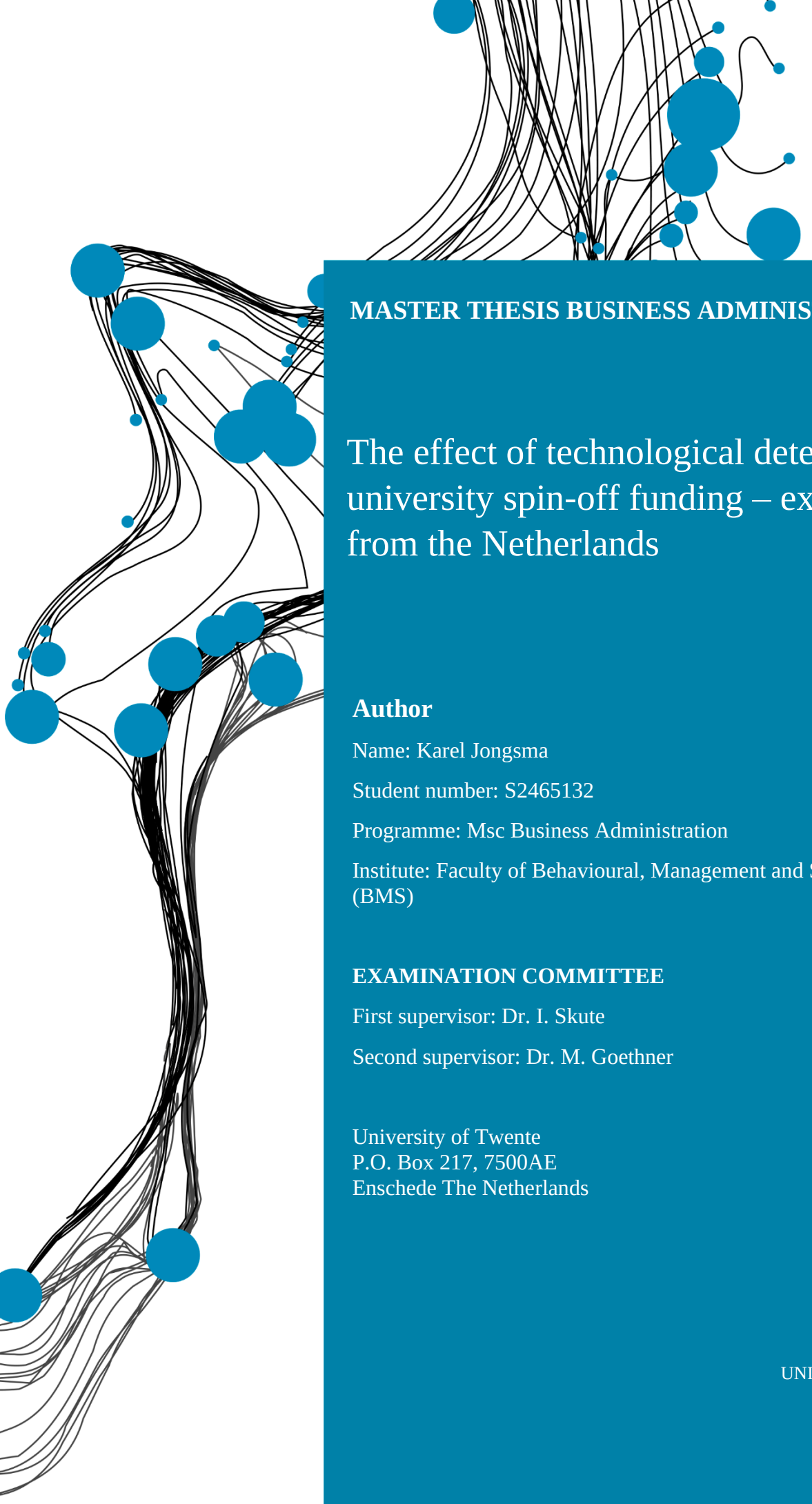

MASTER THESIS BUSINESS ADMINISTRATION

The effect of technological determinants on university spin-off funding – examples from the Netherlands

