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Master Thesis: "*Barriers to technological innovation in SMEs: quantitative analysis of investment barriers and strategic decisions*".

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Abstract

Small and Medium-sized Enterprises (SMEs) play a pivotal role in driving economic growth and innovation. However, despite the critical importance of technological innovation, SMEs often lag behind larger companies in adopting innovations. This research paper investigates which factors constrain SMEs from investing in technological innovations, addressing the research question: what factors constrain SMEs from investing in technological innovation? The aim of this study is to identify which factors prevent SMEs from investing in technological innovations. This was done using a quantitative research method in the form of a survey in which 80 SMEs participated. Whether SMEs have encountered barriers to investing in technological innovations in the past was used as a benchmark for the dependent variable, the extent to which SMEs invest in technological innovations. The dependent variable was analysed against six independent variables: skilled workers, financial capabilities/resources, lack of information, recognition to innovate, support and cooperation, and policies and regulations. To explore the relationships between these factors and the extent of perceived barriers a statistical analysis has been performed, using both a univariate Spearman rank test and a multivariate test in the form of a logistic regression analysis. Results reveal that while none of the factors in this study demonstrated a statistically significant effect on the extent to which SMEs invest in technological innovations. However, the factor financial resources were identified by SMEs as the biggest inhibiting factor. Furthermore, a significant and negative correlation was found between the factors financial resources and recognition to innovate, suggesting that financial constraints may heighten SMEs' awareness of alternative innovation opportunities. Furthermore, this research also has its limitations, the variables in this study were not clearly defined. This led to issues when conducting the tests. Additionally, the SMEs participating in the study were mostly from the manufacturing sector, meaning that other sectors were less represented or not included, making the results less generalisable. Future research could therefore decide to explore other factors or examine which factors act as barriers to technological innovations across different sectors.

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1. Introduction

The decision to innovate and in what areas are perhaps the most important strategic decisions a company will have to make. Innovations ensure that companies can enter new markets, maintain or strengthen their market share, remain competitive compared to competitors and can respond to (technological) changes (Gunday et al. 2011). For small and medium-sized enterprises (SMEs), innovations are crucial, because innovations are seen by SMEs as a strategic instrument that can influence competitiveness, sustainability and possible growth (Bayarçelik et al., 2014). In addition, Small and medium-sized enterprises (SMEs) are seen as important players in the field of innovation, and SMEs also play an essential role in the national economies of countries. This is partly due to the fact that SMEs represent 99% of all companies in Europe and therefore provide more than 65 million jobs. In the Netherlands, 99% of all companies consist of SMEs (up to 250 employees), making SMEs responsible for 73% of employment in the Netherlands.

Small and medium-sized enterprises are thus seen as important actors for the economy, because they play an important role in poverty reduction, job creation, promotion of foreign trade and technological innovation (Gherghina et al., 2020). This is therefore one of the reasons why the focus of this study is mainly on SMEs. Another reason is that compared to large companies, SMEs tend to be more flexible and adaptable to market fluctuations and new customer requirements. This is often due to the fact that the organisational culture of SMEs allows for faster decision-making, while in larger firms this is often more complex and bureaucratic (Gherghina et al., 2020). In addition, it is true that SMEs often have fewer (financial) resources compared to large companies and they have to deal with a higher competitiveness (Kazemargi & Spagnoletti, 2020). But research by Hamilton and Asundi (2008) shows that SMEs have found a solution to the competition problem and profitability, namely investment in technological innovations (IT). So, this shows that despite limited financial resources, it is very important for SMEs to invest in technological innovations to stay competitive in an ever-changing environment and to differentiate themselves from the rest. The impact of SME investment in technological innovations will be further discussed later on in this research report.

An SME is defined as companies with fewer than 250 employees and an annual turnover of less than €40 million (Berglund, 2007). SMEs are therefore seen as the drivers of innovations and are responsible for stimulating competition in various (economic) sectors. Lawson and Samson

(2001) define the innovative capacity of SMEs as the ability to convert ideas and ongoing knowledge into new products, processes and systems, which creates added value for the company and its stakeholders and is an indispensable part of a company's strategy. Making investment decisions is seen as a complex and dynamic process and involves extensive analysis and evaluation of factors (financial, market, technological). But these choices will have to be made by SMEs to keep adapting to the ever-changing environment and remain competitive.

But besides the need to invest in technological innovation, these decisions also face some obstacles and barriers. That is why the main focus of this research will be on to what extent do SMEs invest in technological innovation and what barriers influence this decision? One of the reasons for this research is that many small and medium-sized enterprises often lag behind in the adoption of digital and technological innovations compared to other companies and digitalisation is a key driver of an organisation's productivity growth (Dossou-Yovo & Keen, 2021; OECD, 2021; Bayarçelik et al., 2014). In addition, it can also be noted that many SMEs do recognise the need for technological investment and are also willing to invest in digital technologies, but simply do not know how. Related to this, research by OECD (2021) shows that the Covid-19 crisis played an important role in the increase in IT investment. For worldwide, around 70% of SMEs intensified their use of digital technologies as a result of lockdowns and social distancing. In addition, this study also identifies the possible barriers or impeding factors in the implementation and adoption of technological innovations. Mapping the potential barriers aims to raise awareness among SMEs about potential challenges and obstacles, helping them to anticipate and overcome these issues. Therefore, the central research question guiding this paper is: ***'What factors constrain SMEs from investing in technological innovation?'***.

The main purpose of this research article is to outline the factors influencing the process of technological innovation decisions by SMEs and to identify the most common barriers. Thus, the focus in this study will be particularly on the factors that hinder SMEs from investing in technological innovations and to what extent they hinder technological innovation. This will be done so that SMEs are more familiar with these factors and can take them into account where possible.

Various research has been conducted in the past on the impact of technological innovations among enterprises and the barriers involved. This research differs from previous research in that it will focus here on small and medium-sized enterprises. In addition, the focus of this research is particularly on the inhibiting factors that hinder SMEs from investing in technological innovation. Moreover, compared to previous research on technological innovations, this research focuses on SMEs' perceptions of barriers and focuses on how SMEs perceive their own situation and limitations, through statements in a survey. In addition, this research has a multilayered approach, which will involve testing at both univariate and multivariate levels. As a result, combined effects of multiple factors (multivariate) will be examined in addition to individual relationships (univariate).

This study contributes to the theoretical literature and is highly relevant, because it helps SMEs identify the most common barriers to investment in technological innovations. This research contributes to increasing understanding about the failure of many SMEs to invest in technological innovation. By identifying the specific factors that influence or hinder SMEs in the innovation process, this research will contribute to a better understanding about why some SMEs lag behind in technological innovation. In addition, the results of this research will help researchers and SMEs to better understand the challenges involved investing in technological innovation. Furthermore, this research helps to refine the existing theory and will test factors that could potentially influence the technological innovation process. Finally, this research will also be able to serve as a basis for future studies. This is due to the fact that this research is mainly explanatory in nature and tries to understand which factors could influence the extent to which SMEs invest in technological innovations.

Besides theoretical contributions, this research also brings several practical contributions. By investigating the extent to which SMEs invest in technological innovation and the factors that hamper it, SMEs can gain a better understanding of current trends and patterns in technology adoption (Duarte et al., 2017). This will lead to SMEs being better able to implement technological innovations in the future and enables firms to evaluate and adapt their own investment strategies to trends and market developments (Rahman et al., 2016). Furthermore, this research allows companies to identify and understand potential barriers that may hinder the growth and development of their business. This enables SMEs to take action against this (if

possible) to overcome barriers and stimulate innovations. Because by investing in technological innovation, SMEs can improve their efficiency, enter new market opportunities, improve product and service quality, and increase their competitiveness (Bayarçelik et al., 2014). So basically, this research aims to identify the factors that influence SMEs' decision-making to invest in technological innovation. So that SMEs can take these factors into account in the future and better deal with the challenges involved investing in technological innovation. The next section will look at what the existing literature says about this topic, followed by a section on research design and methodology.

2. Literature review

This section will look at what the existing literature says about the extent to which SMEs are prevented from investing in technological innovations by potential barriers. First, this literature section will look at the strategic innovation process and strategy of SMEs. Then, this section will look specifically at technological innovations and adoption by SMEs. Finally, based on the literature, the most common barriers to technological innovations will be discussed.

By covering these topics and looking at what the existing literature says, it can give a better picture on the topic. To find the appropriate scientific sources, the following search engines were used*: Scopus, Scholar, Worldcat, FindUT (UT Libary) and ScienceDirect.* However, non-scientific sources were also used for inspiration*: ICTMagazine*[1]*, DutchITchannel*[2]*, Sharp*[3] and many more. The following keywords were used to obtain the scientific literature: *innovation, digitalisation, SMEs, investments, technological innovation, ICT, information technology, barriers, challenges, performance.* In the past, a lot of research has been done on the impact of innovations on companies. One of the first to conduct extensive research into the influence of innovations in organizations was Joseph Schumpeter. He is therefore considered the founder of research into innovations with his groundbreaking book: “Capitalism, Socialism and Democracy” (1943). Jospeh Schumpeter emphasized the importance of entrepreneurship and innovations in the economic process. Schumpeter's ideas on innovation continue to influence how innovation studies and the understanding of entrepreneurship are viewed today (Hospers, 2005). In addition, Schumpeter (1934) also distinguished between different types of innovations: Product, Process, Marketing and Organizational innovation. These four types of innovation can easily be combined, but an SME can also choose to focus on just one category. Moreover, successful innovation in one category can also lead to innovation in other areas (Karlsson & Tavassoli, 2015).

[1] https://www.ictmagazine.nl/ondanks-hoge-inflatie-investeert-mkb-fors-in-it/
[2] https://www.dutchitchannel.nl/news/375285/mkb-investeert-ruim-in-it-ondanks-economische-uitdagingen
[3] https://www.sharp.eu/news-and-events/blog/tech-investment-is-critical-to-smes-success-in-2023

2.1 Strategic innovation strategy for SMEs

In today's environment of rapid and incessant globalisation and technological change, it is well known that SMEs' competitiveness depends on their capacity to innovate. So, SMEs' decisions to innovate are the most fundamental strategic decisions an organisation will have to make. This is partly due to the increasingly new and rapidly growing markets with high competition and rivalry, rapid technological changes and the pursuit of shorter process times (Bayarçelik et al., 2014). But to achieve these goals, SMEs will first have to decide where or in what area they want to innovate. If SMEs know where they want to innovate, the first thing an SME should do is develop an innovation plan or innovation strategy. Such an innovation strategy has different definitions in the literature. According to Gilbert (1994), it is an innovation strategy that determines to what degree and in what way a firm attempts to use innovation to execute its business strategy and improve its performance. And according to Lendel and Varmus, (2011) an innovation strategy is *''an innovative direction of company approach to the choice of objectives, methods and ways to fully utilize and develop the innovative potential of the enterprise. This is the direction given of its boundary, which determines the potential of innovative strategies"*. It's also good to mention that innovations by SMEs or other organisations do not arise randomly or out of the blue, but are the result of intentional and systematic processes (Heimonen, 2012). So, when SMEs want to start investing in innovation, and especially in technological innovations, it is important to have a clear innovation strategy. Thereby, according to research by Barney (1991) SMEs are heterogeneous in their performance capabilities and an SME can gain competitive advantage when it is able to implement a value-creating (innovation) strategy that cannot or hardly be imitated by any competitors and there are few or no good alternatives. Innovation is therefore crucial for SMEs and enables them to better meet consumer needs, stay ahead of the competition and better match with market opportunities (Bayarçelik et al., 2014). There are a number of factors that influence the innovation process of SMEs, these consist of internal and external factors for an SME, which will be briefly explained. The first group of factors that strongly influence the innovative capacity of SMEs are external sources. This concerns the SME network that provides access to new markets, new knowledge and new (technological) skills (Dossou-Yovo & Keen, 2021). The other group of factors that influence the innovative capacity of SMEs concerns the internal factors within an SME. These include corporate culture, employee involvement, employee education level and experience, R&D and financial resources. Financial

resources play a crucial role here, because they are essential for SMEs that want to innovate. In an SME, innovative capacity mainly consists of financial capabilities and specialized employees (Laforet, 2011). The availability of financial resources is crucial for successful investment and innovation in process innovation by SMEs, due to the fact that the implementation of process innovation often entails organisational costs (Kim & Chung, 2017). In addition, it is often assumed in the literature that larger companies are more likely to innovate than smaller companies, due to the fact that larger companies have more financial resources, more internal and external inputs, have more talent, more R&D capacity and can generally spread the risks of innovations more and better (Karlsson & Tavassoli, 2015; Bertello et al., 2021). Taking these success factors into account as an SME can increase the chance of successfully implementing innovations and also improve efficiency and competitiveness.

2.2 Technological innovation

After creating an innovation plan or strategy, an SME may choose to focus on technological innovation. Technology alone refers to the equipment, machines, tools and instruments that SMEs use to conduct their business activities and thereby accelerate them (Rahman et al., 2016). Technological innovation refers to the process by which SMEs adopt and implement the design and production of products or services that are significantly different from before (Mytelka & Farinelli, 2005). Technological innovation is very important in achieving SME competitiveness. In order to maintain this advantage and gain access to new markets, technological innovation is inevitable and necessary. When SMEs decide to invest in the field of technology and digitalisation, they will have to take a few things into account. Namely the distinction between technological product and process orientations as technological output for a SME. SMEs that are mainly product-oriented in terms of technological innovation seem to be mainly concerned with R&D. They see this as their long-term goal, seeking to increase innovation capacity in order to support R&D-based investment and regulate costs (Hervás-Oliver et al., 2021). Process-oriented activities are more short-term and based on experience and learning-by-doing. Compared to product, process-oriented activities cost less resource commitment because they are not driven by R&D activities (Hervás-Oliver et al., 2021). So basically, SMEs can invest in innovations in many different ways and this can also differ per sector. But the literature on process-oriented innovators shows that two groups and/or patterns can be clearly distinguished for SMEs that

invest in innovation. The first innovation pattern regarding SMEs concerns the acquisition of embodied knowledge, also called tacit knowledge (Hervás-Oliver et al., 2016). This way of innovating and acquiring knowledge can take place both internally and externally. Internally through the knowledge of specialized employees (skilled workers) and investing in the development and training of their skills. But knowledge can also be acquired by investing in external knowledge. Access to external knowledge can be obtained through customer needs, suppliers, competitors, consultants, universities, etc. (support and cooperation) (Laforet, 2011). SMEs can also invest in open innovation, collaborations, acquisitions and/or mergers to acquire external knowledge for process innovation (Chen & Tsou, 2012). Then the second innovation pattern that is often used by SMEs that innovate in technology, which is focused on R&D developments and a high absorption capacity. This is a more internal study and refers to studying and analysing existing business processes to, for example, reduce waste, shorten lead times and increase overall quality and efficiency (Chen & Tsou, 2012; Hervás-Oliver et al., 2016). So, in short, the two patterns can be labelled as externally-oriented innovation (tacit knowledge acquisition) and internally-oriented innovation (process improvement and R&D). Table 1 will provide an overview of whether the six factors studied are more internally or externally oriented. Furthermore, nothing will be done in this study with the two patterns described above. The literature shows that SMEs, from a wide variety of sectors, investing in technology and implementing innovations, that these technological innovations are often an important determinant of the success of these SMEs (Subrahmanya et al., 2010). However, it is worth noting that the innovative capability of SMEs often varies from the size, sector, focus, (financial) resources and business environment in which it operates. Furthermore, the literature (Iorun, 2014; Oyeku et al., 2014; Rahman et al., 2016) shows that there is further evidence that technological innovation determines the success of SMEs. The results of these studies claim that SMEs that invest in technological and innovative growth, compared to SMEs that do not innovate in technology, are more successful and show better (sustainable) performance. Thus, the literature shows that technological innovation is significantly related to business performance (Rahman et al., 2016).

2.3 Possible barriers for technological innovation

Today, SMEs' success in investing in technological innovations is still hampered by a number of inhibiting factors. According to the results of several studies on technological innovations (Caloghirou et al., 2017; Indrawati et al., 2020; Kazemargi & Spagnoletti, 2020; OECD, 2021; Pessot et al., 2023), there are a number of inhibiting factors that can affect the implementation of technological innovations. The most common factors based on the existing literature and from previous studies on this topic are shown in Table 1. These inhibiting factors can be distinguished into internal and external factors. Internal factors are the things an SME can (largely) influence, such as attracting skilled employees, lack of market and technology information, lack of recognition to innovate, limited in-house budgets and lack of reserves. The external factors that can inhibit technological innovations include lack of support and policies and regulations. The financial constraint can both be an internal and external barrier. Indeed, a lack of capital, a lack of internal budgeting and a lack of accumulated reserves are financial constraints that you, as an SME, can influence and control to some extent. However, there are also some (external) financial constraints that you as an SME have no influence or control over such as access to credit or grants and funding or economic circumstances. But in this study the financial constraints will be considered as an internal barrier for technological innovation.

INTERNAL BARRIERS	EXTERNAL BARRIERS
SKILLED EMPLOYEES	*LACK OF SUPPORT*
FINANCIAL RESOURCES/CAPABILITY	*POLICIES & REGULATIONS*
LACK OF INFORMATION	
LACK OF RECOGNITION TO INNOVATE	

Table 1: Most common barriers for technological innovation based on existing literature

2.3.1 Skilled employees

The first inhibiting factor is the lack of skilled human resources and the lack of technological skills, information technology, low formal competencies and innovative skills (Caloghirou et al., 2017). As a result, managers and employees are unable to find technological/digital solutions needed to adapt business processes (OECD, 2021). In addition, limited technological capabilities and shortcomings in market information and customer response also play an important role in the competitiveness. Because if SMEs are unable to quickly adapt to the changing market and customer demands, it will lose the battle with its direct competitors who do innovate in

technology. But conversely, the presence of skilled employees can also stimulate and positively influence the adoption of technological innovations (Hvolkova et al., 2019). So, in fact, it can be said that the lack of intellectual capital at SMEs affects technological capability (Caloghirou et al., 2017). Moreover, research by Song (2022) shows that a business culture that does not encourage innovations and where knowledge exchange and information sharing is not promoted is more likely to lead to even more communication and interaction barriers between employees and SMEs managers.

