONT_2, and BMI_CONT_3.

	Product Innovation Productivity	Process Innovation Productivity	Business Model Innovation Productivity
Dependent Variables	Num_PDI	Num_PRI	Num_BMI
Independent Variables (Composite Factors)		Flexibility Responsiveness Partner_Collab	
Common Control Variables		EU Geo_EU Ind_MANU Ind_SERV Ind_Tech Org_Size, Tech_Int Exo_Tech, Exo_Macro.	
Additional Controls	PDI_CONT_1 PDI_CONT_2	PRI_CONT_1 PRI_CONT_2 PRI_CONT_3 PRI_CONT_4 PRI_CONT_5	BMI_CONT_1 BMI_CONT_2 BMI_CONT_3

Table 4.11 Three independent regressions and their respective independent variables

For all three regressions, four models were created.

The first model included the independent variables of Flexibility, Responsiveness and Partner_Collab. The second model further included the controls EU, Geo_EU, Ind_MANU, Ind_SERV, and Ind_Tech. The third model further included Org_Size, Tech_Int, Exo_Tech, and Exo_Macro. Lastly, the fourth model included the specific PDI, PRI and BMI controls as well.

By creating four separate models and running step-wise regressions, it was possible to see the impact on the coefficients and the significance levels as more variables were added to the equations.

4.4.3.1 Product Innovation Productivity

The results for the Negative Binomial regression for Num_PDI can be found in Table 4.12.

In order to assess the impact of the independent variables on Num_PDI, model (4) was used as it gives the most unbiased results due the presence of relevant controls. The coefficients of the three independent variables can be interpreted as follows:

- For a one unit change in Flexibility, the difference in the logs of expected counts of Num_PDI is expected to change by 0.148, given all other variables in the model are held constant. However the result is insignificant as the p-value depicts a value higher than 0.05.

- For a one unit change in Responsiveness, the difference in the logs of expected counts of Num_PDI is expected to change by 0.300, given all other variables in the model are held constant. The result is significant as the p-value depicts a value lower than 0.05.

- For a one unit change in Partner_Collab, the difference in the logs of expected counts of Num_PDI is expected to change by 0.341, given all other variables in the model are held constant. The result is highly significant as the p-value depicts a value lower than 0.01.

	(1) Num_PDI	(2) Num_PDI	(3) Num_PDI	(4) Num_PDI
Num_PDI				
Flexibility	-0.0642	-0.0675	0.0619	0.148
	(-0.50)	(-0.55)	(0.50)	(1.12)
Responsiveness	0.131	0.218	0.271*	0.300*
	(1.21)	(1.86)	(2.19)	(2.33)
Partner_Collab	0.525***	0.348**	0.288*	0.341**
	(4.08)	(2.76)	(2.37)	(2.75)
EU		0.308	0.283	0.131
		(0.89)	(0.85)	(0.38)
Geo_EU		-0.499	-0.423	-0.427
		(-1.89)	(-1.70)	(-1.70)
Ind_MANU		0.749**	0.459	0.484
		(2.94)	(1.63)	(1.68)
Ind_SERV		-0.489	-0.244	-0.219
		(-1.87)	(-1.02)	(-0.93)
Ind_Tech		0.553*	0.579*	0.485
		(1.99)	(2.37)	(1.89)
Org_Size			0.223*	0.176
			(2.20)	(1.69)
Tech_Int			-0.165	-0.179
			(-0.82)	(-0.90)
Exo_Tech			-0.162	-0.0423
			(-0.44)	(-0.12)
Exo_Macro			0.700**	0.747**
			(2.86)	(3.04)
PDI_CONT_1				-0.130
				(-1.43)
PDI_CONT_2				-0.0408
				(-0.45)
_cons	2.488***	2.008***	1.299	2.501*
	(20.04)	(4.53)	(1.39)	(2.13)
lnalpha				
_cons	0.101	-0.101	-0.332	-0.370*
	(0.66)	(-0.62)	(-1.94)	(-2.14)
N	78	77	77	77
*AIC*N*	561.0	546.0	535.4	536.6

Table 4.12 Negative Binomial regression for Num_PDI

As the coefficients given in the Negative Binomial regression are interpreted as the difference between the *log* of expected counts, the incident rate ratios must be computed in order to assess the impact in terms of percentages. The following table shows the values of the coefficients in incident rate ratio form with respect to model (4).

	(4) Num_PDI
Num_PDI	
Flexibility	1.160 (1.12)
Responsiveness	1.350* (2.33)
Partner_Collab	1.406** (2.75)

The coefficients of the incident rate ratios can be interpreted as follows:

- A one unit change in Flexibility increases product innovation productivity by 16%, given all other variables in the model are held constant. However the result is insignificant as the p-value depicts a value higher than 0.05.

- A one unit change in Responsiveness increases product innovation productivity by 35%, given all other variables in the model are held constant. The result is significant as the p-value depicts a value lower than 0.05.

- A one unit change in Partner_Collab increases product innovation productivity by 40.6%, given all other variables in the model are held constant. The result is highly significant as the p-value depicts a value lower than 0.01.

In addition to the independent variables above, the control variable Exo_Macro gives a significant result and suggests that exogenous macroeconomic factors may have a significant impact on product innovation productivity. The result suggests a positive relationship.

In order to test for the robustness and goodness of fit of the four models, the Akaike Information Criterion (AIC) values were used. The AIC values were multiplied with the number of observations N. As a rule of thumb, a lower AIC*N value represents a better goodness of fit of the model.

The regression table depicts these values for the four models independently with model (1) having the highest value of 561.0, and model (3) and (4) having the lowest value of 535.4 and 536.6 respectively. Therefore, the decision to choose model (4) as the optimal model is a reasonable one.

4.4.3.2 Process Innovation Productivity

The results for the Negative Binomial regression for Num_PRI can be found in Table 4.13.