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Abstract

University spin-offs (USOs), ventures which are based on publicly funded research, are one of the most direct and visible forms of the commercialization of scientific knowledge. Because of their potential economic value and positive impact on our society policymakers have developed a growing interest to support USOs. However, many early-stage USOs fail to achieve firm growth and are not successful in creating economic impact because they have difficulties with the obtainment of funding. This paper describes the effect of technological determinants on the obtainment of governmental funding by analysing a sample of 109 proposals which were filed for the valorisation grant. The data was collected using content analysis based on a fully aggregated and anonymized data set. Binary logistic regression was used as statistical test in order to analyse our data. The results indicate that two of our tested variables seem to be positive and significant. First of all we found a positive and significant effect of radicalness of technology on the obtainment of funding. The results indicate that USOs that develop radical technologies in combination with radical business models are more likely to obtain funding. Secondly, we found a positive and significant effect of intellectual property, in the form of a patent, on the obtainment of governmental funding. These results indicate that USOs that possess a patent are more likely to obtain governmental funding. Implications of this research contribute towards filling the gap in the literature regarding the topic of firm-level determinants and their influence on the obtainment of funding by USOs. In addition, the results are valuable for academic entrepreneurs and policymakers who seek to broaden their knowledge regarding the influence of technological determinants on the obtainment of USO funding.

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1. Introduction

The commercialization of scientific knowledge is an important mechanism for achieving practical and meaningful results from scientific research, such as economic growth and new products or services (Fini, Rasmussen, Siegel, and Wiklund, 2018; Miranda, Chamorro and Rubio, 2017). One of the most direct and visible forms of this commercialization of scientific knowledge are ventures based on publicly funded research, also referred to as university spin-offs (USOs) (Fini et al., 2018). Although many USOs do not develop into mature companies there are some successful high-tech USOs from the Netherlands, for example Xsens and DEMCON, who were both founded within the university of Twente (University of Twente, 2016).

Because of their potential economic value and positive impact on our society policymakers have developed a growing interest to support USOs. Many countries have established funding programs inspired by the American Bayh-Dole act as a way to stimulate the growth of early-stage USOs by reducing the funding gap (Rasmussen & Sørheim, 2012). According to Pattnaik and Pandey (2014) USOs are enablers of economic development, they provide business opportunities which are translated into workable technologies leading to market solutions. In addition, USOs also tend to be a catalyst for the formation of geographic clusters of firms regarding a particular technology (Fini et al., 2018; Pattnaik & Pandey, 2014). Beside their contribution to economic development USOs also play an important role in transferring scientific knowledge and inventions into practical application for new technologies (Fini et al., 2018; Rasmussen & Sørheim, 2012; Pattnaik & Pandey, 2014).

In order to support this commercialization of scientific knowledge and academic entrepreneurship many universities have established structures such as technology transfer offices (TTOs), science parks and incubation centers (Perkman et al., 2013). However, many USOs seem to have a modest growth and performance and fail to have a significant economic impact (Fini et al., 2018). This is also emphasized by Mathisen and Rasmussen (2019) who state that there are scholars that question the impact and importance of USOs. These scholars support the claim by Fini et al. (2018) who state that most USOs are predominantly small firms with negligible growth and limited economic impact.

One of the reasons that most USOs fail to achieve firm growth and economic impact may be the fact that early-stage USOs struggle with attracting funding. New ventures face the liability of newness and smallness which block their access to resources, for example financial capital (Rasmussen and Sørheim, 2012). According to Rasmussen and Sørheim (2012) USOs have difficulties attracting investors until the technology and market potential is identified. Therefore USOs find it hard to obtain funding in their early existence. Investors are reluctant when it comes to investing in early-stage USOs because of their high uncertainty and long payback times (Rasmussen & Sørheim, 2012). This is also underlined by Sørheim, Widding, Oust, and Madsen (2011) and Galati, Bigliardi, Petroni and Marolla (2016) who state that financing USOs is reported as the main restriction in the creation of successful ventures. The consequences of this funding gap ensures that USOs often don't have enough resources to scale and reach a sustainable market position (Rasmussen & Sørheim, 2012). Therefore governmental funding programs are an important source of financing for many USOs. The rationale and effects of these governmental funding programmes however seem to be controversial. The funding initiatives are based on the assumption that the government is able to identify investments that will yield social, private or financial returns. According to Rasmussen and Sørheim (2012) these assumptions are elusive and governmental funding programmes are still highly experimental. Therefore it would be helpful for policymakers, entrepreneurs and universities to get a better understanding regarding determinants that influence the decision making process regarding the obtainment of governmental funding by USO.