2.3.2 Financial resources/capability

The second hindering factor and according to the literature also the biggest barrier for SMEs in technological innovations is a lack of financial resources and capability (Caloghirou et al., 2017; Indrawati et al., 2020; Kazemargi & Spagnoletti, 2020). As mentioned earlier, this hindering factor is both an internal and external barrier. SMEs often have limited financial resources and this therefore makes it difficult to invest in the latest technologies. Besides the high purchase cost of these new technologies, they also need to be updated and employees also need to be trained. These all cost a lot of money and together pose a significant internal barrier for SMEs, because they can be influenced and controlled by the SMEs. Moreover, SMEs often rely on financial loans from banks or third parties to finance investment and innovation, this is the external side of this financial constraint (Ş. C. Gherghina et al., 2020). Furthermore, Indrawati et al. (2020) also found that access to financial resources is the most fundamental barrier for SMEs. This is partly due to the fact that some investments in innovations are seen as intangible investments. In addition, uncertainty about the success of a technological innovation also plays a role (Caloghirou et al., 2017). As a result, financial institutions may be unwilling to lend for technological innovations due to the lack of tangible and physical collateral. But besides financing technological innovations, high interest rates and long payback periods can also be a barrier for SMEs (Gambatese & Hallowell, 2011; Savignac, 2007). Financial resources, obtaining loans and high interest costs combine to form the constraint that prevents SMEs from investing in technological innovations. In addition, SMEs may also be reluctant to invest in new technologies if the potential benefits and return on investment (ROI) are unknown (Tarutė & Gatautis, 2014). So, the lack of certainty may also hinder SMEs' adoption and investments in new technologies.

2.3.3 Lack of technological and market information

When, as an organisation, you want to start investing in technological innovations, it is required that you have enough knowledge of the market in which you operate or want to operate. In addition, you must also have enough knowledge of the particular innovation you want to invest in, so that you have a good understanding of the benefits of the technological innovation and know how to start applying it. Hence, according to OECD (2005) and Oslo Manual (2005), technological innovation will have to be seen as an interface or connection between the market potential and the knowledge and technological capabilities of the company. However, several studies (D'Este et al., 2012; Talegeta, 2012; Duarte et al., 2017) show that the lack of technological and market information is a major obstacle to investment in technological innovations in SMEs. This mainly concerns the limited access and use of available technological information, but also the lack of in-depth knowledge for technological solutions that may be relevant to the organisation (Talegeta, 2012). But in addition to knowledge and expertise about the technological innovations themselves. A lack of knowledge about the market and needs of customers can also hinder investments in technological innovations (D'Este et al., 2012; Silva et al., 2008). This is why it is so important for companies to gain in-depth insight and information about the market, trends and (technological) challenges. When this is done properly, the organisation will be able to develop and implement technological solutions.

2.3.4 Lack of recognition to innovate

Fourth, it may also be that an SME or other organisation is unaware of the need for (technological) innovations or simply does not realise it. According to the literature that has researched this in the past (Gambatese & Hallowell, 2011; Talegeta, 2012; Duarte et al., 2017; Silva et al., 2008), it is the case that, companies that lack recognising innovation may lag behind competitors that do actively innovate in the longer term. The failure to recognise that the market and customer needs are constantly evolving, and thus the rigid attitude towards innovations, can therefore have major consequences for organisations. When this is the case, an organisational culture of rigidity prevails, according to Talegeta (2012). This has therefore been identified as a major barrier to SMEs in the technology industry (Duarte et al., 2017). Sticking to existing practices, processes and systems, while not recognising the benefits of innovations, is one such characteristic of a rigid and conservative organisational culture. However, according to Hvolková

et al. (2019), it can also be the case that there is simply no demand for innovations, which means that there is no need to innovate. Finally, an organisation may also not recognise or consider innovations necessary because of previous innovations that are implemented before. The innovations are then considered as unnecessary or redundant (Duarte et al., 2017; Gambatese & Hallowell, 2011).

2.3.5 Lack of support and cooperation

The lack of support and cooperation may also affect the extent to which SMEs invest in technological innovations. The existing literature therefore shows that a lack of support and cooperation is an important factor for investments in technological innovations (Gambatese & Hallowell, 2011; Talegeta, 2012; Duarte et al., 2017; Indrawati et al., 2020). A lack of support can come from within the organisation (employees) as well as from outside the organisation (business partners). Duarte et al (2017) and Indrawati et al (2020) investigated the influence of a lack of support and collaboration and found that this had a significant effect on the extent to which SMEs implement technological innovations. In addition, they also found that collaboration with business partners plays a crucial role in improving competitiveness. Gambatese and Hallowell (2011) and Talegeta (2012) complemented these findings and explained the lack of support and collaboration by poor communication channels. They mentioned that a good communication network with staff and business partners can improve performance and facilitate the implementation of technological innovations. In addition, employees' attitudes towards (technological) innovations play an important role for organisations. If employees are resistant, then such an innovation will not be properly implemented and will have little chance of success (Silva et al., 2008). This makes the attitude and support of employees crucial for the successful success of innovations; after all, they are the ones who have to do the work. In any case, what the literature agrees on (Gambatese & Hallowell, 2011; Talegeta, 2012; Duarte et al., 2017; Indrawati et al., 2020) is that the level of support and cooperation can encourage organisations to start investing in innovations and that less support and cooperation will start hampering technological innovations.

2.3.6 Policies and regulations

Sometimes SMEs can also face strict regulatory and legislative requirements, often imposed by the government. These regulatory and legislative requirements relate in particular to security of sweeps and other privacy legislation issues. These imposed regulations can therefore become a barrier when investing in new technologies or innovations. For SMEs in particular, this can therefore be an additional challenge. The literature shows that with the studies by Talegeta (2012), Indrawati et al (2020) and Gambatese and Hallowell (2011), unfavourable rule and legislation by the government is an obstacle block to investments in technological innovation among SMEs. In particular, they found that the low protection of patent rights and the absence of government loans to finance R&D were major obstacle blocks. Moreover, according to Silva et al (2008), government regulations and legislations, in particular, are a major stumbling block for small companies and less so for larger or public organisations. This is due to the fact that larger firms are less dependent on government funding. Furthermore, Ajagbe et al. (2015) claimed that policymakers are expected to play an active role in making accessible, acquiring external knowledge and they should make the necessary facilities available to organisations, such as financial support. But besides the fact that policies and regulations can be a barrier, it can also act as an incentive for SMEs. This is evident, for example, in a number of incentive programmes for SMEs, such as grants and small-scale deduction. Lastly, D'Este et al. (2012) argues that policymakers, with their power and legislation, should instead ensure that rule and legislation should not be an obstacle block, but rather ensure that through government regulation, the obstacles to technological innovations should decrease and stimulate SMEs.

2.4 Conceptual Framework

Based on the literature review above, it can be assumed that there are many different factors that can potentially prevent or even inhibit SMEs' investments in technological innovations. As a result, due to the influence of these factors, SMEs may not (dare to) innovate in the technological field and falling behind competitors in the market. This will potentially reduce the market shares of the SMEs concerned and their competitive ability will also deteriorate. Moreover, literature studies have shown that SMEs that fail to innovate are less able to respond to opportunities and possibilities in the ever-changing environment. Based on the literature review a conceptual framework has been drawn up (see figure 1).

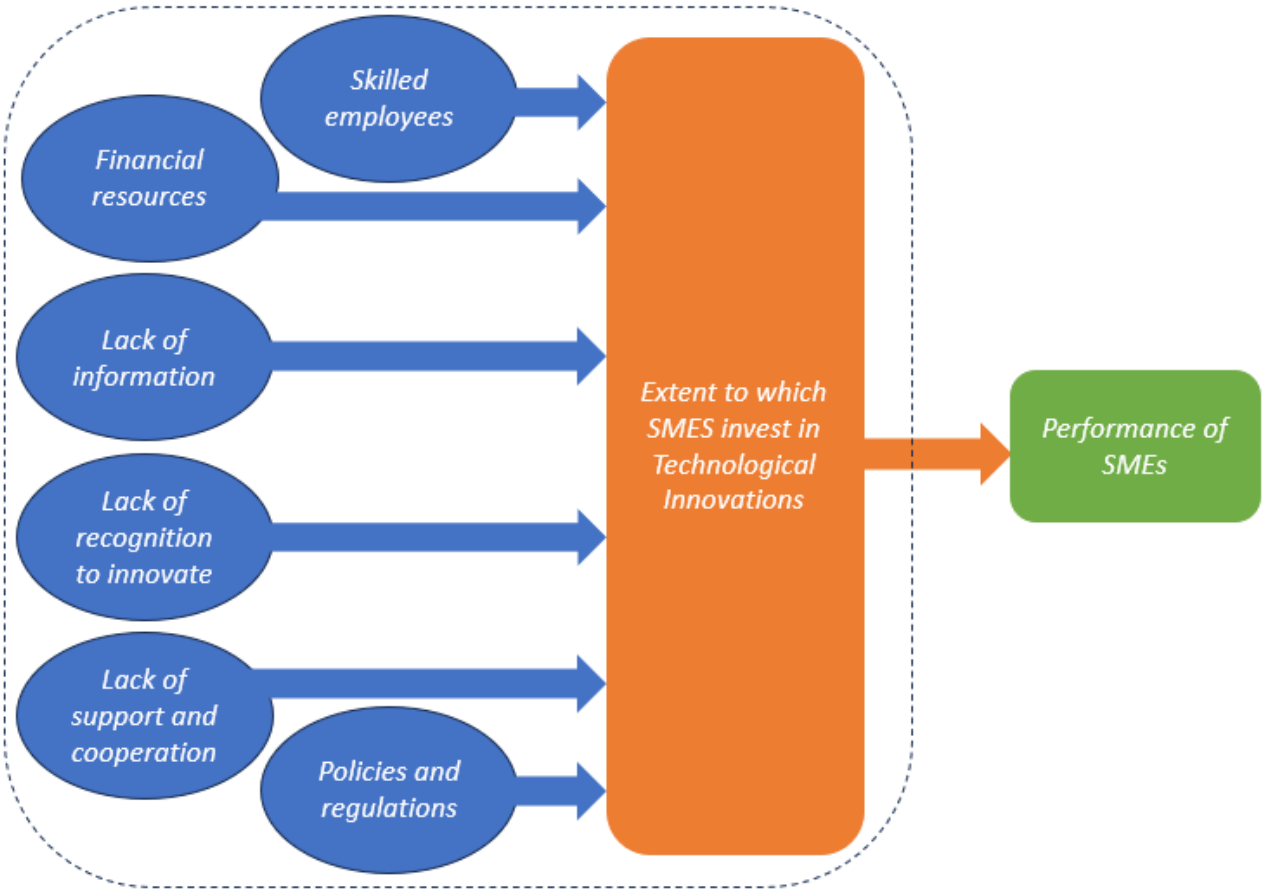

Figure 1: Conceptual Framework

Figure 1 shows on the left side of the model the six independent variables that influence the dependent variable 'investments in technological innovations'. In addition, 'performance of SMEs' has been added on the far-right side. This is because there has been done a lot of research in the literature on how technological innovations affect the performance of organisations. These

studies (Chen & Tsou, 2012; Tarutė & Gatautis, 2014; Tavassoli & Karlsson, 2015; Rahman et al., 2016) have therefore shown that technological innovations have a positive impact on the performance of SMEs. It can therefore be seen from the conceptual framework that the variable 'investments in technological innovation' plays a mediating role. But in this study, the focus will not be here but will be mainly on the left and dotted-line surrounded side. This is due to the fact that much is already known in the literature about the impact of technological innovation on a firm's performance.

2.5 Hypotheses

This chapter formulates the hypotheses that will be further investigated later in this study. This involves the expected relationships that the six independent variables have with the dependent variable ‘The extent to which SMEs invest in technological innovation’.

Skilled workers are very important to SMEs. With their expertise and knowledge, they form the intellectual capital of an organisation. Therefore, skilled workers are expected to have a significant effect on the extent to which SMEs invest in technological innovations.

H1: Skilled workers have a significant effect on the extent to which SMEs invest in technological innovations.

Secondly, the financial resources/capability is expected to have a significant impact on the extent to which SMEs adopt technological innovations, making it a major barrier.

H2: Financial constraints have a significant impact on the extent to which SMEs invest in technological innovations.

It is also expected that a lack of knowledge about the market in which the SME operates or about the technology that is required will negatively affect an SME's innovativeness in technology.

H3: A lack of information about the market and technology has a significant effect on the extent to which SMEs invest in technological innovations.

According to the literature (Gambatese & Hallowell, 2011; Talegeta, 2012; Duarte et al., 2017), a failure or lack of recognition to innovate also has a negative impact on the innovativeness of an SME

H4: A lack of recognition to innovate have a significant effect on the extent to which SMEs invest in technological innovations.

Support and cooperation is also an important factor for SMEs that invest in technological innovations. Therefore, this factor is expected to play an important role.

H5: Lack of support and cooperation have a significant effect on the extent to which SMEs invest in technological innovations.

Finally, it is expected that governments can also strongly influence the extent to which SMEs innovate in technology through regulation and legislation. But on the other hand, governments can also support and encourage SMEs through regulation and legislation, it is therefore expected that:

H6: Policies and regulation have a significant effect on the extent to which SMEs invest in technological innovations.

3. Methodology

To answer the research question, this research paper will discuss how the factors that are discussed in the literature review, hinder technological innovation in SMEs. To do this, the next section will describe the research methodology and variables that are also discussed in the literature review. The variables from the hypotheses (see chapter 2.5) will also be made measurable.

3.1 Research method

This study examines the factors that constrain or prevent SMEs from investing in technological innovations. This will mainly be investigated through a quantitative study, as this research is largely explanatory in nature, but this research also has some qualitative components (e.g. literature study). As quantitative research methods, a survey will be prepared, from which it will become clear to what extent and by what factors SMEs are held back from investing in technological innovation. A survey was chosen because a survey is very efficient and compared to other research methods, the survey is the most appropriate form for this research, because using a survey is an efficient way of questioning a large group of people in the same way and to collect a large number of respondents (Dalati & Gómez, 2018). Moreover, surveys use standardised questions, so every participant is asked the same questions, ensuring the consistency of the survey (Dalati & Gómez, 2018). This will facilitate the process of comparing answers between different respondents. Furthermore, the use of surveys also preserves respondents‘ anonymity and this benefits respondents’ willingness to cooperate in the survey (Nayak & Narayan, 2019). The survey will be designed using the findings and results from the literature on SME performance and technological innovations. The survey will consist of both closed-ended and open-ended questions. This will be done as this will generally lead to a more balanced and holistic approach to data collection and there will be more depth to the research. Most of the questions from the survey data will be measured using a five-point Likert scale (ordinal). The value intervals will consist of the following response options: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree) and 5 (strongly agree). This will be done so as to allow for good comparison of responses and to keep the analysis as consistent and reliable as possible. The survey will be sent to a large population of small and medium-sized enterprises to ensure sufficient data for comparison and analysis. A sufficient number of respondents for this study is achieved when at

least 50 surveys have been completed. This because, with a lower response rate the statistical power of the analyses may be inadequate. Furthermore, a sample size of more than 50 is highly recommended, particularly when using more advanced tests that involve multiple independent variables. So in short, a sample of 50 or more increases the statistical power of the test and is potentially more representative and generalisable.

This research will be mainly explanatory, due to the fact that this study will examine the most common factors from the literature on investment in technological innovation using the hypotheses that are drawn up. The aim of this study is to investigate which constraining factors have a significant impact on the extent to which SMEs invest in technological innovations so that they can be controlled in the future. After the surveys are collected, the data will be cleaned up and can be compared and tested. Testing the data will be done using the programme SPSS 29. To assess which factors influence SMEs' level of investment in technological innovations, a univariate test will first be conducted in the form of a Spearman's rank correlation matrix. This will be done to assess the strength and direction of the association between the variables. This will make it easy to see which factors have a significant relationship with the level of investment or correlate significantly with the other factors studied. A Spearman correlation test is chosen because the data obtained from the survey is not normally distributed and when this is the case, you are not allowed to use a Pearson correlation test, because it does not meet the normality requirements. However, a univariate test examines only one variable at a time in relation to the dependent variable without accounting for other possible influences. Therefore, a multivariate analysis is necessary to obtain a more comprehensive and accurate picture of how these factors interact. For this reason, a multivariate test in the form of a logistic regression analysis will be conducted in addition to the univariate test. Moreover, the logistic regression analysis is very appropriate for this study, due to the fact that this test is specially designed for a binary dependent variable. In this study, the binary dependent variable is whether SMEs have experienced previous barriers when investing in technological innovations (0/1). Furthermore, this study examines multiple factors or independent variables in relation to the dependent variable, and a logistic regression analysis allows the researcher to include these factors simultaneously in a single model. Moreover, for the independent variable, there are less stringent restrictions in terms of data type and it can adopt different types (continuous, categorical etc.). This approach provides insight into how each factor contributes to the likelihood of barriers to investment in

technological innovations. It also makes it possible to determine which variables have a significant impact on the dependent variable when tested and analysed together. Additionally, the dataset used for testing contains no outliers or missing values, which is a prerequisite for using logistic regression analysis.

By combining the univariate Spearman's rank test and the multivariate logistic regression analysis, insight is gained into both the bivariate relationships and the influence of the independent variables together on the dependent variable. So, running a univariate test alone will not be enough and conducting a multivariate test is essential for this study. After the tests are carried out, the results can be analysed and interpreted. Besides looking at what factors influence the level of technological innovations at SMEs, distinctions will also be made for different types of SMEs (Micro, Small and Medium). These distinctions will be made according to the size and scope of the SMEs. This makes it easy to see which type of SME suffers from which constraining factor, this will be done in chapter 4.2.

3.2 Variables

This section explains and defines the variables in the study. The variables are divided into two groups, namely the dependent and independent variables. This distinction is made so that they can be tested. The testing of the variables will be done through a survey, using a 5-point Likert scale, similar to other studies on this phenomenon.