In order to assess the impact of the independent variables on Num_PRI, model (4) was used as it gives the most unbiased results due the presence of relevant controls. The coefficients of the three independent variables can be interpreted as follows:

- For a one unit change in Flexibility, the difference in the logs of expected counts of Num_PRI is expected to change by 0.213, given all other variables in the model are held constant. However the result is insignificant as the p-value depicts a value higher than 0.05.

- For a one unit change in Responsiveness, the difference in the logs of expected counts of Num_PRI is expected to change by 0.363, given all other variables in the model are held constant. The result is highly significant as the p-value depicts a value lower than 0.01.

- For a one unit change in Partner_Collab, the difference in the logs of expected counts of Num_PRI is expected to change by 0.235, given all other variables in the model are held constant. The result is significant as the p-value depicts a value lower than 0.05.

	(1)	(2)	(3)	(4)
	Num_PRI	Num_PRI	Num_PRI	Num_PRI
Num_PRI				
Flexibility	-0.105	-0.100	-0.0138	0.213
	(-0.91)	(-0.88)	(-0.12)	(1.92)
Responsiveness	0.323*	0.399**	0.293*	0.363**
	(2.51)	(2.88)	(2.04)	(2.88)
Partner_Collab	0.116	0.104	-0.0198	0.235*
	(0.96)	(0.87)	(-0.16)	(2.00)
EU		-0.237	-0.0835	-0.407
		(-0.78)	(-0.27)	(-1.47)
Geo_EU		-0.0480	-0.0844	-0.185
		(-0.19)	(-0.34)	(-0.85)
Ind_MANU		0.107	0.00532	0.197
		(0.41)	(0.02)	(0.76)
Ind_SERV		-0.438	-0.245	-0.230
		(-1.66)	(-0.93)	(-0.98)
Ind_Tech		-0.260	-0.322	-0.244
		(-1.02)	(-1.24)	(-1.07)
Org_Size			0.227*	0.195*
			(2.25)	(2.20)
Tech_Int			0.145	0.0818
			(0.85)	(0.50)
Exo_Tech			-0.0610	0.182
			(-0.17)	(0.56)
Exo_Macro			0.281	0.475*
			(1.15)	(2.23)
PRI_CONT_1				-0.215*
				(-2.03)
PRI_CONT_2				-0.302***
				(-3.47)
PRI_CONT_3				0.281**
				(2.99)
PRI_CONT_4				-0.218*
				(-2.27)
PRI_CONT_5				0.292**
				(2.68)
_cons	1.646***	2.052***	0.152	1.269
	(14.39)	(5.11)	(0.17)	(1.39)
lnalpha				
_cons	-0.236	-0.317	-0.460*	-0.986***
	(-1.15)	(-1.50)	(-2.08)	(-3.87)
N	76	75	75	75
*AIC*N*	424.2	423.4	423.0	404.5

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.13 Negative Binomial regression for Num_PRI

As the coefficients given in the Negative Binomial regression are interpreted as the difference between the *log* of expected counts, the incident rate ratios must be computed in order to assess the impact in terms of percentages. The following table shows the values of the coefficients in incident rate ratio form with respect to model (4):

	(4) Num_PRI
Num_PRI	
Flexibility	1.237 (1.92)
Responsiveness	1.438** (2.88)
Partner_Collab	1.265* (2.00)

The coefficients of the incident rate ratios can be interpreted as follows:

- A one unit change in Flexibility increases process innovation productivity by 23.7%, given all other variables in the model are held constant. However the result is insignificant as the p-value depicts a value higher than 0.05.

- A one unit change in Responsiveness increases process innovation productivity by 43.8%, given all other variables in the model are held constant. The result is highly significant as the p-value depicts a value lower than 0.01.

- A one unit change in Partner_Collab increases process innovation productivity by 26.5%, given all other variables in the model are held constant. The result is significant as the p-value depicts a value lower than 0.05.

Apart from the three independent variables above, the controls of Org_Size, Exo_Macro, PRI_CONT_1, PRI_CONT_2, PRI_CONT_3, PRI_CONT_4, and PRI_CONT_5 are also significant. This suggests that these variables have a significant impact on process innovation productivity and it was important to take their impact into account.

In order to test for the goodness of fit of the four models, the AIC*N values were used from the regression table. The regression table depicts these values for the four models independently with model (1) having the highest value of 424.2, and model (4) having the lowest value of 404.5 respectively. Therefore, the decision to choose model (4) as the optimal model is a reasonable one.

4.4.3.3 Business Model Innovation Productivity

The results for the Negative Binomial regression for Num_BMI can be found in Table 4.14.

In order to assess the impact of the independent variables on Num_BMI, model (4) will be used as it gives the most unbiased results due the presence of relevant controls. The coefficients of the three independent variables can be interpreted as follows:

- For a one unit change in Flexibility, the difference in the logs of expected counts of Num_BMI is expected to change by 0.264, given all other variables in the model are held constant. The result is significant as the p-value depicts a value lower than 0.05.

- For a one unit change in Responsiveness, the difference in the logs of expected counts of Num_BMI is expected to change by 0.138, given all other variables in the model are held constant. However, the result is not significant as the p-value depicts a value higher than 0.05.

- For a one unit change in Partner_Collab, the difference in the logs of expected counts of Num_BMI is expected to change by 0.099, given all other variables in the model are held constant. However, the result is not significant as the p-value depicts a value higher than 0.05.