1.1 Problem statement

Although allot of research concerning USOs has been executed and policymakers recognize the importance of USOs there are still some unexplored aspects. There seems to be a gap in the literature about the funding process and the corresponding determinants that influence the funding decision of early-stage USO. Also there seems to be a literature gap regarding how early-stage USO can be fostered. As mentioned before allot of USOs have difficulties with obtaining funding until the technology and market potential is identified and therefore fail to achieve significant firm growth (Rasmussen and Sørheim, 2012; Sørheim, Widding, Oust, and Madsen, 2011). Therefore it would be useful to get a better understanding of the early-stage factors that have an influence on the obtainment of USO funding. Why do some USOs obtain governmental funding while others do not? Which factors lead to USO funding success? Druilhe and Garnsey (2004) state that most spin-out research is focussed on the environment and the infrastructure that support USOs. This is also underlined in a more recent literature

review conducted by Miranda, Chamorro and Rubio (2017) where it is clearly visible that there has been paid limited attention to antecedents and factors on firm level regarding financing of USOs. Mathisen and Rasmussen (2019) also emphasize this and state that (1) there is important gap in the literature on the firm level of analysis and (2) that it is still unclear how USOs identify successful business models and how this is influenced by for example technological factors.

Based on the literature it is clear that there has been paid limited attention to technological factors and their influence on USO funding. Since various researchers call for more research on the USO firm- level this study will focus on the identification of USO firm-level determinants, with the centre of attention on technological factors, that influence the obtainment of funding. In particular, based on the literature gap, there is a need to investigate the role of USOs technological and innovative capabilities in combination with strategic commercialization abilities. Therefore this research will explore the influence of technological factors such as radicalness of technology, technology readiness levels and technology leverage competency on the obtainment of governmental funding together with commercial factors such as geographical market segmentation. In order to address the goal of this research the following research question was established:

RQ: Which technological determinants contribute to the USOs chance of obtaining governmental funding?

1.2 Implications

The results of this study will have several implications. First of all the results of this study will contribute towards filling the gap in the literature regarding the topic of firm-level determinants and their influence on the obtainment of funding by USO. This study will complement earlier work by Miranda, Chamorro and Rubio (2017) and Mathisen and Rasmussen (2019) who stated that there has been paid limited attention to firm-level determinants such as technological factors.

The theoretical benefits gained from this study can also be converted into practical implications. A better understanding of factors influencing the funding process will help academic entrepreneurs in their decision making. This knowledge will help them by creating a better understanding of the funding process and which competences they need to develop if they wish to obtain governmental funding.

For policymakers the results of this study will contribute towards the understanding of their own funding process. When the results of this study are combined with research regarding the

survival rate of USOs policymakers will be better able to determine which valorisation grants are worthwhile. This will help them to make a distinction between worthy and unworthy USOs.

1.3 Structure

The structure of this thesis is as follows. Chapter one contains the introduction to this research. Chapter two contains the theoretical framework. Chapter three will discuss the research method and data-analysis. Chapter four will present the results from the data-analysis. Chapter five will contain the discussion and conclusion of this research. Chapter 6 will contain the implications. Chapter 7 will discuss the limitations and future research possibilities of this research. The acknowledgements can be found in chapter 8. The references and appendixes can be found in chapter 9 and 10.

2. Theoretical framework

2.1 Academic entrepreneurship

In the last decades there has been a growing interest regarding research focussed on the understanding of implications and interactions between academics and the private marketplace (Mars and Rios-Aquilar, 2009). Something that is widely recognized in the literature, based on the amount of publications in the past years, is the importance of academic entrepreneurship in relation to technological, economical and societal impact (Skute, 2019). There has been an increased pressure on universities to focus on the so called 'third mission (TM)' (Compagnulli and Spigarelli, 2020; Taheri and van Geenhuizen, 2011). This means that although universities are primarily focussed on teaching and performing research they should also focus on making a contribution to our society. These universities that focus on the TM are becoming important factors that contribute to social, economic and cultural development in the regions they are based (Compagnulli and Spigarelli, 2020). USOs are a way of academic entrepreneurship to realise and commercialize technological breakthroughs which may otherwise remain unexploited and would not be developed any further(van Burg, Romme, Gilsing and Reymen, 2008).