3.2.1 Dependent variable

Compared to previous studies, this study investigates which factors influence and/or hinder the extent to which SMEs invest in technological innovations. However, before that can be done, the dependent variable must first be defined. The dependent variable is the extent to which SMEs invest in technological innovations. This variable will be measured using the open question from the survey, in which the participating SMEs are asked whether they have ever experienced barriers when investing in technological innovations in the past (Q4). The responses to this question will then be classified into two groups, i.e. a binary distribution. The aim is to determine whether the SMEs have previously encountered problems with the implementation of technological innovation, and if so, in what way or which factors were the cause. SMEs that indicate they have not previously invested in technological innovations or have not experienced

any difficulties are assigned a 0 = ‘no barriers experienced’. SMEs that indicate they have previously encountered barriers when investing in technological innovations are assigned a 1 = ‘barriers experienced’. Additionally, question 4 of the survey will also consider the factors that caused these earlier barriers. Once the variables are properly defined, the hypotheses can then be tested with the ultimate goal to measure, based on the dependent variable and the six independent variables, which factors have a significant influence on the extent to which SMEs invest in technological innovation. This will be done using a Spearman correlation matrix to see which factors significantly correlate with the extent to which SMEs invest in technological innovation. The extent to which SMEs are able to invest in tech innovations depends on six independent factors. These six independent factors can be seen on the left-hand side of the model (see figure 1). These factors have been determined from the literature and are the main actors and most common barriers for investing in technological innovations (Hervás-Oliver et al., 2021; Rahman et al., 2016). So, when the dependent variable is made measurable, it can be tested against the six independent variables using the Spearman matrix to see if there is a significant correlation.

3.2.2 Independent variables

For the independent variables, the factors on the left of the conceptual model will be used (see figure 1). These six factors will serve as predictors for the dependent variable ‘the extent to which SMEs invest in technological innovation’. The first variable skilled workers, can be defined by the extent to which an SME has skilled staff with extensive technological knowledge and expertise, high formal competences and innovative skills (Caloghirou et al., 2017). In addition, this variable will be measured by the extent to which technological innovations are introduced bottom-up, (i.e. coming from employees). The limitations regarding financial resources will be measured by looking at the extent to which SMEs have access to financial resources. Moreover, financial resources can be measured by looking at the extent to which innovations have not gone ahead because of high financial costs. The variable market and technological information will be measured by looking at the technological capabilities of the company and the market share they possess. Because companies with the right amount of information are better able to respond to technological changes and market needs (Duarte et al., 2017). The variable lack of recognition to innovate will be measured by looking at how aware SMEs are of the importance of technological innovations. Moreover, awareness of innovating can also be measured by looking at the R&D spending of SMEs. Then lack of support and cooperation, this will be measured by looking at the

extent to which SMEs cooperate with business partners and the attitudes of employees towards technological innovations. Lastly, the variable policies and regulations will be measured by looking at whether regulations have affected innovative capacity. The six independent factors will be measured through specific questions in the survey (see appendix 1).

3.3 Data and sample

To answer the research question, this research paper uses a sample of companies that identify themselves as small and medium-sized enterprises (SMEs) and also comply with European standards such as headcount and turnover (see Table 2). Distinctions are made when examining and analysing the data, as SMEs can still vary greatly with each other in terms of size and scope. By making these distinctions, it is possible to properly analyse and identify which barriers apply to which kind or type of SME. For example, an SME with a turnover of 40 million euros may have less difficulty in investing in technological innovations than an SME with less than a million euros turnover. The sample period of this study will cover the past 15 years, i.e. from 2010 to the present (2010-2024). A total of 86 SMEs completed the survey, however, about six respondents indicated that their company had more than 250 employees. In addition, these six companies also indicated having a turnover of more than €50 million. This ensures that according to the European Commission's guidelines and Berglund's (2007) definition, these six companies cannot be included in the survey and will therefore be removed from the data. This leads to the sample size being N = 80 and fully obtained from the survey.

Company	Headcount	Turnover
Medium-sized	< 250 employees	≤ € 50 million
Small-sized	< 50 employees	≤ € 10 million
Micro-sized	< 10 employees	≤ € 2 million

Table 2: Classification of SMEs

3.4 Validity and reliability

In this study, a survey was used as measurement tool, its validity was ensured by basing the questions on the established literature on the barriers SMEs face when investing in innovations in general. Six independent variables were therefore chosen from this existing literature to explore, such as financial strength in innovations, lack of information and support etc. These were chosen because these six variables were found to be the most common barriers to SMEs in innovations and thus adequately represent the common barriers experienced by SMEs. The survey mainly used a 5-point Likert scale. This is a good a common method in survey research and, moreover, its use enhances construct validity. Furthermore, no causal relationships can be shown in this study. But however, the internal validity is ensured as the analysis focuses on significant relationships between the variables and covers all relevant aspects of the variables studied in investment in technological innovations. Finally, external validity, or the extent to which your results are generalisable, is ensured by the good sample size (N = 86). Despite the fact that some companies in this survey are very different from each other, they are highly representative of the SME population in their sector and region.

4. Results

This results chapter will first look at the more general information and discussing some descriptive statistics on the survey results. Then, in the second part of this chapter, some differences between the different sizes and scopes of SMEs will be mapped out. Then the section that follows will cover the two different tests (univariate and multivariate). And finally, the hypotheses will be answered followed by a conclusion.

4.1 Descriptive statistics

As mentioned earlier, 86 companies initially participated in the survey, with 80 remaining after filtering the responses. Notably, over half (52.5%) of the 80 SMEs involved identified as small-sized organisations with between 10 and 50 employees. This distribution of SMEs is visualised below (see Figure 2). Additionally, 46% of the participating SMEs reported an annual turnover of less than €2 million, 28% between €2 million and €10 million, and 26% between €10 million and €50 million. Furthermore, nearly half (49%) of the SMEs surveyed operate in the engineering, manufacturing, and construction sectors, primarily within the manufacturing and production industry. This representation is advantageous for the survey, as such companies frequently encounter substantial investments in machinery and technological innovations.

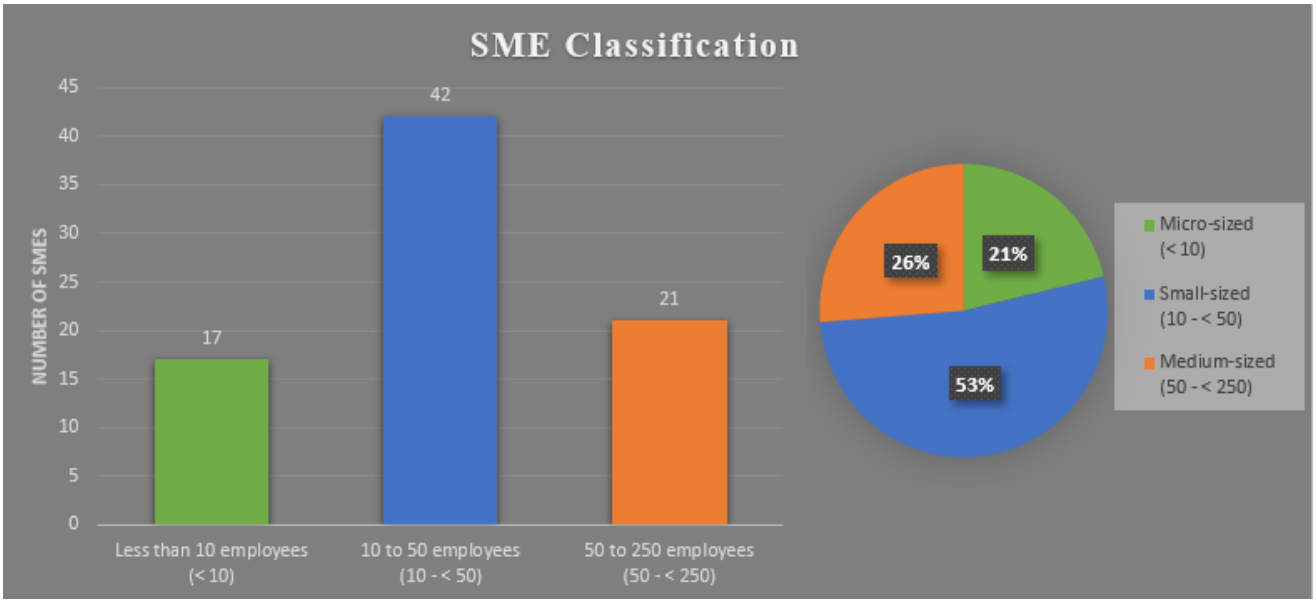

Figure 2: SME classification, Micro, Small and Medium-sized enterprises

Table 3 provides an overview of the descriptive statistics for questions 4 to 14. As previously noted in section 3.2, the dependent variable was derived from the open question about whether SMEs had ever encountered barriers to investing in technological innovation before (Q4). The responses to this question were subsequently analysed and coded. If an SME indicated that it had not previously encountered obstacles to investing in technological innovation, a '0' was assigned (0 = no previous obstacles). If obstacles had been encountered, a '1' was assigned (1 = previous obstacles). Among the 80 respondents, 46 SMEs reported having previously faced barriers to investing in technological innovation, representing 57.5%. Further examination of Table 3 reveals that questions 5 to 14 were rated on a 5-point Likert scale, where 1 = strongly disagree and 5 = strongly agree. Notably, for questions 6, 9, and 10, none of the 80 participants selected 'strongly disagree,' resulting in a minimum score of 2 for these questions rather than 1, as observed with the other questions on the 5-point Likert scale.

	N	Minimum	Maximum	Mean	Std. Dev.
Q4	80	0	1	0,57	0,497
Q5	80	1	5	3,57	0,965
Q6	80	2	5	3,24	0,860
Q7	80	1	5	3,25	1,061
Q8	80	1	5	3,21	1,144
Q9	80	2	5	3,61	0,864
Q10	80	2	5	3,88	0,848
Q11	80	1	5	3,96	0,665
Q12	80	1	5	3,74	0,853
Q13	80	1	5	3,39	1,013
Q14	80	1	5	3,09	0,874
Valid N (listwise)	80				

Table 3: Descriptive statistics survey question 4 until 14

Q1: *How many employees does the company have?*	○ *Less than 10 (< 10) employees* ○ *Between 10 and 50 employees* ○ *Between 50 and 250 employees* ○ *More than 250 (> 250) employees*
Q2: *What is (estimated) the company's annual turnover?*	○ *Less than < €2 million turnover* ○ *Between €2 and €10 million turnover* ○ *Between €10 and €50 million turnover* ○ *More than > € 50 million euro turnover*
Q3: *In which sector does the company operate?*	○ *Trade and (business) services sector* ○ *Information and communication sector* ○ *Engineering, manufacturing and construction* ○ *Agricultural sector* ○ *Transport and logistics sector* ○ *Other namely;*
Q4: *Has the company ever experienced barriers to investing in technological innovation? If so, can you briefly describe them?*	_____ _____
Q5: *How would you rate the current level of employees' expertise and skills in technological innovation?*	○ *Insufficient* ○ *Moderate* ○ *Sufficient* ○ *Good* ○ *Very good*
Q6: *Ideas to innovate (or to invest in innovations) come mainly from employees/bottom-up*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q7: *Having insufficient skilled workers within the company will reduce investment in technological innovations*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q8: *The process of obtaining financial resources to invest in (technological) innovations is not an obstacle for the organisation*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q9: *The company has sufficient market information/technological knowledge and invests part of its budget in R&D*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q10: *The company is constantly looking for new ways and innovations to meet the ever-changing market demand/customer needs*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*

Q11: *Employees within the company are positive about innovations and/or technological change*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q12: *The company works well and/or extensively with external parties and business partners on innovation*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q13: *The government, through its regulation and legislation, influences the extent to which the company invests in technological innovations*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q14: *In general, government has a greater negative influence than positive influence on investments in technological innovations*	○ *Strongly disagree* ○ *Disagree* ○ *Neutral* ○ *Agree* ○ *Strongly agree*
Q15: *Which of the following factors would deter you as a company from investing in technological innovation?*	○ *Lack of skilled workers* ○ *Lack of financial resources* ○ *Lack of technological/market information* ○ *Lack of recognition* ○ *Lack of support and cooperation* ○ *Policies and regulations*

Table 4: Overview of the (translated) survey questions

Figure 3 below summarises the specific barriers that were reported in question 4 of the survey by the 46 SMEs that indicated they had struggled with technological innovations in the past. Looking into the responses to the open-ended question, then it is immediately noticeable that financial constraints and lack of time for technological innovations in particular were seen as impeding factors (see figure 3). There are also a number of other factors that affected SMEs that have invested in technological innovations in the past, namely lack of support, no expertise or knowledge to innovate, grants and government policies etc. But as in the literature (Tarutė & Gatautis, 2014; Caloghirou et al., 2017), the factor financial constraints is seen and perceived as the biggest barrier to technological innovations.

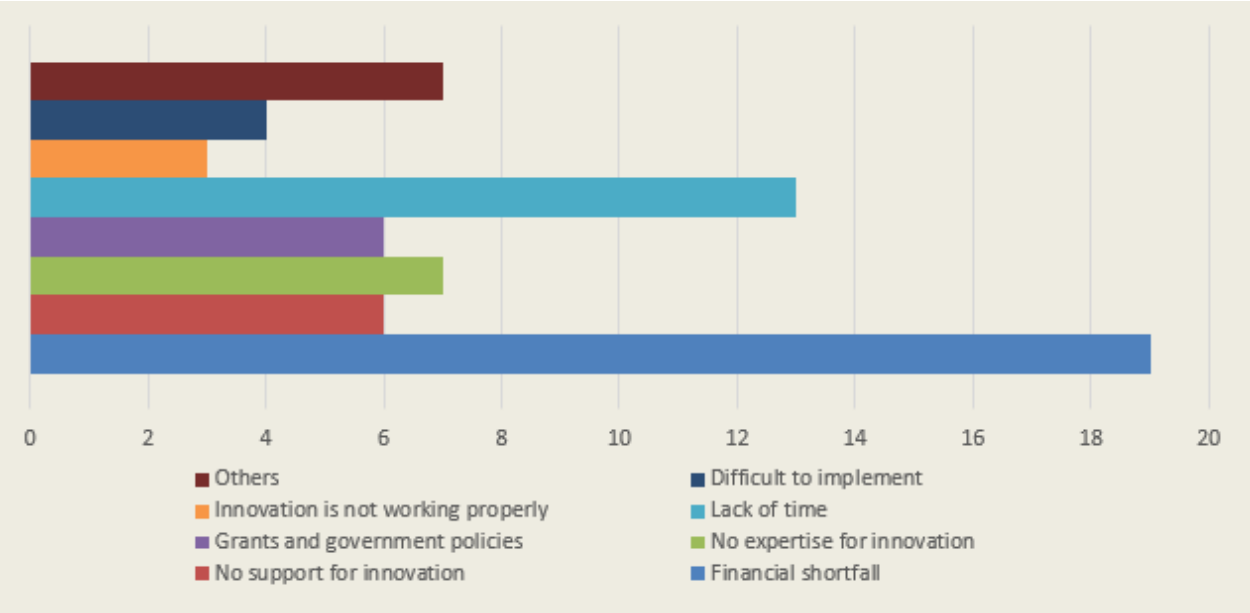

Figure 3: Overview of responses on previous perceived barriers to technological innovation (Q4)

Table 5 shows the responses to the last question what factors would prevent you as a company from investing in technological innovation. When answering this question, respondents could tick multiple factors. What is immediately noticeable is that there are no missing values (see Table 5) and that the factor financial resources by far has the highest mean (0.54), followed by the constraining factor policies and regulations (0.39). Because the lack of financial resources is the only factor for which the majority indicated it was perceived as constraining, this factor is therefore the only one of all six factors that has a median and mode of 1. Looking at the bottom of Table 5, you can see what the 80 SMEs answered for each factor. The factor of financial resources is by far the largest, with 43 out of 80 SMEs finding it a barrier to investing in

technological innovation. In contrast, the factor failure to recognise innovation opportunities and lack of knowledge about the market and technology both scored 19 out of 80. But the factor lack of support and cooperation scored even lower at 18 out of 80, scoring the lowest on this question and thus perceived by SMEs as the least hindering. Looking at Table 5, it can be concluded that the factor financial resources, with a mean of 0.54, seems to be the biggest limiting factor for SMEs wanting to invest in technological innovations. This finding is consistent with previous results from the question whether SMEs have ever experienced barriers to investing in technological innovation before (see figure 3). Moreover, based on responses to the last question from the survey, the factor policies and regulations (mean 0.39) also pose a significant challenge in terms of technological innovations. The answers to this last question on the six constraining factors and the open-ended question from the survey will together form the basis for the Spearman's rank correlation test in section 4.3. In which there will be a Spearman's rank correlation matrix between the dependent variable and the six independent factors. The following section 4.2 looks at the differences between SMEs and how they perceive the impeding factors. Here, a distinction is made between size and scope (micro, small and medium).

		Skilled workers	**Financial resources / capability**	**Lack of information**	**Recognition for innovation**	**Lack of support / cooperation**	**Policies and regulations**
N	*Valid*	80	80	80	80	80	80
	Missing	0	0	0	0	0	0
Mean		0,28	0,54	0,24	0,24	0,23	0,39
Median		0,00	1,00	0,00	0,00	0,00	0,00
Mode		0	1	0	0	0	0
Std. Dev.		0,449	0,502	0,428	0,428	0,420	0,490
Minimum		0	0	0	0	0	0
Maximum		1	1	1	1	1	1
Constraining *(N=80)*	*No*	58	37	61	61	62	49
	Yes	22	43	19	19	18	31
	Total	80	80	80	80	80	80

Table 5: Descriptive statistics question 15: six factors survey results

4.2 Significant differences between the various categories of SMEs

This section looks specifically at the differences in size and scope of SMEs and how they perceive the impeding factors. Questions 1 and 2 of the survey were used to classify the size and scope of the SMEs. These questions are about the company's workforce and annual turnover. Furthermore, for the perceived hindering factors, the last question and the open question from the survey were used. Based on this and according to the European guidelines, SMEs could be divided into micro, small and medium-sized companies and thus compared with each other. So, this section zooms in further on the factors and looks at the influence of the six factors on (technological) innovativeness for each group. Table 6 shows, for each type and size, what percentage of SMEs perceive the factors as hindering. Looking at the first factor, it is immediately noticeable that a lack of expertise and skilled employees are perceived as hindering especially by the micro-sized SMEs (52.9%). In contrast, small-sized SMEs indicate that, of all six factors, lack of skilled workers is actually the least felt hindering factor of all (23.8%). Looking at lack of financial ability and resources, a pattern immediately stands out. Namely, the percentages decrease as SMEs become larger in size. For example, 70.6% of micro-sized SMEs experience this factor as constraining, 61.9% for small-sized SMEs and 47.6% for medium-sized SMEs. Thus, this factor clearly shows a pattern and, on the other hand, also corresponds well with previous studies on financial constraint as a hindering factor (Caloghirou et al., 2017; Duarte et al., 2017; Hvolkova et al., 2019).