	(1) Num_BMI	(2) Num_BMI	(3) Num_BMI	(4) Num_BMI
Num_BMI				
Flexibility	0.105	0.117	0.230^{*}	0.264^{*}
	(1.01)	(1.14)	(2.19)	(2.54)
Responsiveness	0.272^{**}	0.266^{**}	0.215^{*}	0.138
	(2.76)	(2.59)	(2.03)	(1.32)
Partner_Collab	0.188	0.202^{*}	0.144	0.0990
	(1.90)	(2.00)	(1.43)	(0.98)
EU		0.133	0.153	0.0277
		(0.49)	(0.58)	(0.11)
Geo_EU		0.0406	0.0356	0.0727
		(0.19)	(0.18)	(0.38)
Ind_MANU		0.275	0.0786	0.0733
		(1.28)	(0.35)	(0.33)
Ind_SERV		0.0540	0.144	0.162
		(0.25)	(0.72)	(0.86)
Ind_Tech		0.481^{*}	0.516^{*}	0.535^{**}
		(2.26)	(2.48)	(2.67)
Org_Size			0.220^{*}	0.237^{**}
			(2.54)	(2.86)
Tech_Int			-0.119	-0.153
			(-0.79)	(-1.03)
Exo_Tech			-0.00397	0.192
			(-0.01)	(0.68)
Exo_Macro			0.330	0.371^{*}
			(1.70)	(2.00)
BMI_CONT_1				-0.0948
				(-1.37)
BMI_CONT_2				0.0694
				(0.95)
BMI_CONT_3				0.145^{**}
				(2.70)
_cons	1.135^{***}	0.624	-0.146	-0.627
	(11.31)	(1.82)	(-0.19)	(-0.69)
lnalpha				
_cons	-1.028^{**}	-1.147^{**}	-1.516^{***}	-1.860^{***}
	(-3.02)	(-3.21)	(-3.55)	(-3.64)
N	70	69	69	69
*AIC*N*	320.5	320.7	316.5	313.9

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.14 Negative Binomial regression for Num_BMI

As the coefficients given in the Negative Binomial regression are interpreted as the difference between the *log* of expected counts, the incident rate ratios must be computed in order to assess the impact in terms of percentages. The following table shows the values of the coefficients in incident rate ratio form with respect to model (4):

	(4) Num_BMI
Num_BMI	
Flexibility	1.302*
	(2.54)
Responsiveness	1.148
	(1.32)
Partner_Collab	1.104
	(0.98)

The coefficients of the incident rate ratios can be interpreted as follows:

- A one unit change in Flexibility increases business model innovation productivity by 30.2%, given all other variables in the model are held constant. The result is insignificant as the p-value depicts a value lower than 0.05.

- A one unit change in Responsiveness increases business model innovation productivity by 14.8%, given all other variables in the model are held constant. However, the result is not significant as the p-value depicts a value higher than 0.05.

- A one unit change in Partner_Collab increases business model innovation productivity by 10.4%, given all other variables in the model are held constant. However, the result is not significant as the p-value depicts a value higher than 0.05.

Other than the three independent variables above, the controls of Ind_Tech, Org_Size, Exo_Macro and BMI_CONT_3 are also significant and their impact on business model innovation cannot be disregarded.

Once again, in order to test for the goodness of fit of the four models, the AIC*N values were used from the regression table. The regression table depicts these values for the four models independently with model (1) having the highest value of 320.5, and model (4) having the lowest value of 313.9 respectively. Therefore, the decision to choose model (4) as the optimal model is a reasonable one.

4.4.4 Industry Specific Analysis

The main analysis in the previous section was across multiple industries that were controlled for in order to account for their impact on the three types of innovations. However, as the industries vary in nature and strategy, it was considered important to conduct an industry specific analysis as well.

For this reason, two different datasets were created. The first dataset contained all organisations that belonged to the Manufacturing industry (Ind_MANU == 1). The second dataset contained all organisations that had operations in the Service industry (Ind_SERV == 1). After filtering the two datasets, a total of 37 observations were deleted for Ind_MANU and only 45 valid observations remained. Similarly, a total of 48 observations were deleted for Ind_SERV and only 34 observations remained.

Independent regressions were then run using both datasets to ascertain the industry specific impact of Flexibility, Responsiveness and Partner_Collab on Num_PDI, Num_PRI and Num_BMI. The model used in this analysis takes the form of the same regression equation as that of model (4) in the previous section, but without the industry controls. The results of the regressions are grouped together in the tables below and only the coefficients of the three independent variables are shown for the purpose of clarity. In addition, the coefficients have been converted to their incident rate ratios in order to interpret the results in percentage form.

Ind_MANU==1

	(1a) Num_PDI	(2a) Num_PRI	(3a) Num_BMI
Flexibility	1.369	1.142	1.774^{***}
	(0.262)	(0.217)	(0.264)
Responsiveness	1.670^{**}	1.467^{*}	1.269
	(0.330)	(0.282)	(0.181)
Partner_Collab	1.548^{*}	1.259	0.958
	(0.347)	(0.260)	(0.130)

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.15 Negative Binomial regression for manufacturing industry

Ind_SERV==1

	(1b) Num_PDI	(2b) Num_PRI	(3b) Num_BMI
Flexibility	1.206	1.237	1.228
	(0.312)	(0.229)	(0.222)
Responsiveness	1.323	1.603*	0.851
	(0.386)	(0.372)	(0.180)
Partner_Collab	0.803	1.036	0.880
	(0.158)	(0.198)	(0.150)

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.16 Negative Binomial regression for services industry

The results for Ind_MANU suggest that Responsiveness and Partner_Collab are significant for Num_PDI; Responsiveness is significant for Num_PRI; and Flexibility is highly significant for Num_BMI. The coefficients of the significant results can thus be interpreted as:

- A one unit change in Responsiveness increases product innovation productivity by 67%, given all other variables in the model are held constant.
- A one unit change in Partner_Collab increases product innovation productivity by 54.8%, given all other variables in the model are held constant.
- A one unit change in Responsiveness increases process innovation productivity by 46.7%, given all other variables in the model are held constant.
- A one unit change in Flexibility increases business model innovation productivity by 77.4%, given all other variables in the model are held constant.

The results for Ind_SERV, on the other hand, suggest that only Responsiveness is significant for Num_PRI and there are no significant results for either Num_PDI or Num_BMI. The coefficients of the significant result can be interpreted as:

- A one unit change in Responsiveness increases process innovation productivity by 60.3%, given all other variables in the model are held constant.

The results of the industry specific analysis above point towards some similarities as well as differences with the cross-industry analysis conducted previously. The table below illustrates the results from both the cross-industry and industry specific analysis:

	Cross-Industry (N = 82)			Ind_MANU (N = 45)		
	Flexibility	***Responsiveness***	***Partner_Collab***	***Flexibility***	***Responsiveness***	***Partner_Collab***
Num_PDI	NS	S	S	NS	S	S
Num_PRI	NS	S	S	NS	S	NS
Num_BMI	S	NS	NS	S	NS	NS

S = Significant NS = Not significant

	Cross-Industry (N = 82)			Ind_SERV (N = 34)		
	Flexibility	***Responsiveness***	***Partner_Collab***	***Flexibility***	***Responsiveness***	***Partner_Collab***
Num_PDI	NS	S	S	NS	NS	NS
Num_PRI	NS	S	S	NS	S	NS
Num_BMI	S	NS	NS	NS	NS	NS

S = Significant NS = Not significant

Table 4.17 Summary of results

The tables above depict that the only difference between cross-industry and Ind_MANU is that Partner_Collab is significant for Num_PRI in the former and not significant in the latter. On the other hand, when it comes to Ind_SERV, only Responsiveness in Num_PRI is significant with everything else being insignificant.

At this point it must be noted that the number of observations were reduced drastically during the industry specific analysis, which makes it harder to rely on the results as stated above. For the case of Ind_SERV, the results should be viewed with greater scepticism due to the fact that the number of observations (N = 34) was well below the minimum number of observations set at N = 40. Anything below N = 40 cannot be given enough weight to consider the results as unbiased and reliable. In short, both Ind_MANU and Ind_SERV require more observations in order for the results to be considered reliable. This presents an important area for future research.

4.5 Results

4.5.1 Product Innovation Productivity

When it comes to PDI productivity, Responsiveness and Partnerships and Collaboration are understood as having a significant impact. The Responsiveness factor includes the agility attributes of having a modular approach towards products or services, an efficient IT System (knowledge management), and an efficient communication setup (both inside the organisation and with external clients). Together these attributes play an important role in bringing about an increase in PDI productivity and their combined effect is positive.

Similarly, the Partnerships and Collaboration factor includes the agility variables of reliance on partners, customer collaboration, and outsourcing and partnering activities. The combined effect of these agility attributes is understood to be positive, even though reliance on partners is assumed to have a negative impact on product innovation productivity. One explanation of this could be that the other two agility attributes crowd out the effect of reliance on partners and the combined result suggests a positive impact. The other explanation could be that the respondents understood reliance on partners as simply a collaborative effort and not as a limiting factor.

Finally, the factor of Flexibility was not found to have any significant impact on PDI productivity. This factor included the attributes of creative climate, iterative strategies, promotion of a fast and flexible mind-set, simplification of products/operations to manage complexity, and delegation of power and decentralised decision-making. Although some of these individual attributes may have a significant impact, the combined effect suggests that the impact is not significant.

4.5.2 Process Innovation Productivity

The results suggest that PRI productivity is also positively affected by the factors of Responsiveness and Partnerships and Collaboration. The agility attributes contained within these factors are the same as those explained in the PRI productivity section above. However, in the case of PRI productivity, Flexibility is almost significant with a p-value of 0.055. This value is very close to the p-value of 0.05 taken as the threshold for measuring the significance of the factors. This almost significant p-value suggests that Flexibility should not be completely disregarded when thinking about PRI productivity. Some of the agility attributes in the Flexibility factor will be more significant than the others, but Flexibility may still be taken as potentially having a significant impact on PRI productivity. However, in order to ascertain this claim, more observations may be required.

4.5.3 Business Model Innovation Productivity

As far as BMI productivity is concerned, the factor of Flexibility comes across as the only significant result. The relationship between Flexibility and BMI productivity is positive. All agility attributes in this factor seem to have a direct link with BMI, as suggested by the literature. On the other hand, Responsiveness and Partnerships and Collaboration do not have a significant impact on BMI productivity. Through this, it can be ascertained that when it comes to BMI productivity, the emphasis is more towards the abstract organisational behaviour and environment. It is widely understood that organisations do not innovate their BMs on a regular basis, however, through this research it was also ascertained that organisations do tend to innovate specific parts of their BMs on a regular basis. It can be argued that innovating a specific portion of the business model inherently implies innovating the business model incrementally. Since the research only took into account three years (2012 – 2014), it can be argued that most BMIs were incremental by nature. Therefore, it can be concluded that Flexibility helps organisations innovate specific parts of their BM, eventually leading to a new BM over time.

5 Conclusion

The overall purpose of this research study was to test if there exists a relationship between a set of defined agility attributes and innovation productivity. The following research question guided the study:

To what extent can agility impact the innovation productivity of large organisations?

In total, eleven agility attributes were defined through a thorough review of the literature. These eleven agility attributes were then used to create three composite factors using the PCA, in order to serve as the independent variables for this study. Based on the literature review, the three composite factors were defined as Flexibility, Responsiveness, and Partnerships and Collaboration; these factors correspond to the agility capabilities. On the other hand, Innovation was broken down into three dependent variables: Num_PDI, Num_PRI and Num_BMI. Finally, a number of controls were added as well in order to account for a biased study.