	Respondents		
Barriers	Micro-sized (< 10) enterprises	Small-sized (10 - < 50) enterprises	Medium-sized (50 - < 250) enterprises
Skilled workers	52.9%	23.8%	33.3%
Financial resources/capability	70.6%	61.9%	47.6%
Lack of information	35.3%	31.0%	28.6%
Lack of recognition	29.4%	26.2%	28.6%
Lack of support / cooperation	23.5%	35.7%	33.3%
Policies / Regulations	35.3%	45.2%	57.1%

Table 6: Barriers to technological innovation activities among different size SMEs

In part, the same can be said for the factor of lack of technological information/market knowledge. Here the percentages also decrease as SMEs grow in size and scope. However, here the percentages are much lower and there are less significant differences between the different groups of SMEs. About the factors lack of recognition to innovate and lack of support and cooperation, little is striking and no pattern can be identified. What does stand out is that among micro-sized SMEs, lack of support and cooperation has the lowest percentage (23.5%) of all factors and all three groups. The last factor policies and regulations shows that in contrast to financial resources and lack of information, there is an inverse pattern. On the contrary, the influence of policies and regulations increases as the SME grows in size (micro-sized 35.3%, small-sized 45.4%, medium-sized 57.1%). So, the larger the SME, the more problems they face with policies and regulations and they perceive this factor as more of a hindrance when investing in technological innovation.

4.3 Analysis of the univariate Spearman's rank test

In this section, the output of the univariate Spearman's rank test will be interpreted and assessed, the output of this test is shown in Table 7 on the next page. This univariate test is examined to assess the strength and direction of relationships between variables, without the influence of other variables on these relationships. The Spearman's rank method was selected because it does not require the assumption of normality, which is important given that the dataset is not normally distributed. Additionally, the dataset primarily consists of ordinal variables (Likert scale) and does not include outliers, making Spearman's rank an appropriate choice. Beyond its suitability for this type of analysis, the method also provides a clear and straightforward matrix, allowing relationships between the factors and the dependent variable, as well as their significance, to be easily identified. Looking at the first factor in the correlation matrix, (1) Skilled workers, it can be seen that this factor has a negative r value of -0.150. This r value indicates the strength and direction of the relationship between the factor skilled workers and the dependent variable (#perceived barriers in the past). In this context, it suggests that SMEs that attach greater importance to skilled workers have generally been less likely to have encountered barriers to investing in technological innovations. There is a weak relationship when the Spearman's correlation (r) coefficient has a value of between 0.00 and 0.29, a moderate correlation by a value between 0.30 and 0.49, and a strong correlation by a value of 0.50 or higher.

		(#)	(1)	(2)	(3)	(4)	(5)	(6)
# Perceived barriers in past	*Spearman Correlation*	1						
	Sig. (2-tailed)							
(1) Skilled workers	*Spearman Correlation*	-0,150	1					
	Sig. (2-tailed)	0,184						
(2) Financial resources	*Spearman Correlation*	0,268*	-0,159	1				
	Sig. (2-tailed)	0,016	0,160					
(3) Lack of information	*Spearman Correlation*	-0,114	0,183	-0,071	1			
	Sig. (2-tailed)	0,312	0,105	0,529				
(4) Lack of recognition	*Spearman Correlation*	-0,114	0,117	-0,248*	0,172	1		
	Sig. (2-tailed)	0,312	0,302	0,026	0,128			
(5) Lack of support	*Spearman Correlation*	0,100	0,137	0,080	0,051	0,051	1	
	Sig. (2-tailed)	0,378	0,224	0,483	0,653	0,653		
(6) Policies and regulations	*Spearman Correlation*	-0,199	0,200	-0,188	-0,022	-0,022	0,063	1
	Sig. (2-tailed)	0,078	0,076	0,094	0,847	0,847	0,579	

Table 7: Spearman's correlation matrix

** Correlation is significant at the 0.05 level (2-tailed).*

However, besides from the factor that the relationship with the factor skilled workers is weak, it is also not significant with a p-value of 0.184 ($p > 0.05$). This indicates that the relationship is most likely due to chance and there is no evidence of a significant relationship. The same applies to the factors (3) lack of information, (4) lack of recognition and (6) policies and regulations. These factors also have a weak and negative Spearman's correlation (r) coefficient in relation to the dependent variable. This means that the more SMEs believe there is a lack of information, the less inclined they seem to be to have experienced obstacles in previous investments in technological innovations. This suggests that SMEs experiencing a lack of information may not have faced the same obstacles in the past, which could mean that a lack of information has allowed these SMEs to find other ways to invest in technological innovations. In contrast, the factors (2) financial resources and (5) lack of support have a weak, but positive Spearman's correlation (r) coefficient in relation to the dependent variable. Here, only factor (2) financial resources with a p-value of 0.016 has a significant effect (p-value < 0.05). This indicates that SMEs that perceive financial resources as a limiting factor have been more likely to have

encountered barriers in the past to investing in technological innovations. Furthermore, the Spearman's rank correlation matrix shows that the factor (2) financial resources significantly correlates with the factor (4) lack of recognition. Here, there is a weak negative Spearman's correlation (r) coefficient of -0.248 with corresponding p-value of 0.026 (p-value < 0.05). This means that SMEs that report experiencing financial resources as a constraining factor are less likely to overlook opportunities to innovate. A lack of financial resources may therefore make SMEs more aware of other possible alternatives to innovate.

So, the output of the Spearman's rank correlation matrix shows that the factor financial resources appears to be a significant predictor of barriers to investment in technological innovations. For the other factors, there seems to be no statistically significant evidence of relationship with the dependent variable. In addition, there is a significant weak and negative correlation between the factors (2) financial resources and (4) recognition to innovate, which could potentially lead to multicollinearity. However, the Spearman's matrix shows that the correlation is very weak (r < 0.5), indicating that it is unlikely to cause any issues within the dataset.

4.4 Analysis of the multivariate Logistic regression test

The previous paper discussed in detail the univariate test using Spearman's rank correlation matrix. In this section, a multivariate test will be conducted and discussed. This multivariate test will be done through a logistic regression analysis. This test was chosen due to the fact that the dataset lends itself very well to this and there is a binary dependent variable here which is one of the requirements for a logistic regression analysis. In addition, this multivariate test allows multiple independent variables to be tested simultaneously. Another requirement for using logistic regression analysis is that the independent variables must be at ordinal or continuous measurement level. For the logistic regression analysis, the following formula will be used:

$$log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 C_1 + \beta_8 C_2$$

For the input of the logistic regression analysis, question 4 from the survey – whether SMEs have previously experienced barriers to technological innovations (0/1) – will serve as the binary dependent variable. For the factor skilled workers, questions 6 and 7 from the survey have been combined and integrated into a single independent variable. This was done by merging the responses to both questions for each SME and calculating their averages. This results in a new

variable, namely *#AverageQ6Q7*, which will be used in the multivariate test and will represent the factor skilled workers. The same was done for the factor policies and regulations, here the questions 11 and 13 have been combined, leading to the new independent variable *#AverageQ11Q12* which will represent the factor policies and regulations. Furthermore, two control variables (*#SizeSME*, *#Turnover*) were added to the multivariate test to ensure that the relationship between the dependent variable and the six independent variables is analysed accurately. These two control variables help to exclude potential confounding factors that might influence the relationship between the variables under investigation. By incorporating the control variables into the multivariate test, it is possible to determine more specifically and accurately whether a factor has a significant effect, rather than the effect being caused by another variable. But before the output of the multivariate logistic regression analysis in Table 9 can be interpreted, it is first necessary to assess whether the model is a good fit to the dataset. This is done using the Hosmer-Lemeshow test (see Table 8). This test measures the goodness-of-fit of the logistic regression analysis and assesses how well the model fits the dataset. According to the test, a good fit is determined by Chi-square and significance level. A good fit to the data occurs when the significance level of the Hosmer-Lemeshow test is greater than the alpha of 5% ($p > 0.05$).

Step	Chi-Square	df	R^2	Sig.
1	11,454	8	0,168	0.177

Table 8: Model Summary and Hosmer & Lemeshow Test

In Table 8, it can be observed that the Hosmer & Lemeshow test has a Chi-Square value of 11.454 with a corresponding p-value (Sig.) of 0.177. This p-value is higher than the predetermined significance level of 0.05 (p-value > 0.05), indicating that there is no significant difference between the predicted and observed values. Since the p-value exceeds the significance level of 0.05, this suggests that the model has a good fit with the dataset and predicts the outcomes well. Additionally, the model has a Nagelkerke R^2 of 0.168. This Nagelkerke R^2 indicates how well the model explains the dependent variable and the extent to which the variation in the dependent variable is explained by the independent variables. In this model, a value of 0.168 means that 16.8% of the variance in the dependent variable is explained by the independent variables. This implies that there are still other variables that have explanatory power and influence on the extent to which SMEs invest in technological innovation.

Looking at the output of the multivariate logistic regression analysis in Table 9, the first column shows the B value. The B-value is the regression coefficient and indicates the strength and direction of the effect of the independent variable on the dependent variable. A positive B-value means that an increase in the independent variable increases the likelihood of the dependent variable occurring, while a negative B-value decreases the likelihood. The Wald statistic, shown in the second column, is a test statistic that determines how significantly the variable contributes to the dependent variable. However, the Wald statistic depends on the significance level, if the corresponding p-value does not meet the significance threshold, the relationship between the independent variable and the dependent variable is likely due to chance. Finally, the Exp(B), also known as the odds ratio, is shown in the last column. This value indicates how the odds change when the independent variable increases by one unit. An odds ratio greater than 1 means that the likelihood of the dependent variable increases as the independent variable increases by one unit. An odds ratio less than 1 means that the likelihood of the dependent variable decreases when the independent variable increases by one unit.

	B	Wald	Sig.	Exp(B)
(1) Skilled workers *(#AverageQ6Q7)*	0,097	0,063	0,801	1,102
(2) Financial capability *(#Q8)*	-0,302	1,656	0,198	0,740
(3) Lack of information *(#Q9)*	-0,037	0,011	0,915	0,964
(4) Recognition to innovate *(#Q10)*	0,602	2,234	0,135	1,826
(5) Lack of support and cooperation *(#AverageQ11Q12)*	-0,023	0,002	0,960	0,977
(6) Policies and regulations *(#Q13)*	-0,257	0,843	0,358	0,774
#Control variable1 *(#SizeSME)*	0,961	2,118	0,146	2,614
#Control variable2 *(#Turnover)*	-0,068	0,017	0,896	0,934
Constant	-2,084	0,833	0,361	0,124

Table 9: Output logistic regression analysis

The first variable, #AverageQ6Q7, which measures the factor skilled workers, has a positive B value of 0.097 in relation to the dependent variable. This suggests that an SME indicating that a lack of skilled workers is a barrier to investing in technological innovation may have previously encountered difficulties in such investments. Furthermore, this variable has a Wald value of 0.063

with a corresponding p-value of 0.801. This low Wald value indicates a minimal contribution and influence on the model, which is also not significant (p-value > 0.05). The odds ratio is Exp(B) = 1.102, which suggests that an increase of one unit in the independent variable skilled workers results in a 10.2% higher chance of experiencing barriers. However, this effect is not significant and therefore cannot be substantiated.

The second variable financial resources/capability, measured by question 8 ('The process of obtaining financial resources to invest in technological innovations is not an obstacle for the organisation'), has a negative B-value of -0.302. This suggests that the more the SME indicates that the process of obtaining financial resources is not an obstacle to investing in technological innovations increases, the likelihood of experiencing obstacles decreases. Thus, the less the SME perceives obtaining financial resources as an obstacle, the less likely it is to have previously experienced obstacles in technological innovations. Furthermore, it has a Wald value of 1.656 with a p-value of 0.198 which means the effect is thus not significant (p-value > 0.05). The odds ratio is Exp(B) = 0.740, which suggests that a higher score on this variable is associated with a 26% lower probability (1 - 0.740) of experiencing barriers.

For the third variable lack of information, measured by question 9 ('The company has sufficient market information/technological knowledge and invests part of its budget in R&D'), the same applies as for the variable financial resources. Again, there is a negative B-value of -0.037. This means that when there is an increase in SME indicating that lack of market information/technological knowledge is not an obstacle, the probability of experiencing obstacles decreases. Moreover, this variable has a very low Wald of 0.011 indicating a low contribution to the model and an associated p-value of 0.915. Furthermore, the variable has an odds ratio Exp(B) of 0.964 indicating a minimal 3.6% (1 - 0.964) decrease in the probability of barriers with an increase in lack of information, but this effect is not significant (p-value > 0.05).

The factor lack of recognition to innovate is measured by question 10 ('The company is constantly looking for new ways and innovations to meet the ever-changing market demand/customer needs'). Table 9 shows that this factor has a B-value of 0.602, meaning that the stronger an SME's emphasis on constantly looking for innovations, the more likely it is to have previously experienced obstacles in technological innovations. In other words, the more an SME focuses on innovation and renewal, the more likely it is that this SME has experienced or will

experience barriers when investing in innovations. Further, compared to the other variables, this variable has a high Wald value of 2.234. However, the variable has a p-value of 0.135 which is above the significance level (p-value > 0.05) and makes the finding not significant. In addition, it has an odds ratio Exp(B) or 1.826 indicating that an increase in this variable increases the probability of experiencing barriers to technological innovations by 82.6%. But statistical support and substantiation is lacking as the variable is not significant.

The factor lack of support and cooperation is measured in the survey by the merged variable #AverageQ11Q12 (‘Employees are positive about technological changes and innovations’ + ‘The SME works well with external parties and business partners’). This variable has a negative B-value of -0.023. This means that the stronger an SME's perception that employees are positive about technological changes and innovations, and that it works well with external parties and business partners, the less likely it is to have previously experienced obstacles in technological innovations. The more support and cooperation that is experienced within and outside the organisation, the less likely the organisation is to have previously experienced obstacles when investing in technological innovations. Furthermore, it has an odds ratio of Exp(B) = 0.977, indicating a very small decrease of 2.3% in the probability of experiencing barriers with an increase in the variable #AverageQ11Q12. However, it has a p-value of 0.960 and thus there is no significant influence (p-value > 0.05).

For the final factor, policies and regulations, the findings are consistent with those of the factor lack of support and cooperation. This factor is measured by question 13 ("The government and its policies and regulations influence the extent to which the SME invests in technological innovations") and has a negative B-value of -0.257. This suggests that the stronger an SME feels that government policies and regulations have less influence on the extent to which they invest in technological innovations, the less likely it is to have previously experienced barriers. The odds ratio Exp(B) of 0.774 indicates that an increase in this variable corresponds to a 22.6% lower likelihood of encountering potential barriers. However, this effect is not statistically significant, as the p-value is 0.358 (p > 0.05).

Finally, there are two control variables the size of the SME, measured by the number of employees (Control Variable1 #SizeSME), and the turnover of the SME (Control Variable2 #Turnover). The first control variable has a positive B-value of 0.961 and an odds ratio Exp(B) of

2.614, indicating that a larger number of employees potentially leads to a 161.4% higher likelihood of experiencing barriers when investing in technological innovations. In contrast, the second control variable has a negative B-value of -0.068 and an odds ratio Exp(B) of 0.934, suggesting that an increase or higher turnover of the SME corresponds to a 6.6% decrease in the likelihood of experiencing barriers when investing in technological innovations. This is logical, as a higher turnover typically means that more financial resources are available for the SME to innovate. However, both control variables are not statistically significant (p-value > 0.05).

Now that all the tests have been conducted, analysed and interpreted, the formula for the multivariate logistic regression analysis can be filled in based on the output of the multivariate test. Therefore, the following completed formula can be used for this study:

$$\log\left(\frac{p}{1-p}\right) = -2.084 + 0.097(\text{Skilled workers}) - 0.302(\text{Financial resources}) - 0.037(\text{Lack of information}) + 0.602(\text{Recognition to innovate}) - 0.023(\text{Lack of support and cooperation}) - 0.257(\text{Policies and regulations}) + 0.961(\text{Size}) - 0.068(\text{Turnover})$$

EXAMPLE: If an SME indicates that it suffers from lack of skilled workers, lack of recognition to innovate and lack of support and cooperation a 1 can be filled in the formula for these three factors. A 0 can be filled in for the other factors, which will give the following formula.

$$\log\left(\frac{p}{1-p}\right) = -2.084 + 0.097 \cdot 1 - 0.302 \cdot 0 - 0.037 \cdot 0 + 0.602 \cdot 1 - 0.023 \cdot 1 - 0.257 \cdot 0 + 0.961 \cdot 0 - 0.068 \cdot 0$$

$$\log\left(\frac{p}{1-p}\right) = -1.408$$

$$p = \frac{1}{1 + e^{-\log\left(\frac{p}{1-p}\right)}}$$

$$p = \frac{1}{1 + e^{1.408}} = 0.197$$

So, this means that in a situation where an SME indicates that it suffers from lack of skilled workers, lack of recognition to innovate and lack of support and cooperation. This according to the formula and output of this study results in an estimated probability p of about 0.197. This means that, based on the given indicated factors, there is a 19.7% probability of SMEs experiencing barriers to investing in technological innovations.

4.5 Hypothesis testing

In the final part of this chapter, the hypotheses will be answered and discussed based on the output of the statistical tests that were conducted. In chapter 2 of this research paper, several hypotheses were formulated, in which predictions were made about the factors that could potentially limit the innovation capacity of SMEs. The first hypothesis that had been drawn up is about the influence of skilled workers on the extent to which SMEs invest in technological innovations. The importance of skilled workers for SMEs was discussed in depth in the previous chapters. With their knowledge and expertise, they constitute the intellectual capital of the organisation. Therefore, based on the literature and past studies (Caloghirou et al., 2017; Hvolkova et al., 2019; Indrawati et al., 2020), hypothesis 1 was formulated:

H1: Skilled workers have a significant effect on the extent to which SMEs invest in technological innovations.