Based on the findings from the three independent regressions, the status of the proposed hypotheses and whether they were accepted or rejected with regards to the cross-industry analysis are shown below:

Hypotheses	Status
H1: Flexibility increases product innovation productivity	✗
H2: Responsiveness increases product innovation productivity	✓
H3: Partnerships and Collaboration increase product innovation productivity	✓
H4: Flexibility increases process innovation productivity	✗
H5: Responsiveness increases process innovation productivity	✓
H6: Partnerships and Collaboration increase process innovation productivity	✓
H7: Flexibility increases business model innovation productivity	✓
H8: Responsiveness increases business model innovation productivity	✗
H9: Partnerships and Collaboration increase business model innovation productivity	✗

✓ = Alternative hypothesis accepted; null rejected
✗ = Alternative hypothesis rejected; null accepted

A cursory look at the table above suggests that H2, H3, H5, H6, and H7 have been accepted, whereas H1, H4, H8 and H9 have been rejected. It must be noted that the factors of Flexibility, Responsiveness, and Partnerships and Collaboration depict a composite impact of the relevant agility attributes contained within these factors. The individual impact of the agility attributes cannot be ascertained through these results. It may very well be the case that in a given factor, a particular agility attribute has a much more significant impact than another. Due to this reason, the factor needs to be taken into account as a whole and the individual agility attributes should all be considered together when assessing the impact of the relevant factor.

There is a possibility to try and determine the individual impact of the agility attributes as well, by using the factor loadings generated during the PCA, however, that method does not provide a reliable way of measuring the individual impact of each agility attribute. As the accuracy of results cannot be verified through this method, the individual impact of each agility attribute was not explored.

The three types of innovation productivity and their results will now be interpreted in further detail.

5.1 Interpretation

Product Innovation Productivity

Partnerships and Collaboration showed significant results for PDI Productivity. When customers collaborate with organisations, they co-create value by expressing their requirements, sharing their knowledge, or by participating in engineering or manufacturing activities. Such activities may in turn help boost the innovation activities of an organisation (Darmody, 2009). Partnering and collaborating with external partners or suppliers can also enhance PDI Productivity. Accessing the knowledge of other firms improves strategic decisions. Also, networking and collaboration improves both innovation and performance (Bock et al., 2012). A firm engaging in partnering activities looks for new knowledge outside its own boundaries, thereby enhancing its PDI Productivity.

Responsiveness also depicted a significant and positive relationship with PDI Productivity. Responsiveness was previously defined as the capability of a firm to identify future changes and to cope with them when unforeseen. In fast-paced business environments such as Fast Moving Consumer Goods or Technology industries, the market is most likely to be disrupted by novel products that cannot always be foreseen due to secrecy. Being responsive in such environments helps increase PDI Productivity by generating a quicker reaction to change than other competitors i.e. being a fast follower; but most importantly by being able to anticipate future trends and being the first to market i.e. being a first mover.

It was expected that Flexibility would depict a positive relationship with PDI Productivity. It comprises of all the cultural aspects of a young organisation (see section 2.2.3). Such cultural aspects were expected to enhance creativity and therefore have a positive impact on PDI productivity. However, the results did not depict such a relationship. The results, however, need to be interpreted cautiously. Even though Responsiveness and Partnerships and Collaboration showed positive results, organisations should not discard the last composite factor of Flexibility, primarily because certain agility attributes in the Flexibility factor could have a potentially significant impact on PDI productivity.

Process Innovation Productivity

Partnerships and Collaboration, along with Responsiveness, also showed significant results for PRI Productivity. A firm's responsiveness can help improve upward communication: if an employee on the production chain identifies room for improvement within the process, a smooth flow of communication up to the top level can tackle the issue in an efficient manner. Adopting a modular approach in production processes is also a good way to enhance dexterity, thereby stimulating PRI productivity.

In the case of PRI, Partnerships and Collaboration can be understood in terms of outsourcing activities. Recently, organisations have engaged in Business-Process Outsourcing, not only as part of an operational effort strategy to reduce costs, but more specifically with the objective to constantly innovate (Lacity and Willcocks, 2013). In order to foster PRI in outsourcing activities, it is crucial for an organisation to create strong incentives for the service provider. Therefore, the outsourcing work is all about collaborating with the service provider and creating a win-win environment, which in turn will lead to a higher PRI productivity.

Business Model Innovation Productivity

Unlike the two previous types of innovations, Flexibility showed significant results for BMI productivity. Flexibility is a key criteria for BMI. In fact, a firm betting on BMI needs to be flexible enough to adapt as the business environment changes (Bock, 2012). As new information flows, the organisation needs to have the capability to absorb the information, interpret it, and adapt the BM accordingly. It is crucial to simplify structures in order to become more flexible and enhance BMI productivity. Also, instilling creativity and a culture of start-ups is highly important when considering BMI (Bock, 2012). BMI is a continuous activity and by promoting a flexible mind-set amongst the employees, BMI productivity can be positively influenced.

Considering the importance of partnering activities in BMs, it was expected that Partnerships and Collaboration would depict a positive relationship with BMI Productivity. Even though the results did not suggest it to be the case, it should be noted that the key factor for BMI is access to knowledge (Bock, 2012). Therefore, the significance level of Partnerships and Collaboration has to be interpreted carefully.

5.2 Limitations

As with all research studies, there are always certain limitations present. This research is subject to three main limitations.

The first limitation is with regards to the research design itself and can be broken down into three sub-limitations:

- Firstly, this research followed a cross-sectional design, with a non-probability sample. Such a sampling technique allowed the application of specific controls to our sample (i.e. EU location, large organisations, employees with specific titles such as “Innovation Director”). However, such a design could have had an adverse impact on internal validity as the observations were not completely randomly assigned and were subject to self-selection due to additional controls.

- Second, as the data was collected through a survey methodology, some of the responses might have been based on the subjective interpretation of the respondents – in particular questions containing the likert-scale.

- Third, it is hard to ascertain through the design of the study whether the number of innovations truly represent the effect of the agility attributes. As the study evaluates the number of innovations per organisation during the time period 2012 - 2014, it may be the case that a given organisation was pursuing intensive R&D and innovation research in the years preceding the observed period, and then launched their innovations in the time period that was observed. This situation also applies vice versa.