To answer this hypothesis, the responses to the last question of the survey, Q15 ('Which of the following factors would deter you as a company from investing in technological innovation?'), will first be examined. In this question, SMEs were asked to indicate which factors (if any) would hinder them from investing in technological innovation, with the option to select multiple factors. The factor of skilled workers was considered a hindrance by 26 out of the 80 SMEs. This represents 32.5% of all SMEs, indicating that a lack of skilled workers is perceived to influence the extent to which investments in technological innovation are made (see Figure 4). Based on the univariate Spearman's rank test in section 4.3, a negative and weak correlation was found between the factor of skilled workers and the extent to which SMEs had previously encountered barriers to technological innovation. Moreover, this correlation was not significant (p-value > 0.05), suggesting that there is no strong relationship between the experience of barriers and the presence of skilled workers. Furthermore, the multivariate analysis showed that the factor of skilled workers had an odds ratio of Exp(B) = 1.102, suggesting that an increase in the perception of skilled workers would increase the likelihood of experiencing barriers by 10.2%. However, in the multivariate analysis, the p-value was also higher than 0.05, and therefore, this finding cannot be considered significant. So based on the two analyses, there is insufficient statistical evidence to assume that the skilled workers factor has a significant impact on the extent to which SMEs invest in technological innovations and H1 cannot be assumed.

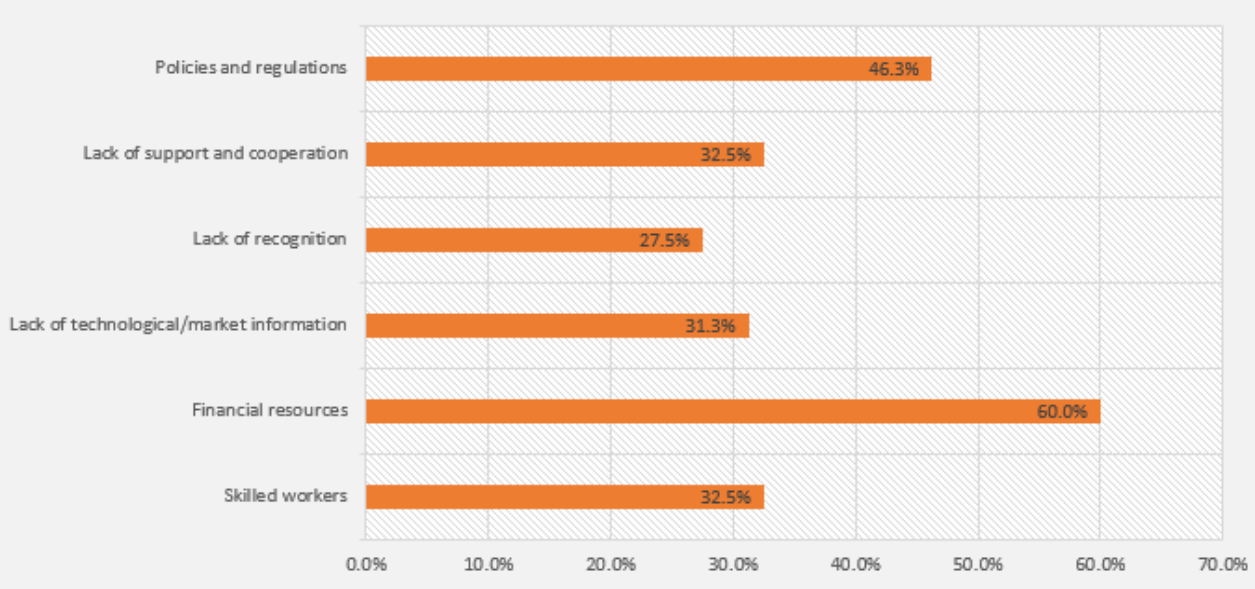

Figure 4: Barriers to investing in technological innovations according to the SMEs (Q15)

Then secondly, the factor financial resources was expected to significantly affect the extent to which the firm would invest in technological innovations. Based on the existing literature (Kazemargi & Spagnoletti, 2020) and previous research by Gherghina et al (2020), hypothesis 2 was constructed:

H2: Financial constraints have a significant impact on the extent to which SMEs invest in technological innovations.

Based on SMEs' responses to the last question in the survey, the financial resources/capabilities factor was seen by 48 SMEs as a limiting factor for the extent to which they invest in technological innovations (see figure 4). This is therefore seen as the biggest barrier by SMEs when investing in technological innovations. These results compare well with those from previous studies (Tarutė & Gatautis, 2014; Caloghirou et al., 2017), because these results also showed that financial constraints was precisely one of the biggest limiting factors for SMEs. The univariate Spearman's rank test found a positive but moderate correlation between the factor financial resources and experiencing barriers in the past. Moreover, the p-value of this correlation was below the significance level of 0.05 and thus significant (p-value < 0.05). However, the multivariate analysis showed that the factor financial resources had an odds ratio of Exp(B) = 0.740, meaning that the less the SMEs considered obtaining financial resources as a barrier, the less likely it was to have previously experienced barriers in technological innovations.

Nevertheless, this finding was not significant (p-value > 0.05). So, the univariate test did find a significant effect between the factor financial resources and the dependent variable and the multivariate test – where multiple factors are considered and they may influence each other – found no significant effect. Therefore, in this study there is not enough evidence and support to accept H2.

It was also expected prior to the research that a lack of knowledge about the market in which the SME operates or the required technology, will affect the SME's ability to innovate in technology. Based on this, hypothesis 3 was constructed.

H3: A lack of information about the market and technology has a significant effect on the extent to which SMEs invest in technological innovations.

The factor lack of information was identified as a hindering factor by 25 out of the 80 SMEs in question 15 of the survey. This corresponds to 31.3% of the SMEs considering a lack of information about the market and the relevant technology as a barrier to investing in technological innovations (see figure 4). The univariate test found a negative and weak correlation between the factor lack of information and the dependent variable (whether SMEs have previously experienced barriers to such innovations). This correlation was also not statistically significant (p-value > 0.05), suggesting that lack of information does not exhibit a strong significant relationship with experiencing barriers. Furthermore, the multivariate analysis found that the factor lack of information has an odds ratio of Exp(B) = 0.964. This indicates that an increase in the perception that lack of information is not an obstacle is associated with a 3.6% lower likelihood of experiencing barriers. However, this finding also has a p-value above the significance level and is therefore not statistically significant. So given the results from both analyses from this study, there is no significant evidence to conclude that a lack of information about the market and technology significantly affects the extent to which SMEs invest in technological innovations and H3 is thus not supported.

In addition, based on the literature (Gambatese & Hallowell, 2011; Talegeta, 2012; Duarte et al., 2017), it was expected that a failure to recognise or a lack of recognition would also be an inhibiting factor on the extent to which SMEs invest in technological innovation. Based on this, hypothesis 4 was formulated.

H4: A lack of recognition to innovate have a significant effect on the extent to which SMEs invest in technological innovations.

This factor was identified as a hindering factor by 22 out of the 80 SMEs in the final question of the survey. This represents 27.5% of SMEs who believe that a lack of recognition for innovation has a limiting influence on the extent to which SMEs invest in technological innovations (see figure 4). The univariate Spearman's rank test revealed that this factor has a very weak and negative correlation with the dependent variable (whether SMEs have previously experienced barriers to such innovations). Moreover, this correlation had a p-value higher than the significance level, indicating that there is no significant relationship. Furthermore, the multivariate logistic regression analysis showed that the factor lack of recognition had an odds ratio of Exp(B) = 1.826. This means that the more an SME emphasises the continuous pursuit of innovations, the likelihood of experiencing barriers to investing in (technological) innovations increases by 82.6%. However, the p-value is higher than 0.05, which means that the effect is not significant. So based on both the Spearman's rank correlation test and the multivariate logistic regression test, there is no significant evidence that lack of recognition to innovate significantly affects the extent to which SMEs invest in technological innovations and thus H4 cannot be accepted as true for this study.

Moreover, a lack of support and cooperation from both inside the organisation and outside the organisation by external business partners was expected to have a negative impact on the extent to which SME will invest in technological innovation. Hypothesis 5 was therefore formulated.

H5: Lack of support and cooperation have a significant effect on the extent to which SMEs invest in technological innovations.

The factor lack of support and cooperation, like the factor skilled workers, was considered by 26 SMEs as a hindering factor in investing in technological innovations. This gives a percentage of 32.5% who feel that lack of support and cooperation affects the extent to which the SME invests in technological innovation (see Figure 4). The univariate Spearman's rank shows in section 4.3 a weak but positive relationship between the dependent variable - whether SMEs have previously experienced barriers to technological innovations - and the factor lack of support and cooperation. But this relationship is not significant as the p-value is higher than the significance

level. The multivariate analysis showed that this factor had an odds ratio of Exp(B) = 0.977. This means that the more support and cooperation within and outside the organisation is experienced by the SME, the lower the probability (decrease of 2.3%) that the organisation was more likely to have experienced barriers in investing in technological innovations. However, again the p-value is not significant. So based on the results of the two analyses, it cannot be assumed that the factor lack of support and cooperation significantly affects the extent to which SMEs invest in technological innovations.

The final factor examined in this study was the influence of policies and regulations on the extent to which SMEs invest in technological innovations. This was expected to have a serious impact on both encouraging and hindering SMEs' technological innovativeness. Based on this, the following hypothesis was therefore formulated.

H6: Policies and regulation have a significant effect on the extent to which SMEs invest in technological innovations.

This factor was identified by SMEs as the second most limiting factor in the final question of the survey. A total of 37 out of the 80 SMEs that participated in the study indicated that the factor policies and regulations influences the extent to which SMEs invest in technological innovation. This accounts for 46.3% of respondents, as shown in Figure 4. The univariate test already revealed that the factor policies and regulations had a weak and negative correlation with the perceived barriers experienced in the past. However, the associated p-value was not significant at the 5% level. The output of the multivariate analysis in Table 9 showed that this factor, in relation to the dependent variable, had an odds ratio of Exp(B) = 0.774. This result indicates that an increase in the perception that policies and regulations are not an obstacle is associated with a 22.6% lower likelihood of experiencing barriers. However, the p-value in this analysis was also higher than the 5% significance level, making this finding statistically insignificant (p-value > 0.05). Therefore, based on both the univariate and multivariate analyses, this study cannot conclude that the factor policies and regulations has a significant role in the extent to which SMEs invest in technological innovations, and H6 cannot be accepted.

5. Discussion

This discussion chapter further explains some of the remarkable findings and discussion points from the results section and provides possible explanations for the results. The discussion section will be followed by a conclusion and acknowledgements chapter.

5.1 Interpretation key findings

This study investigated which factors could potentially constrain SMEs' investment decisions in technological innovations. This was done using two tests, namely the Spearman's rank correlation test that assesses the strength and direction of the relationship between the variables and a multivariate test in the form of a logistic regression analysis that assesses the aggregate influence of the independent variables on the binary dependent variable. The results of both tests show that the factor financial capabilities and resources has the greatest influence on the level of investment in technological innovations, followed by the factor policies and regulations. The other factors were found to have a lesser influence on the dependent variable.

This study found that the factor of financial capabilities and resources is perceived as the biggest limiting factor by SMEs wanting to invest in technological innovations. This result of financial factors having the greatest influence on investment decisions is in good agreement with previous studies on this phenomenon. Indeed, the results of other studies (Indrawati et al., 2020; Caloghirou et al., 2017; Tarutė & Gatautis, 2014) also showed that financial constraints have the greatest influence on the extent of investment decisions. However, what is striking is that in the Spearman's rank test the factor financial resources/capabilities is significant (significance level of alpha 5%) and in the logistic regression test this factor is (just) not significant, which is obviously a contradictory finding. A possible explanation is that the Spearman's rank correlation test purely measures the binary relationship between the two variables without taking into account the influence of the other variables. The multivariate logistic regression test also measures the influence of other independent factors. These other factors may also influence the relationship between financial capability/resources and investment in technological innovations. Therefore, the near-significant value in the logistic regression suggests that financial capability and resources do play a role, but their impact is influenced by the other factors in the model. Another remarkable point from the results section is that the Spearman's rank correlation matrix in Table 7 shows that the factors lack of recognition to innovate and financial

resources/capabilities correlate significantly with each other. In this study, these two constraining factors are the only two independent variables that correlate significantly with each other. There is a negative correlation between these two factors, meaning that when an SME experiences financial constraints and has insufficient financial resources to finance (technological) innovations. This SME suffers less from a lack of recognition to innovate and is thus less likely to overlook innovation opportunities. This is a logical phenomenon because if SMEs want to innovate but do not have the financial resources to do so, they will have to be creative and consider and look at other (cheaper) alternatives. This will actually increase awareness of innovation opportunities, as SMEs will be forced to look differently at how they can achieve their goals within their financial constraints. As a result, innovation opportunities will be less likely to be overlooked.

Further, what is noticeable about the results when looking at some descriptive statistics in table 6, is that 70.6% of micro-sized SMEs indicate that they experience financial constraints. This is therefore the highest percentage for all six factors and for the three different types of SMEs. In addition, it can be seen that as the SMEs become larger in size (micro 70.6%, small 61.9%, medium 47.6%) experiencing the limiting factor financial resources and capability decreases significantly. This can possibly be explained by the fact that smaller SMEs often have fewer financial resources, reserves and less access to external funding. This makes micro-sized SMEs more vulnerable to financial constraints than larger SMEs. It is also often the case that larger companies have greater access to financing opportunities. Moreover, larger established SMEs have a larger financial buffer and can use budgets more flexibly compared to micro-sized SMEs. The same applies for the factor lack of information, although this factor decreases a lot less compared to the financial factor as the SMEs' company size increases. These findings are consistent with previous studies by Hvolkova et al. (2019) and Duarte et al. (2017). In these studies, they also found that the influence of financial constraints significantly decreased as firms grew in size. However, for the factor lack of information, Hvolkova et al. (2019) found just the opposite and the factor actually increased as SMEs grew in firm size, so that just contradicts the results from this study. Medium-sized enterprises experience the policies and regulations factor as the biggest limiting factor. For this factor, experiencing policies and regulations as a limiting factor actually increases significantly as SMEs grow in size. Figure 4 therefore shows that the factor policies and regulations, after financial resources/capability, is considered the biggest

perceived impeding factor by SMEs, this result is therefore in good agreement with previous studies (Indrawati et al., 2020; Talegeta, 2012). In these studies, the influence of the government with its policies and regulations was also one of the biggest limiting factors.

The final striking discussion point from the results chapter is that based on the multivariate test, there is no single variable that has a significant effect or influence on the extent to which SMEs invest in technological innovations. The factor financial resources and capacity came close to a significant effect, but after seeing the output of the logistic regression analysis, even this factor and the associated hypothesis could not be accepted. In the next section, the limitations of this research will be discussed in detail, because like any research paper, this research also has some limitations.

5.2 Limitations

As mentioned in the previous section, this study has a number of limitations that will be discussed in this paper. The first limitation of this study is perhaps also the most striking limitation, namely that none of the factors examined has a significant effect on the extent to which SMEs invest in technological innovations. In fact, based on the existing literature, this study examined six limiting factors that could potentially affect SMEs' investment ability. However, both analyses showed that none of the factors had a significant effect and the hypotheses had to be rejected. This limitation could possibly also be explained by the structure of the study and the survey design. Regarding the survey design, in retrospect it would have been better and easier for the study to make the dependent variable more definable and measurable. The six independent variables were clear and well formulated, especially in the last question of the survey (see Appendix 1, question 15). However, the dependent variable (the extent to which SMEs invest in technological innovation) could have been better formulated into a measurable question in the survey. This would have made later steps in the survey simpler and would also have made running the tests in SPSS better and easier. Furthermore, based on the descriptive statistics it is true that mainly SMEs from the manufacturing and construction sector and mostly work with machinery were approached. In fact, 49% of the SMEs were from the engineering, manufacturing and construction sector. As a result, the sample in this study might have been a little too homogeneous. This might ensure that the results of the study are not generalisable to all the SME companies. So basically, a wider and more heterogeneous sample size may provide new

insights and make it more generalisable in a subsequent study. Moreover, the survey questions mainly consisted of self-assessment questions, where SMEs had to rate and assess themselves. These data are thus based on self-reporting, so it could be the case that some data have been affected by bias and SMEs are outperforming or not completely honest. This could potentially affect the accuracy and reliability of the survey results. Also, some questions in the survey were somewhat suggestive and it would have been easier to formulate the questions more clearly so that they were also more measurable. In retrospect, it would have been better to rephrase some of the questions or replace them with other questions. This emerged especially when running the tests in SPSS. The survey design along with the measurability of the dependent variable was therefore a serious limitation in this study. Another limitation is that, based on question 4 from the descriptive statistics (whether SMEs have previously experienced barriers to technological innovations and, if so, which ones), it was found that in addition to the six factors investigated in this study, there are some other factors that have a significant impact on the level of investment in technological innovations. Indeed, figure 4 showed that a lack of time, after financial constraints, is seen as the biggest limiting factor and has prevented SMEs from investing in such innovations in the past. So, there are many other factors that have hampered SMEs in the past that were not included in this study including lack of time. Lastly as a final limitation, using a survey as a quantitative research method gives limited depth to the insights obtained. Moreover, completing the survey is a cross-sectional method and therefore a snapshot. A longitudinal survey might have observed changes over time, giving a better understanding of how constraints in technological innovations evolve as time proceeds. These are then also the suggestions for any follow-up research on technological innovation at SMEs. In short for a next study, researchers might consider taking a larger and more heterogeneous sample, combining quantitative and qualitative research methods and using a longitudinal study. Furthermore, it is also advisable to conduct sector-specific analyses to understand how barriers to technological innovation vary across industries.