The second limitation is concerned with the sampling method and can be fragmented into three sub-limitations as well:

- Firstly, the number of observations used in the data analysis (82) cannot be deemed adequate for completely unbiased statistical inferences. For optimal results, at least 300 observations should be used as part of the analysis.

- Second, the study is cross-industry in nature. Even though the study design is rigorously controlling for these different industries, it should be kept in mind that different innovation strategies and a different pace of innovation could affect the number of innovations across industries.

- Third, the study is concerned with large organisations, which were defined as organisations with more than 250 employees. The statistical models developed in this research control for the size of the organisation, but it is important to note that the number of innovations might differ significantly between a firm with 250 employees and one with more than 5,000 employees.

The third limitation is concerned with how innovation is measured. In fact, innovation was defined as a new or significantly improved product (good or service), process or business model. However, it may be the case that the respondents interpreted innovation simply as being something new, *a novelty*, rather than an innovation. Innovation can be understood as having the quality of something new, but most importantly innovation should have an impact and create value.

5.3 Future Research

The study of agility attributes and their impact on innovation is still in its neophyte stage and requires extensive research. A high number of participants in this study expressed great interest in the aforementioned field of research, primarily due to it being a novel domain. However, in order to strengthen the validity of this study and improve this research, the following areas should be considered:

- **Adopt an abductive research approach** by adding a qualitative dimension to the study. Conducting interviews could help understand how agility and its attributes are perceived within organisations and therefore help researchers gain a deeper insight into the concept of agility in the "real world". In addition, such interviews could have also helped rephrase the attributes and select the most important ones to be tested.

- **Focus on one type of industry, one country or one type of innovation,** in order to improve the internal validity of the research and to increase the possibility of making sound statistical inferences with regards to the observed population. It could be interesting for instance to analyse the impact of agility attributes on innovation in the service industry or to assess the impact of agility on just Business Model Innovation.

- **Carry out a case study research**, by observing one or more organisations internally. The researchers could use hard data from these organisations through official documents, especially regarding how innovation is dealt with. Researchers could also assess if the firm is promoting a culture of agility or not by observing the internal environment and disseminating surveys throughout the organisation. Such an approach would help decrease the problem of subjectivity and therefore increase the reliability and validity of the study.

A recommendation for future research would be to investigate the impact of agility on innovation process speed. In fact, it was previously argued that there is a need for innovation speed as a result of increasing global competition, the exponential advancement in technology and the repetitively shifting nature of customer demand (Chakrabarti, 1996). "*Accelerating the innovation process*" is one of the three critical drivers of innovation success as stated by Morris (2014). An appropriate method of conducting such a research would be through a case study approach. This is because access to information regarding the timeframe of innovation activities is critical, and is only possible internally. Furthermore, it would also be possible to assess the presence of agility attributes internally. This area of research will address a major challenge for organisations that have slow or stagnant innovation processes.

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7 Appendices

Appendix A: Agile Methods

In the last decade of the 20th century emerged – in parallel of business agility – the concept of Agile methods, as a response to the rather inflexible, bureaucratic, slow and formal software development process (Gasmann et al., 2006). These two concepts – business agility and Agile software development methods – were rarely brought together in the literature. Here, certain methods employed in the SD process that could be applied to the Product Development process are presented.

As for the literature on business agility, there is no general definition of Agile software development. (Hannola et al, 2013). Nevertheless, the “Manifesto for Agile Software Development”, published in 2001 by software consultants and leaders software development, reports the extolled values of Agility:

1. Individuals and interactions over process and tools.
2. Working software over comprehensive documentation.
3. Customer collaboration over contract negotiation.
4. Responding to change over following a plan.

The Agile Manifesto Principles (2001)

It is interesting to denote the common traits between these four principles and the literature on business agility. In fact, the literature revealed the role of the individual and the importance of collaboration in order for the firm to be agile and this corresponds to value 1. The customer-focused behaviour and the customer relationship attributes of agility refer to value 3. Value 4 “responding to change” is an integral part of business agility as defined by Zhang and Sharifi when presenting the proactive side of agility.

Kettunen (2009) described the foundation of Agile SD as a small co-located team, working closely together with customers, therefore creating a high-value product cost-effectively and with continuous short iterations. Abrahamsson (2002) identified an Agile SD when it is incremental (small releases and rapid cycles); cooperative (integration of customers in the process); straightforward (the method is easy to understand); and adaptive (adapt to change). Similarly, Lindvall et al. (2002) recognised Agile methods as being incremental, iterative, self-organising and emergent.

Two of the most popular Agile method will be adressed: Scrum (the most popular method as revealed by a survey conducted by Forrester, 2012), eXtreme Programming – commonly called XP – (Gassmann et al., 2006).

The XP software development method focuses on iterative work and rapid cycles of development. It consists of six distinct phases: Exploration; Planning; Iterations to first release; Productionising; Maintenance; and Death (Beck, 2000, as cited by Bodje et al., 2012). Teams are co-located, usually organised in pairs; they are coding in a clean and simple style and working in a collaborative and cooperative environment, where quick feedback are required, in order to deliver small and simple software packages in short two-week intervals i.e. incremental work.

Schwaber (1995, 2002) described Scrum as being a flexible, adaptable, empirical, productive and iterative method. The main idea of the Scrum method is that SD process involves several variables, environmental and technical (requirements, time frame, resources and technology) which are likely to change during the development process (Abrahamsson et al., 2002). Schwaber (1995) distinguished three phases which composed Scrum: pre-game; game or development; and post-game. The pre-game phase has two sub-phases: planning and high level design. In the planning phase, a product backlog record listing the entire current requirements is created and a definition of the system being developed is properly articulated. Based on that, the architecture of the system is planned during the high level design sub-phase. In the development phase, the system is developed in Sprints – a one to two-week chunk of work where functionality is developed or enhanced to produce new increments. Finally, in the post-game phase, the system is ready for release. Actions such as testing and documentation take place here.