5.3 Practical recommendations

This study found that the factor financial resources is the biggest limiting factor for SMEs willing to invest in technological innovations and also the only factor significantly correlated with the extent to which SMEs invest in technological innovation. In particular, smaller SMEs indicated in

the survey that they perceived this as a major stumbling block. Moreover, a large proportion of survey respondents indicated that obtaining financial resources was a hurdle for the organisation. One-way SMEs can overcome this hurdle is to look at other alternatives to obtain financing besides the traditional bank loans, such as venture capital, business angels, grants and crowdfunding. For financing early-stage SME innovations, business angels are well suited because, in addition to bringing in money, they also bring with them a wealth of knowledge and entrepreneurial experience and often have a large network that can be deployed. However, business angels are not always easy to find. In addition, SMEs should look closely at the financial support programmes and grants offered by the government. These opportunities exist to encourage innovation in organisations. Many organisations do not know about the existence of these support programmes and grants, so these opportunities should be actively explored and if possible, applied for. In this process SMEs may consider using a financial and/or legal advisor who specialise in obtaining funding for technological innovations. These institutions can help identify the best funding options and assist with funding applications. In addition, these experts can also provide advice on complex laws, regulations and other legal issues. This will reduce legal risks and prevent any potential problems. Another recommendation for SMEs that can boost technological innovations is to invest in training and development programmes. As an SME, investing in training and development programmes will improve and boost the technological knowledge and skills of employees. Moreover, this investment also tackles the problem of a lack of skilled workers. Because whenever a group of skilled workers falls away, there are plenty of other skilled workers who can fill this gap with their technological knowledge. This prevents the technological knowledge and expertise from resting with only a small group of workers and instead, multiple workers possess these technological skills. In addition to - or in combination with - investing in training and development programmes, it is also highly recommended for SMEs to cooperate with high schools and universities. This is often a relatively low-cost way to enhance and strengthen the technological innovation capabilities of SMEs. One way to do this is to offer internship programmes and graduation projects. Besides being cost-effective for SMEs, these collaborations with high schools and universities also offer other benefits. Namely, attracting young and talented individuals who can help implement technological innovations. But besides collaborating with high schools and universities, as an SME it is also highly advisable to form partnerships with other (larger) companies. Indeed, by entering into strategic partnerships

with other companies, SMEs can benefit from shared resources, expertise and knowledge. This can help them implement technological innovations and strengthen their competitive advantage. For instance, with the help of partnerships, SMEs could gain access to advanced technologies and networks of larger companies and this knowledge could be easily exchanged. In addition, such partnerships can facilitate access to new markets which can lead to cost savings for SMEs. So, in a nutshell, such partnerships are a good and cost-effective way for SMEs to strengthen their innovation capacity. Thus, by implementing these recommendations, SMEs can reduce their constraining factors regarding technological innovations and increase their competitiveness in the market.

5.4 Theoretical recommendations

Besides the recommendations for companies and SMEs, there are also a number of recommendations for science and literature. In this master thesis, research has been conducted on SMEs' innovation behaviour in the field of technology and what barriers influence these investment decisions. A recommendation for science and possible follow-up research is to further refine the research by investigating specific sectors or regions within SMEs. This is due to the fact that some sectors in which SMEs operate are more affected by technology and investment in it, than other sectors in which technological innovation is not as big a thing. An additional recommendation here is to use a longitudinal study to better track the dynamics of technological innovation in SMEs over time. Indeed, as a researcher, a longitudinal study allows you to better understand trends and changes in innovation strategies of SMEs. Moreover, a follow-up study could also specifically examine innovation behaviour by size (micro, small and medium-sized enterprises). This ensures that you compare SMEs on a more equal footing and makes the research with its results more precise and accurate. And finally, future research could also look at the influence of new technologies, such as AI and Blockchain, on innovation processes among SMEs. This is because these new technologies are partly responsible for the rapidly changing technological landscape and this therefore opens up new opportunities in terms of the innovation process. Examining these new technologies on SMEs' innovation behaviour offer new insights and may be of value to existing science and literature.

6. Conclusion

This research investigated the factors that limit and hinder SMEs from investing in technological innovations, focusing on the research question: "*What factors constrain SMEs from investing in technological innovation?*" To answer this question, a Spearman's rank correlation matrix was used in combination with a logistic regression analysis to examine the constraining factors and assess whether they have a significant relationship with the extent to which SMEs invest in technological innovations.

The results of the Spearman's rank correlation tests revealed that limited financial capability is the only factor with a significant correlation to the level of SME investment in technological innovations. Additionally, the analysis showed that the factor financial resources has a significant negative correlation with the factor lack of recognition to innovate. This suggests that SMEs that view financial resources as a barrier are less likely to perceive lack of recognition as an issue. A possible explanation for this is that SMEs experiencing financial constraints are forced to think more creatively and strategically in order to innovate. This could mean that they are more aware of the need to fully utilise existing opportunities (which are less capital-intensive) and are therefore less likely to overlook potential opportunities. However, the logistic regression analysis, which tested at multivariate level and included the influence of the other variables, did not show a significant effect for an alpha of 5%. Based on the results, it can be said that the factor financial resources and capability is a major barrier to investment in technological innovation. Namely, 60% (48 SMEs out of 80 who participated in the survey) indicated that they perceived this factor as a hindering factor. In particular, micro-sized (70.6%) and small-sized (61.9%) SMEs considered this factor a significant barrier to technological innovation. It can therefore be concluded that larger SMEs face fewer obstacles related to financial resources. This finding is consistent with previous research by Talegeta (2012) and Hvolkova et al. (2019).

For the skilled workers factor, 32.5% of SMEs indicated that a lack of skilled workers was a barrier to their investments in technological innovations. However, both the Spearman correlation matrix and the logistic regression analysis showed that there is no significant effect between the factor skilled workers and the extent to which SMEs invest in technological innovations. However, the finding that smaller firms are more constrained by the lack of skilled workers than

larger firms, was consistent with the findings of Hvolkova et al (2019). So, although a lack of skilled workers was not shown as a significant barrier in either test, it remains an important factor for SMEs' perceptions of barriers to technological innovation.

Similarly, 31.3% of SMEs indicated that lack of market information and technological knowledge was a barrier to investing in technological innovation. The data further revealed that as SMEs grow in size, the influence of this factor diminishes. However, the Spearman's rank correlation matrix showed no significant relationship between this factor and SME investment in technological innovations. Moreover, the logistic regression analysis also showed that there was no significant relationship and thus the corresponding hypothesis could not be accepted.

The same pattern was observed for the factors lack of recognition to innovate (27.5%) and lack of support and cooperation (32.5%). Although these factors may affect SMEs' willingness to invest in technological innovation, both tests found no significant relationship between these factors and the level of investment in technological innovations. Therefore, hypotheses H4 and H5 were not supported by the data.

Finally, 46.3% of SMEs indicated that government policies and regulations affect their investments in technological innovations, making it the most important barrier after financial constraints. However, the Spearman's rank correlation matrix and multivariate logistic regression analysis found no significant effect for this factor. As a result, H6 could not be supported by the findings of this study. However, even though the hypothesis could not be accepted, it remains a serious (perceived) barrier to SMEs.

In summary, this study concludes that, of all the factors studied, the factor financial resources is the biggest limiting factor on the extent to which SMEs want to invest in technological innovations, followed by the factor policies and regulations. However, both the tests showed that none of the factors had a significant relationship or effect on the investment level of SMEs. So, although no direct or significant effect was found, it is always good to keep an eye on these factors and control them where possible.

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Appendices

Appendix I: Survey questions

Geachte Heer/ Mevrouw,

Voor mijn Master Thesis (Business Administration) doe ik onderzoek naar de factoren die kleine en middelgrote ondernemingen (SMEs) ervan weerhouden om te investeren in technologische innovatie. Het doel van deze enquête is om de belemmerende factoren te identificeren om zo SMEs een helder beeld te geven van de mogelijke obstakels die zich voor kunnen doen bij het innovatieproces. Uw antwoorden en respons zullen enorm worden gewaardeerd en als zeer waardevol worden beschouwd. Het invullen van de enquête zal slechts enkele minuten van uw tijd in beslag nemen en is ***volledig anoniem*.**

Q1: Hoeveel werknemers telt het bedrijf?

1. *Minder dan 10 (< 10) werknemers*
2. *Minder dan 50 (< 50) werknemers*
3. *Minder dan 250 (< 250) werknemers*
4. *Meer dan 250 (> 250) werknemers*

Q2: Wat is (naar schatting) de jaarlijkse omzet van het bedrijf?

1. *Minder dan ≤ € 2 miljoen euro omzet*
2. *Minder dan ≤ € 10 miljoen euro omzet*
3. *Minder dan ≤ € 50 miljoen euro omzet*
4. *Meer dan ≥ € 50 miljoen euro omzet*

Q3: In welke sector opereert het bedrijf?

1. *Handel en (zakelijke) dienstverlening sector*
2. *Informatie en communicatiesector*
3. *Techniek, productie en bouwsector*
4. *Agrarische sector*
5. *Transport en logistiek sector*
6. *Anders namelijk; _____*

Q4: Heeft het bedrijf weleens belemmeringen ervaren bij het investeren in technologische innovatie? Zo ja, kunt u deze kort beschrijven?

_____

_____

Q5: Hoe zou U de huidige mate van expertise en vaardigheden van de werknemers op het gebied van technologische innovatie beoordelen?

A) *Onvoldoende: Onze werknemers hebben weinig tot geen kennis of vaardigheden op het gebied van technologische innovatie.*
B) *Matig: Onze werknemers hebben over het algemeen beperkte kennis en vaardigheden op het gebied van technologische innovatie.*
C) *Voldoende: Sommige werknemers beschikken over enige kennis en vaardigheden op het gebied van technologische innovatie*

D) *Goed: Over het algemeen beschikken onze werknemers over solide kennis en vaardigheden op het gebied van technologische innovatie.*
E) *Zeer goed: Onze werknemers hebben uitgebreide expertise en vaardigheden op het gebied van technologische innovatie*

Q6: Ideeën om te innoveren (of om te investeren in innovaties) komen voornamelijk vanuit werknemers/bottom-up

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q7: Het beschikken over onvoldoende vakbekwame werknemers binnen het bedrijf zal ervoor zorgen dat er minder geïnvesteerd zal worden in technologische innovaties

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q8: Het proces van verkrijgen van financiële middelen om te kunnen investeren in (technologische) innovaties vormt geen obstakel voor de organisatie

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q9: Het bedrijf beschikt over voldoende marktinformatie/ technologische kennis en investeert een deel van zijn budget in R&D

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q10: Het bedrijf is constant opzoek naar nieuwe manieren en innovaties om te voldoen aan de steeds maar veranderende marktvraag/klantbehoeftes

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q11: Werknemers binnen het bedrijf staan positief tegenover innovaties en/of technologische verandering

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q12: Het bedrijf werkt op het gebied van innovatie goed en/of veel samen met externe partijen en businesspartners

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q13: De overheid oefent met haar regel- en wetgeving invloed uit op de mate waarin het bedrijf investeert in technologische innovaties

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q14: Over het algemeen heeft de overheid een grotere negatieve invloed dan positieve invloed op investeringen in technologische innovaties

1. *Sterk mee oneens – 2. Mee oneens – 3. Neutraal – 4. Mee eens – 5. Sterk mee eens*

Q15: Welk van de volgende factoren zou U als bedrijf ervan weerhouden om te gaan investeren in technologische innovatie?

- *Gebrek aan geschoolde werknemers*
- *Gebrek aan financiële middelen*
- *Gebrek aan technologische/marktinformatie*
- *Gebrek aan herkenning*
- *Gebrek aan ondersteuning en samenwerking*
- *Beleid en regelgeving*

Appendix 2: Answers on survey questions

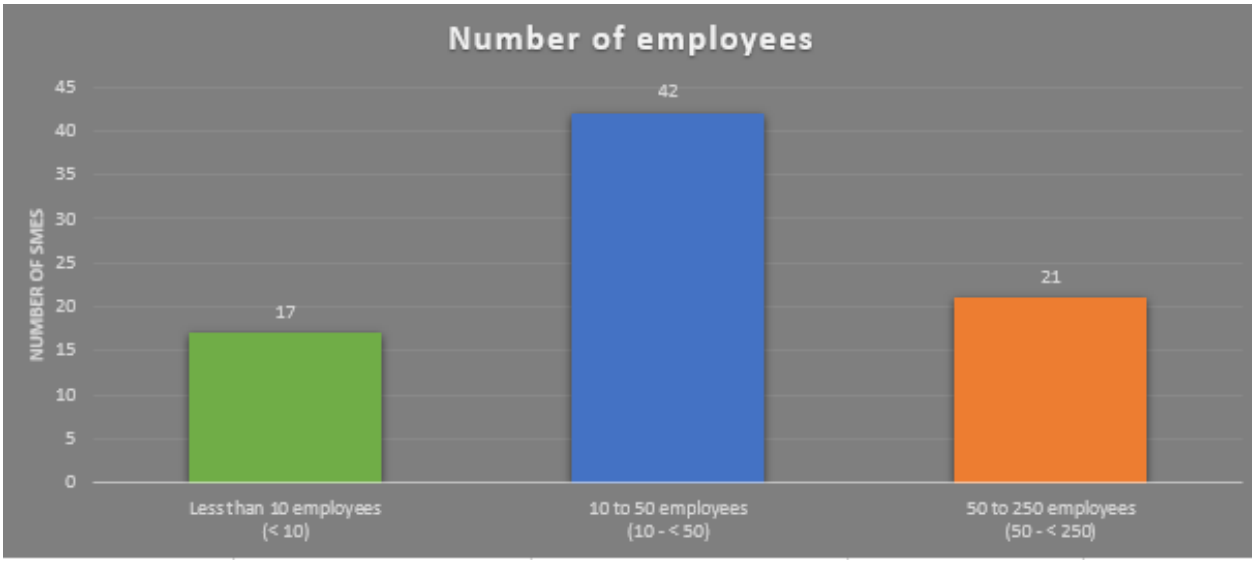

Figure 5: Number of employees within the SMEs (Q1)

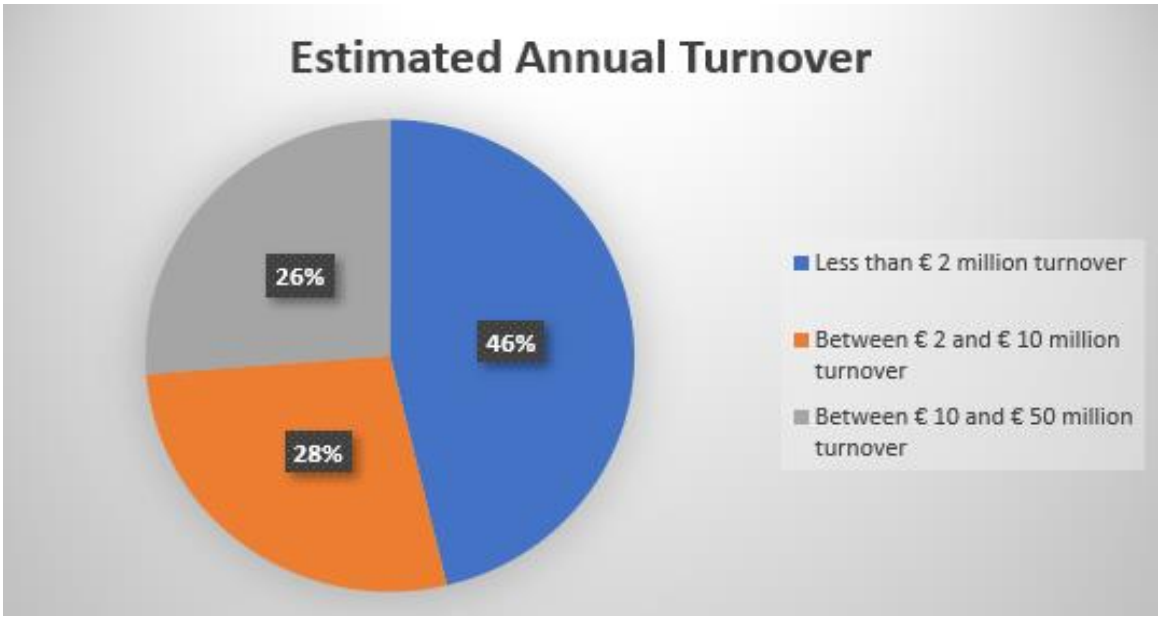

Figure 6: Estimated annual turnover SMEs (Q2)

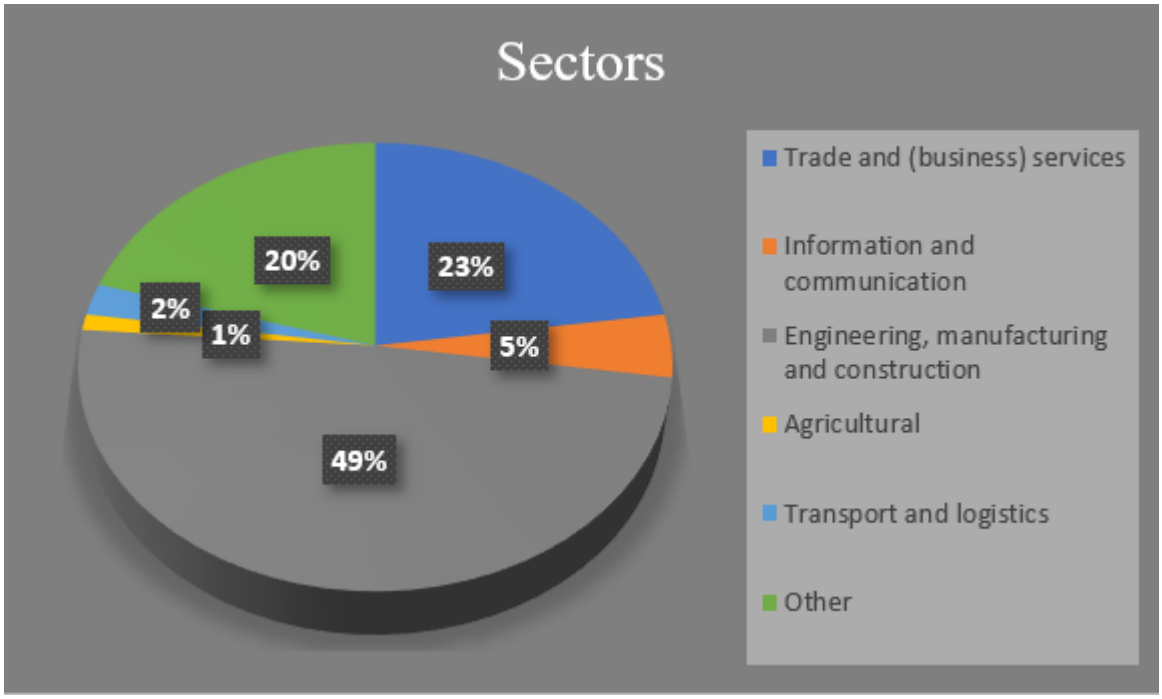

Figure 7: Sectors where the participated SMEs operate (Q3)