Table 1: A Combined List of XP and Scrum Practices (adapted from Beck, 2000 and Schwaber & Beedle, 2002)

XP Practices	Scrum Practices	Explanation
Pair Programming		Code is written by two programmers on the same machine.
Testing		Continually write tests, which must run flawlessly for development to proceed. Write test code before writing function code.
Metaphor		Guide all development with a simple shared story of how the system works
Collective Ownership		Anyone can change any code anywhere in the system at any time.
Refactoring		Programmers restructure the system, without removing functionality, to improve code, performance, simplicity, and flexibility.
Coding Standards		Adherence to coding rules which will facilitate communication through code.
Simple Design		The design of the system should be as simple as possible.
Continuous Integration		Integrate and build the system every time a task is completed - this may be many times per day.
40-Hour Week		Work time is generally limited to 40 hours per week.
On-Site Customer		Include an actual user on the team, available full-time to answer questions.
Small Releases	Sprints	Put a simple system into production quickly, then release new versions on a very short cycle.
Planning Game	Sprint Planning	Prioritisation of scope for next release based on a combination of business priorities and technical estimates.
	Architecture	System architecture modification and high-level design regarding implementation of backlog items.
	Post Game Sessions	Reflect on method strengths and weaknesses after eachg cycle.
	Daily Meetings	Short daily status meeting.

Source: Beck, 2000 and Schwaber & Beedle, 2002

Appendix B: Contact Message Draft

<u>Personalised message first e-mail :</u>

Hi *(name of respondent),*
Hope you're doing well. I am a final year Masters student at the University of Gothenburg, Sweden, and am currently working on my Masters Thesis project. My research aims to ascertain the link between agility and its impact on the speed of the three types of innovation i.e. Product, Process and Business Model Innovation.
Problem: Nowadays, most organisations are involved in one or all of the abovementioned innovation activities, however, the problem stems from the fact that the speed of innovation activities in most organisations is slow and far from optimal. But is agility the solution? That's where this research comes in.
As you are *(respondent position)* at *(company name),* I believe your profile is a great fit for this study. The following questionnaire contains some structured questions that, through your contribution, will help this study attain fruition.
I am available to respond to any questions you may have regarding the study, and will be glad to share my research findings with you once the research is completed. I believe, given your line of work, this study will help you gain some valuable insights as well.

Questionnaire link: https://qtrial2014az1.az1.qualtrics.com/SE/?SID=SV_9YWv7pXzhrqlURT
Average time to take the survey is 10 minutes. The results of this survey will be completely anonymous, and no identities will be revealed in the final report.

Thank you very much for your time *(name of respondent).* Have a nice day!

<u>Personalised message second e-mail:</u>

Hi *(name of respondent),*

I reached out to you last week regarding a questionnaire pertaining to my current Masters Thesis research.

As I've not heard back from you, I am writing to check if you are still willing to participate in this study. As of now, I have received over 80 responses from Innovation Leaders, Innovation Directors and VPs from all over Europe. As you are a great fit for this study, I believe your participation will add great value to the findings of this study.

Questionnaire link: https://qtrial2014az1.az1.qualtrics.com/SE/?SID=SV_9YWv7pXzhrqlURT

Average time to take the survey is 10 minutes. The results of this survey will be completely anonymous, and no identities will be revealed in the final report.

Looking forward to hearing from you.

Appendix C: Questionnaire

General Information:

Name of Organization

Position/role within the organization

Are the headquarters of your organization located in the European Union (EU), EFTA or an EU candidate country?

- Yes
- No

In which geographic markets did your organization sell goods and/or services during the three years 2012 to 2014? Tick all that apply.

- Local/regional within [your country]
- National (other regions of [your country]
- Other European Union (EU), EFTA or EU candidate countries
- All other countries

Which sector or industry does your organization belong to? Tick all that apply.

Manufacturing	Fashion/luxury
Services	Fast Moving Consumer Goods
Retail	Technology
Banking/Financial	Energy
Consulting	Other (please specify)

In terms of number of employees, what is the overall size of your organization?

- Less than 250
- Between 251 and 500
- Between 501 and 1000
- Between 1001 and 5000
- Between 5001 and 10000
- Greater than 10000

Which of the following exogenous factor(s) do you believe will have a major impact on your organization's activities in the next two years? Tick all that apply.

Market forces	Technological advancements
Industry Competition	Geopolitical issues
Macroeconomic forces	Environmental issues
Globalization	

How important is technological integration to your business processes?

	Least important	Slightly important	Important	Very important	Most important
Technological Integration	○	○	○	○	○

How flexible do you consider your organization to be when it comes to implementing the key elements of your innovation strategy?

	Inflexible	Slightly flexible	Flexible	Very flexible	Extremely flexible
Organizational flexibility	○	○	○	○	○

Product (good or service) innovation

A product innovation is the market introduction of a **new** or **significantly** improved **good** or **service** with respect to its capabilities, user friendliness, components or sub-systems.

- Product innovations (new or improved) must be new to your enterprise, but they do not need to be new to your market.
- Product innovations could have been originally developed by your enterprise or by other enterprises.

A **good** is usually a tangible object such as a smart phone, furniture, or packaged software, but downloadable software, music and film are also goods. A **service** is usually intangible, such as retailing, insurance, educational courses, air travel, consulting, etc.

During the three years 2012 to 2014, did your organization introduce:

New or significantly improved goods (exclude the simple resale of new goods and changes of a solely aesthetic nature)?

Yes

No

New or significantly improved services?

Yes

No

If you answered yes to any or both of the above questions, how many new products/services, as well as significant improvements to existing products/services, has your organization introduced from 2012 to 2014?