Heeft het bedrijf weleens belemmeringen ervaren bij het investeren in technologische innovatie? Zo ja, kunt U dit kort beschrijven?
Nee
Ja, door bijv beperkte omzetgroei, te weinig financiële middelen.
Ook door het moederbedrijf, die geeft de strategie aan en welke ruimte er is voor investeringen.
nee
Gebrek aan tijd en specifieke expertise om technologie te vertalen en toe te passen.
Nee
Nee niet ervaren, wij vragen altijd zelf subsidie zoals WBSO aan. En dit verloopt altijd vrij eenvoudig.
Ja, investering werkte niet naar behoren of zoals gewenst.
Technologische innovatie gaat ons inziens altijd gepaard met belemmeringen, maar wij zien dat als uitdagingen.
Een goede timing, product/markt combinatie en bijbehorende financiering zijn hierin lastiger dan een goed idee technologisch uitwerken.
Technologisch is tegenwoordig heel erg veel mogelijk, als je een beetje de weg weet.
Nee, wij hebben geen belemmering gehad.
Nee
Bureaucratie bij subsidieprojecten voor innovatie
Ja, €
nee
Nee
Nee
Nee
Nee
Wij zijn een NL verkoopkantoor van een internationale multinational.
Innovaties vinden met name plaats op onze R&D locaties en worden gevoed uit de markt.
Mijn antwoorden zijn op de complete organisatie gebaseerd.
Tot op heden niet, vrij recent gestart.
Wij moeten steeds de nieuwste technologie hebben voor onze bedrijfsopleidingen.
Nee
Nee
ja
Nee
Ontbreken van voldoende middelen (geld/machines/docententijd)
financiele middelen die niet ter beschikking staan belemmerd ons
Nee
Nee
Ik heb in het verleden ervaren dat de aandeelhouders niet inzagen dat een investering in nieuwe processen
d.m.v. interne automatisering een uiteindelijke besparing zou kunnen opleveren.
Het invoeren van Gatewise, een digitaal hulpmiddel voor ERP systemen.
We zouden hier licenties moeten aanschaffen en dan ook nog werk voor onze leveranciers moeten doen.
Gebrek aan kennis. Te weinig investeringsruimte
Kapitaal om te kunnen investeren
beperkt kapitaal beschikbaar om snel stappen te maken, lange visum aanvraag processen
niet echt
Ja zeker, bijvoorbeeld capaciteit of beschikbaarheid developers. Of het vinden van nieuwe developers.
Bij elke innovatie bestaat een belemmeringen, maar er is niet een zodanige belemmering geweest wat de desbetreffende innovatie heeft stilgelegd.
ja, tijd
nee
Wij ontwikkelen innovatieve installaties, waarbij financiering een uitdaging is.
Nee
Nee
Niet echt
Langdurig administratief proces bij m.n. subsidie projecten
Belemmering door regelgeving, beperkte kennis van de materie, risico's uit de markt die investeringen tegen houden.

Nee, geen belemmeringen ervaren in het verleden.
Tijdgebrek, investeringsomvang
Bij het ontwikkelen van een product of het maken van maatwerk voor een opdrachtgever kost veel tijd.
Verwachtingsmanagement is daarin belangrijk maar gaat niet altijd goed, alles kost meer tijd en investeringen dan gedacht.
Dit en gebrek aan resources en mensen is een van de belangrijkste belemmeringen.
Mogelijke belemmering I: ROI te lang.
Nee
Ja, vaak verloopt het implementatieproces niet gemakkelijk en moeten ook werknemers wennen aan het werken met nieuwe machines.
Dit kost in het begin veel tijd.
Nee
Jazeker, machines die niet goed werken waardoor je juist meer verliest dan dat het opbrengt
Nee
De verschillende opties van platformen die we nodig hebben voor het centraliseren van alles
Wil graag investeren echter staan de prijzen zo onderdruk dat we niet kunnen investeren
Ja, lopen hierbij nogal eens tegen het feit aan dat producten beschermd geregistreerd staan.
Digitalisering dmv vernieuwde op maat gemaakte database
Nieuwere technologieën verschillende systemen wat beter is voor het milieu dat er niet doorheen komt door de kosten wat eraan vast komt te hangen
Ja nieuwe verbeterde verfsystemen die langer mee gaan en beter zijn voor het milieu
Druk op de huidige projecten. Innovatie kost tijd en die is er niet.
Zovaak. Mensen moeten willen innoveren, bedrijven die gekoppeld moeten worden moeten dat ook willen
Niet zozeer bij het investeren, maar wel bij de implementatie.
Wij hebben geïnvesteerd in een CRM systeem waarbij intern draagvlak enorm belangrijk is.
Dit heeft enige tijd geduurd om alle medewerkers hier gedisciplineerd mee aan het werk te krijgen.
Onmogelijk om diverse software aan elkaar te koppelen.
Elke verandering levert weerstand op binnen het team, maar uiteindelijk geen echte belemmeringen ervaren
Nee
Mate investeringen in innovaties is afhankelijk van de behaalde omzet
Nee
Het werken met nieuwe kassasystemen kan soms leiden tot onduidelijk heden voor werknemer/klanten.
Bezorgauto's/bezorgscooter die niet soms niet werken naar behoren.
Nee
Ja, financiele belemmeringen door hoge investeringskosten. Daarnaast kost het veel manuren
nee
Nee
Nee
Bij het inkopen van technologie zijn vaak start-ups betrokken die vaak snel geld willen verdienen,
maar niet snel op kunnen schalen ivm organisatiegrootte en arbeidskracht.
Ja, bij de ontwikkeling van ons eigen klantenportaal.
Dit heeft aanzienlijk langer geduurd dan gepland en het uiteindelijke product is ook afgeweken van het geplande product.
Conservatieve medewerkers
Nee
Financiele belemmeringen. Deze processen gaan soms met hoge kosten gepaaard.
Daarnaast ontbreekt het in bedrijven vaak aan kennis, denk hierbij bijvoorbeeld aan AI
Mismatch bij partners en de industriële tak

Figure 8: Previously experienced barriers to technological innovation (Q4)

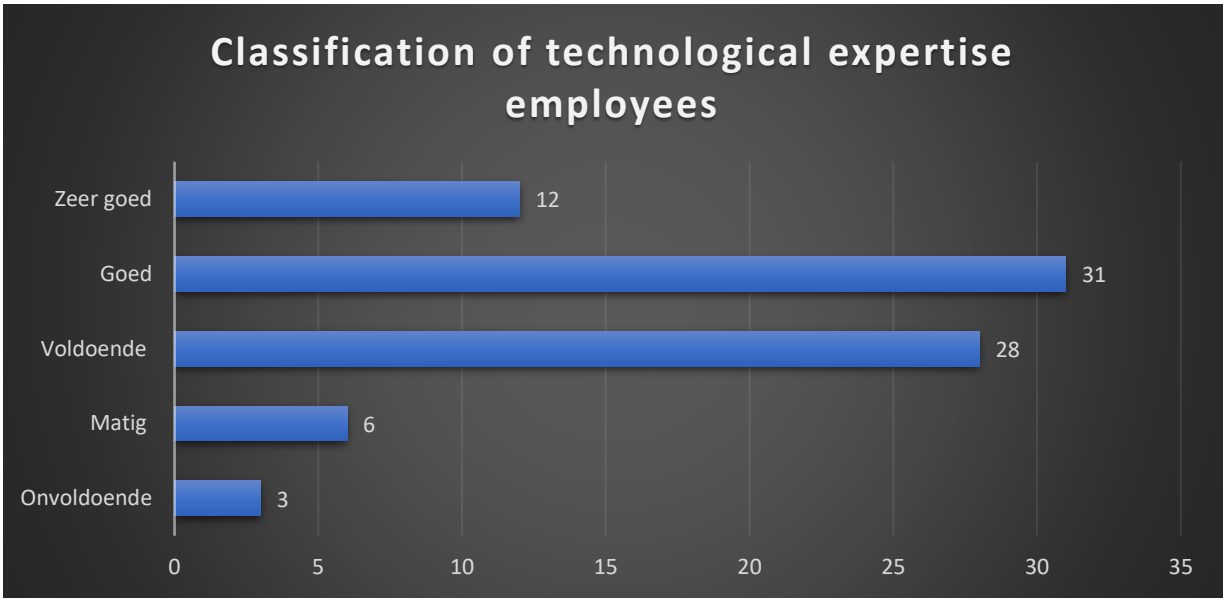

Figure 9: Classification of technological expertise (Q5)

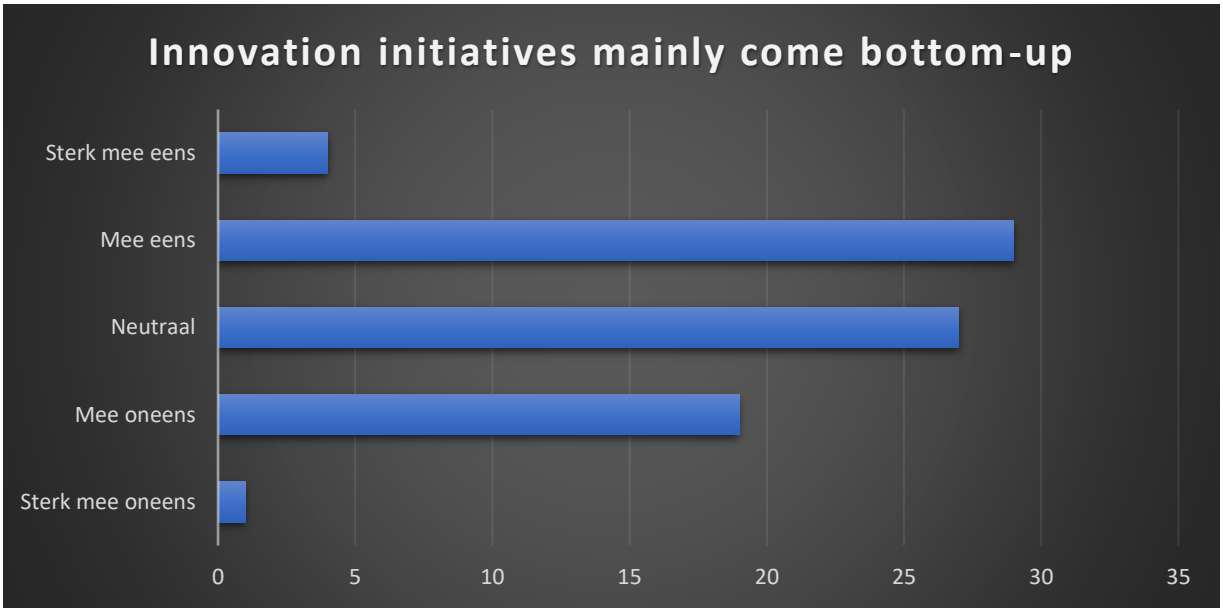

Figure 10: Innovation initiatives come from bottom-up (Q6)

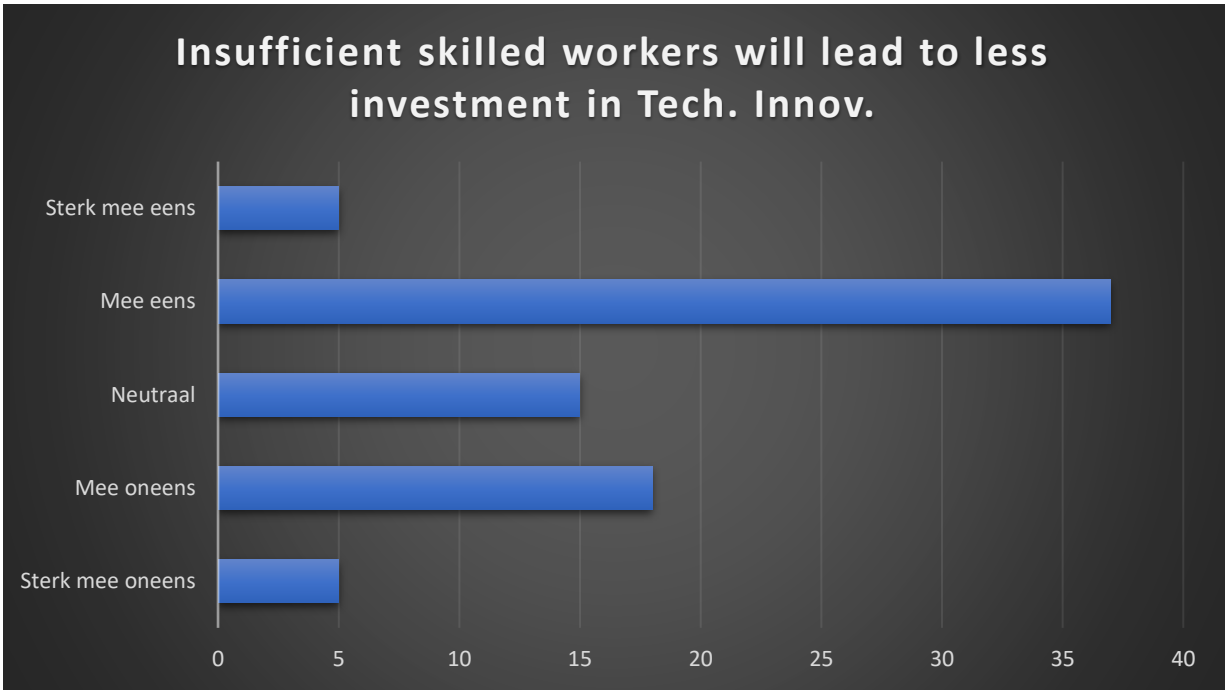

Figure 11: Insufficient skilled employees lead to less tech. innovations (Q7)

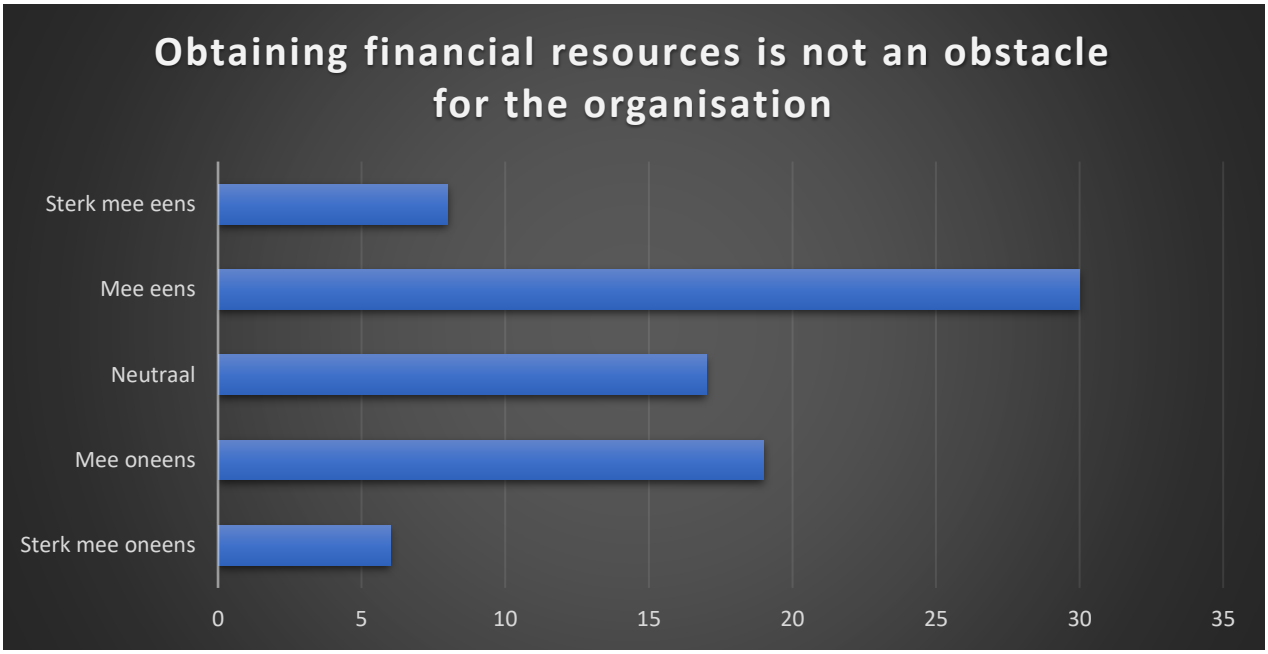

Figure 12: Financial resources as an obstacle for the organisation (Q8)