0	1	2	3	4	5	Greater than 5 (please specify)

Process innovation

A process innovation is the implementation of a **new** or **significantly** improved production process, distribution method, or supporting activity.

- Process innovations must be new to your enterprise, but they do not need to be new to your market.
- The innovation could have been originally developed by your enterprise or by other enterprises.

During the three years 2012 to 2014, did your organization introduce:

New or significantly improved methods of manufacturing or producing goods or services

Yes

No

New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services?

Yes

No

New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing?

Yes

No

If you answered yes to any or all three of the above questions, how many new processes, as well as improvements to existing processes, has your organization introduced from 2012 to 2014?

0	1	2	3	4	5	Greater than 5 (please specify)

Business Model Innovation

Business Model Innovation is the creation of **new** or **significantly** improved value offering, by taking into account the customers, infrastructure, and revenue model.

During the three years 2012 to 2014, did your organization introduce:

New or significantly improved value offering to customers

Yes

No

New or significantly improved customer relationships, customer segments, or distribution channels

Yes

No

New or significantly improved key partners, key activities, or key resources

Yes

No

New or significantly improved cost structures or revenue streams

Yes

No

If you answered yes to any or all four of the above questions, how many times has your organization re-invented its business model from 2012 to 2014?

0	1	2	3	4	5	Greater than 5 (please specify)

Innovation Objectives

How important were each of the following objectives for your organization's product/service, process, business model, or organizational innovations introduced during the three years 2012 to 2014 inclusive?

Answer the following questions on a scale of 1 - 7, where 1 means that the objective is not important at all and 7 means that the objective is of critical importance. 4 means that the objective holds average importance.

Product/Service Innovation:

	1	2	3	4	5	6	7
Penetration of current market	O	O	O	O	O	O	O
Improvements to current products or services	O	O	O	O	O	O	O
Increase of direct sales force	O	O	O	O	O	O	O
Increase in the use of electronic channels	O	O	O	O	O	O	O
Entry into new geographic markets	O	O	O	O	O	O	O

Process Innovation:

	1	2	3	4	5	6	7
Improvement in operations responsiveness to customers	O	O	O	O	O	O	O
Application of new science or technology to core processes	O	O	O	O	O	O	O
Application of new IT to automate processes	O	O	O	O	O	O	O
Optimization of core processes	O	O	O	O	O	O	O
Reduction in cycle time/complexity	O	O	O	O	O	O	O
Integration of functional business processes	O	O	O	O	O	O	O

Business Model Innovation:

	1	2	3	4	5	6	7
Organizational structure changes	O	O	O	O	O	O	O
Major strategic partnerships	O	O	O	O	O	O	O
Shared services	O	O	O	O	O	O	O
Alternative financing/investment vehicles	O	O	O	O	O	O	O
Divestitures/spinoffs	O	O	O	O	O	O	O
Use of a third party operating utility	O	O	O	O	O	O	O

Agility and Organizational Behaviour

Answer the following questions on a scale of 1 - 7, where 1 means the factor has no presence within the organization and 7 means it has an extremely strong presence within the organization. 4 means the factor has a moderate presence.

How would you rate the following in the context of your organization?

	1	2	3	4	5	6	7
Presence of a creative climate	O	O	O	O	O	O	O
Simplification of products and operations to manage complexity	O	O	O	O	O	O	O
Delegation of power and decentralized decision-making	O	O	O	O	O	O	O
Use of iterative strategies, relying on quick and speedy decisions	O	O	O	O	O	O	O
Outsourcing and partnering activities	O	O	O	O	O	O	O
Reliance on partners	O	O	O	O	O	O	O
Customer collaboration	O	O	O	O	O	O	O
Modular approach towards products/services	O	O	O	O	O	O	O
Efficient IT system (knowledge management)	O	O	O	O	O	O	O
Effective communication, both internal and external	O	O	O	O	O	O	O
Promotion of a fast and flexible mindset	O	O	O	O	O	O	O

Thank you for participating in this study.

Disclaimer: Some of the questions in this survey have been adapted from the Community Innovation Survey (CIS) 2010.

Appendix D: Respondent Sample – Organisations

1	Naseba	42	Solina Denmark
2	Telenor	43	Accià
3	Volvo Group	44	Pepsico
4	Electrolux	45	Ericsson
5	Unilever	46	MasterCard
6	Royal Canin	47	Mindjet
7	N/A	48	Arla Foods
8	HP Inc	49	SKF
9	N/A	50	Airbus
10	Salesforce	51	Bouygues
11	DLL	52	RWE npower
12	AkzoNobel	53	Salesforce
13	Philips	54	BSH
14	Kaba	55	Scottish Water
15	Corbion	56	Xerox
16	TeliaSonera	57	Nokia Networks
17	Airbus	58	N/A
18	Widex A/S	59	Philips
19	Barcelona City Council	60	Belron
20	KABA / AWM	61	Elbisco
21	Avery Dennison	62	Enel
22	Bank	63	LesEchos
23	Cemusa	64	L'Oreal
24	CSC	65	BBVA
25	Volvo	66	N/A
26	Casinos Austria	67	Tarkett
27	Nestle	68	Abbvie
28	Raiffeisen Bank Poland	69	Carlsberg
29	Novozymes	70	Embraco
30	Sopra Steria UK	71	SIGVARIS
31	TINE SA	72	Oriflame
32	Volvo Trucks	73	SCA Personal Care
33	N/A	74	Siemens
34	N/A	75	Bouygues Immobilier
35	Pepsico	76	Leo Burnett
36	Haagen-Dazs	77	Isabel nv.
37	ASSA ABLOY	78	Supercommunications Ltd
38	Volvo Group Trucks Technology	79	SSI
39	PwC	80	Climate-KIC
40	N/A	81	Efigence
41	AREVA	82	Alm. Brand A/S