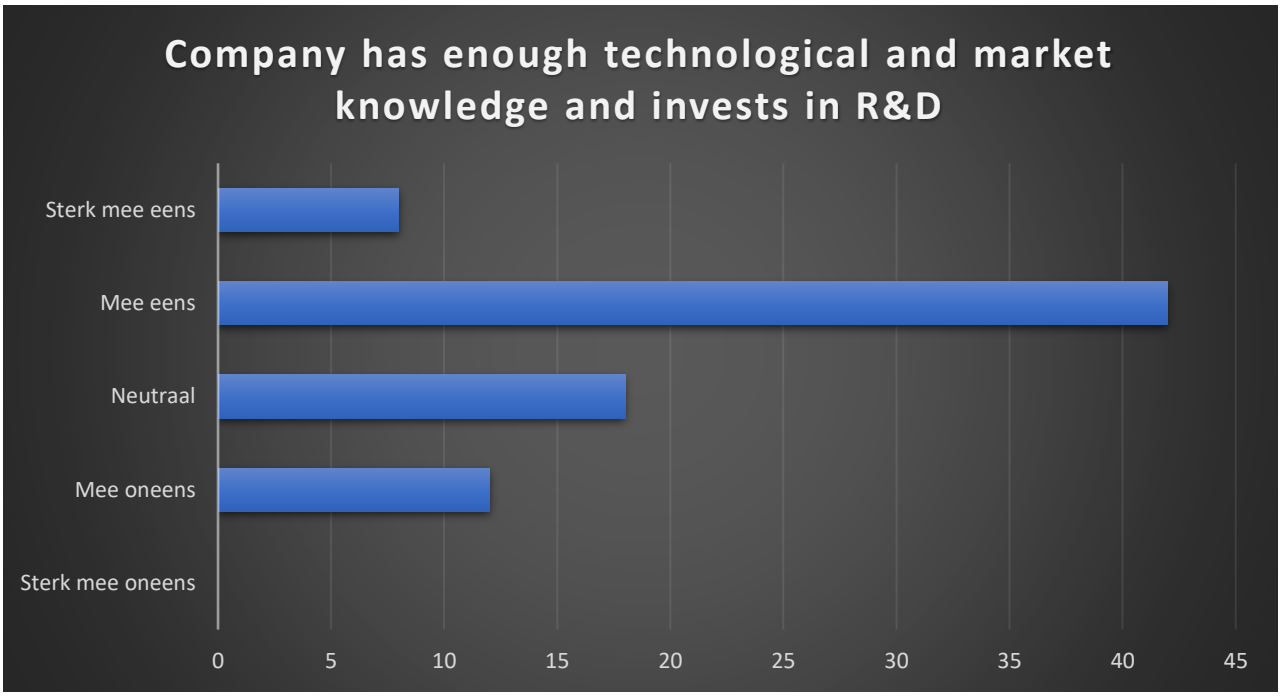

Figure 13: Technological/market knowledge and investments in R&D (Q9)

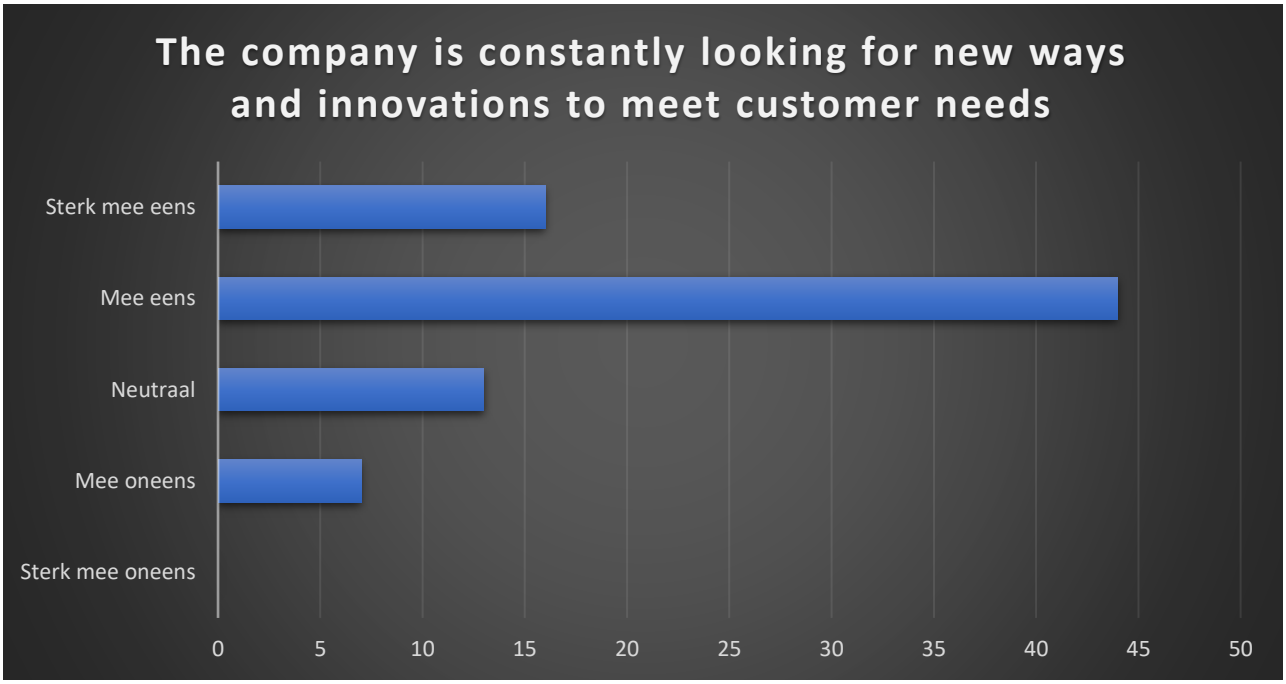

Figure 14: Recognising innovation opportunities (Q10)

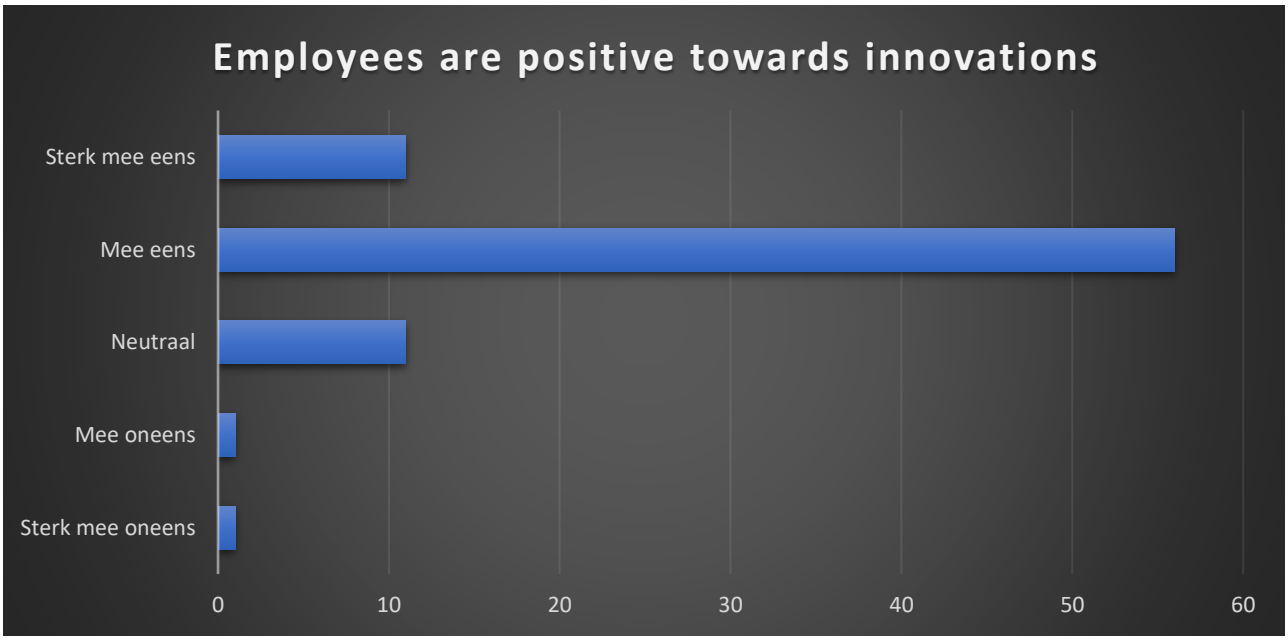

Figure 15: Attitude of employees regarding innovations (Q11)

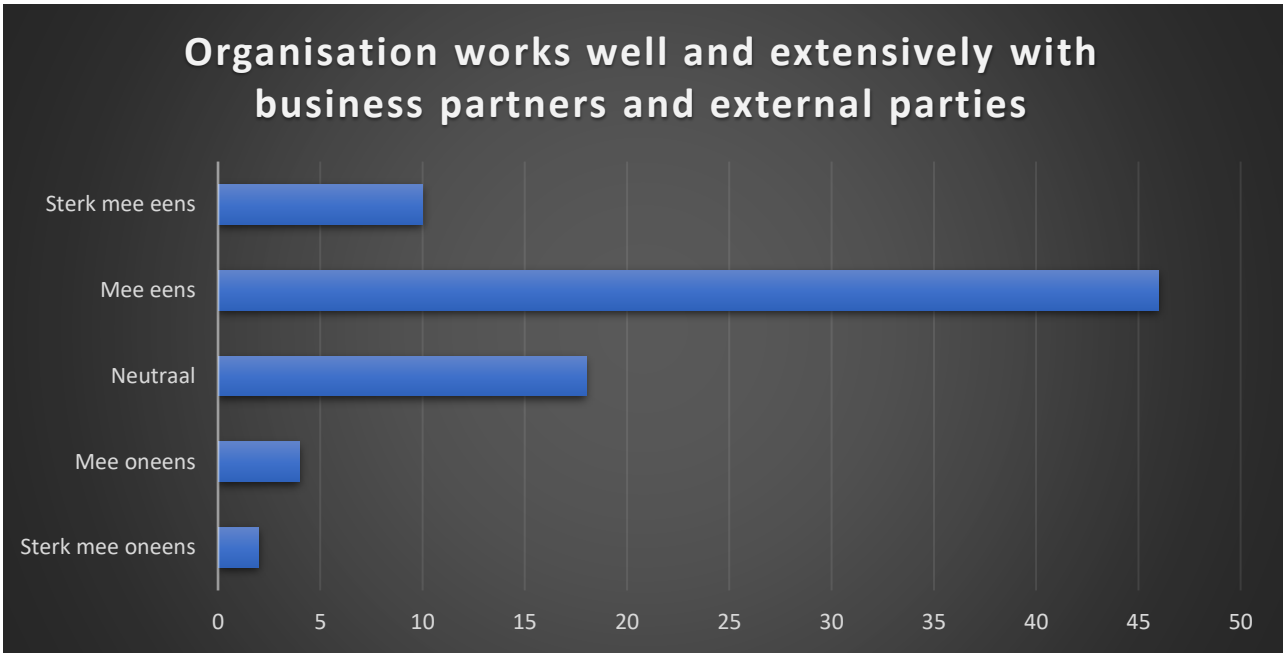

Figure 16: Collaborating with business partners and external parties (Q12)

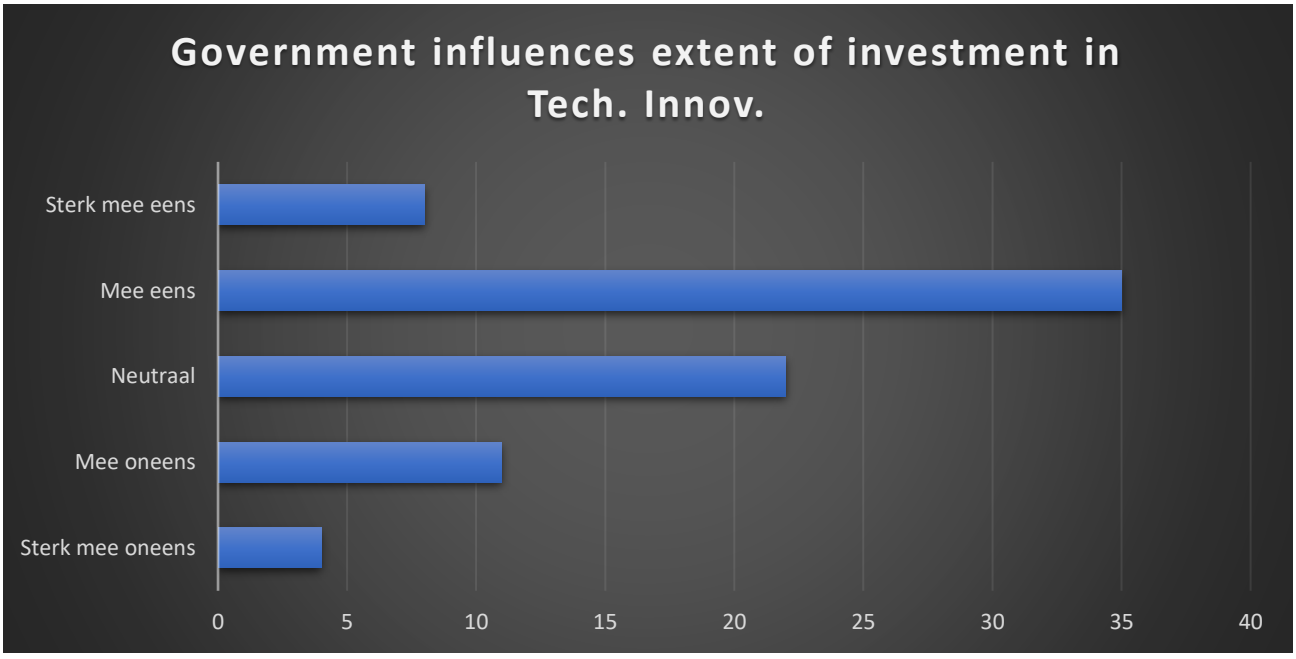

Figure 17: Influence of policies and regulations on technological innovation (Q13)

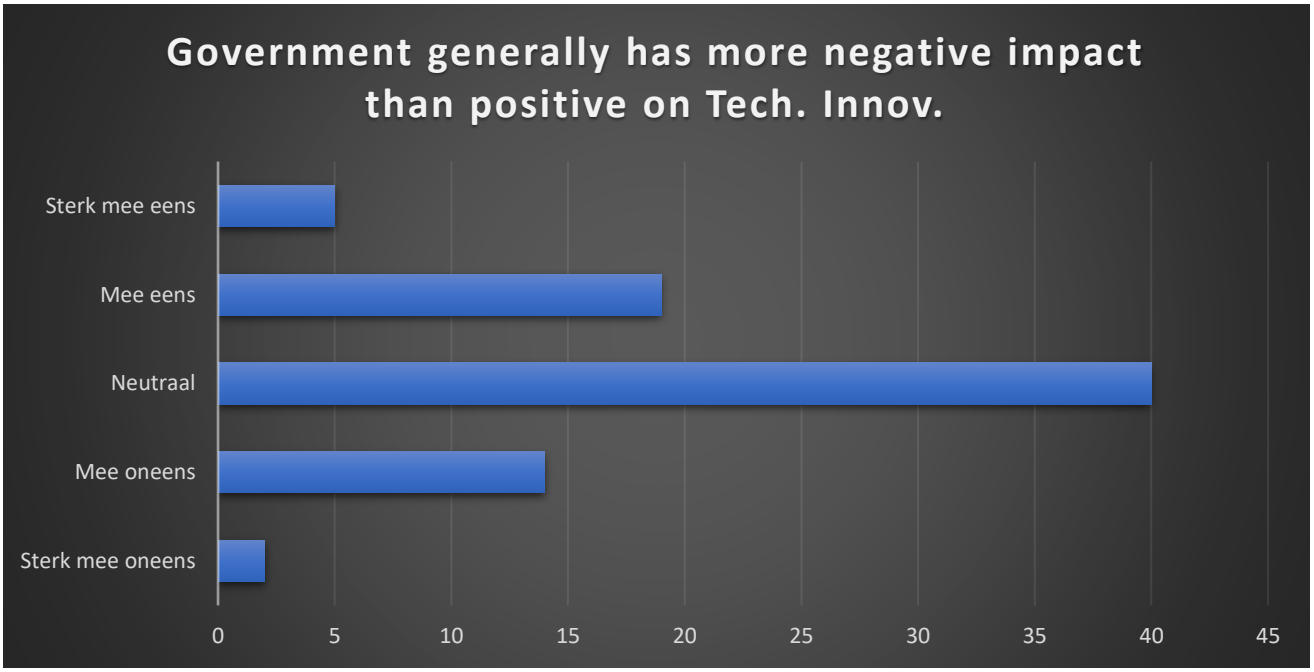

Figure 18: Government influence has a more negative impact (Q14)

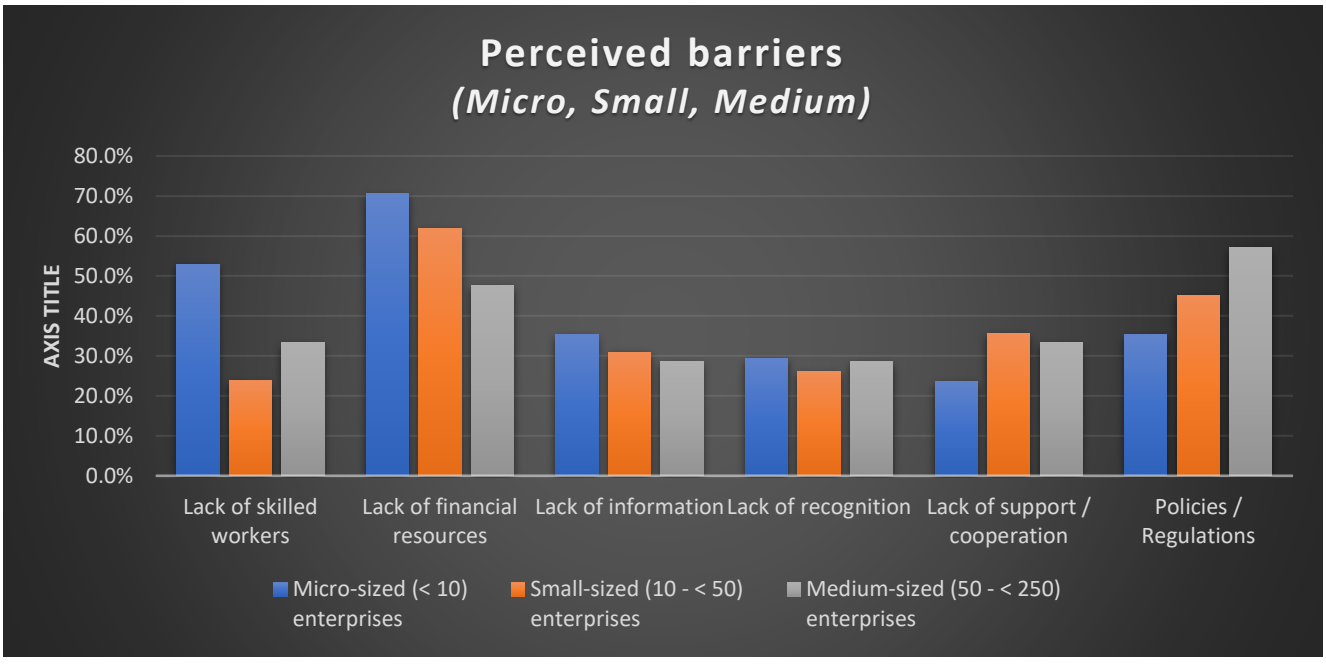

Figure 19: Perceived barriers for every type of SME (Q15)