Some universities generate higher numbers of USO than others (van Burg, Romme, Gilsing and Reymen, 2008). There are many factors that influence why some universities produce higher amounts of USOs compared to others. For example, according to Zhang (2009) the role of distinguished scientists play an important role of the amount of USOs established within an university. Many USOs are from top tier research universities and only a small amount from teaching universities or colleges (Zhang, 2009). Fini, Fu, Mathisen, Rasmussen and Wright

(2016) researched the role of TTO's and found out that there is a positive link between the presence of a TTO and the amount of USOs originated from those universities. Van Burg et al. (2008) on the other hand suggest that the university infrastructure and support mechanisms play an important role for the creation of USOs. Van Burg et al. (2008) also mention downsides from the creation of USOs for an university such as conflicts of interests between commercial and academic work and the risk for harm of the universities reputation if the founders act inappropriately.

Within the Netherlands the most entrepreneurial university seems to be the university of Twente. The university of Twente has won the election by Scienceworks, an organization that supports the transfer of scientific knowledge to society, for the fourth time in a row (ScienceWorks, 2020). According to the university of Twente this is due to the pioneering nature of the university, the innotiative power of the Twente system and the contributions made my Novel-T, an organisation that support high-tech innovation and entrepreneurship (University of Twente, 2020).

2.2 Definition of USO

According to Pirnay, Surlemont and Nlemvo (2003) USOs can be defined as new firms created to exploit or commercialize knowledge, technology or research results that are developed within an university. They emphasise that in order to be a 'spin-off' three conditions must be fulfilled. First of all, the spin-off must take place within an existing organisation, in case of USOs this is the university (Miranda, Chamorro and Rubio, 2017). Secondly, the spin-off must have several individuals involved. Thirdly, the individuals involved must leave their parent organisation. Zhang (2008) defines USOs as companies founded by university employees and refers to their founders as academic entrepreneurs. Next to the term USOs there are also other terms often used referring to USOs. Other terms that are also used are for example research-based spin-offs (RBSOs) (Mustar et al., 2006) and academic spin-off (Algieri, Aquino and Succurro, 2011; Bigliardi, Galati and Verbano, 2013). Although the different terms used they seem to share common elements. Elements that are presents in all of the definitions are focussed around: new ventures, commercialisation of knowledge or technologies and the involvement of academic personnel. Mathisen and Rasmussen (2019) state that USOs are a subset of new-technology based firms (NTBF) where the firms originate from an academic institution.

2.3 Literature streams in relation with USO

An important starting point in developing policies and strategies aimed to address challenges regarding USOs seems to be the understanding of the nature of the venture (Mustar et al., 2006).

Therefore various researchers have tried to create typologies to identify commonalities and differences for USOs. According to Mustar et al. (2006) there are three main streams in the literature trying to establish these typologies. The first one focusses on the resources of a firm as differentiator and a predictor of competitive advantage. Within this resource-based perspective there can be made a distinction between social, technological, financial and human resources. A second perspective within the literature describes product market combinations, technological regime and sectoral differences. This stream in the literature is referred to as the business model perspective (Mustar et al., 2006). The third stream focusses on the relation of USOs with their parent organisation. These studies try to find a link between decisions made by the parent organisation and how this influences the business model of the USO. This stream in the literature is regarded as the institutional perspective (Mustar et al., 2006).

Mathisen and Rasmussen (2019) further developed the framework proposed by Mustar et al. (2006) by providing a dynamic view and a conceptual framework focussing on the development, growth and performance events of USOs (USO DGP). Therefore they conducted a literature review which overviewed 105 relevant articles. They empathise the importance of this work because governmental and university policies will be misguided without an understanding of the factors contributing to the development, growth and performance. They suggests three levels of analysis as determinants for the USO DGP. A visual representation of this framework will be shown in figure 1.

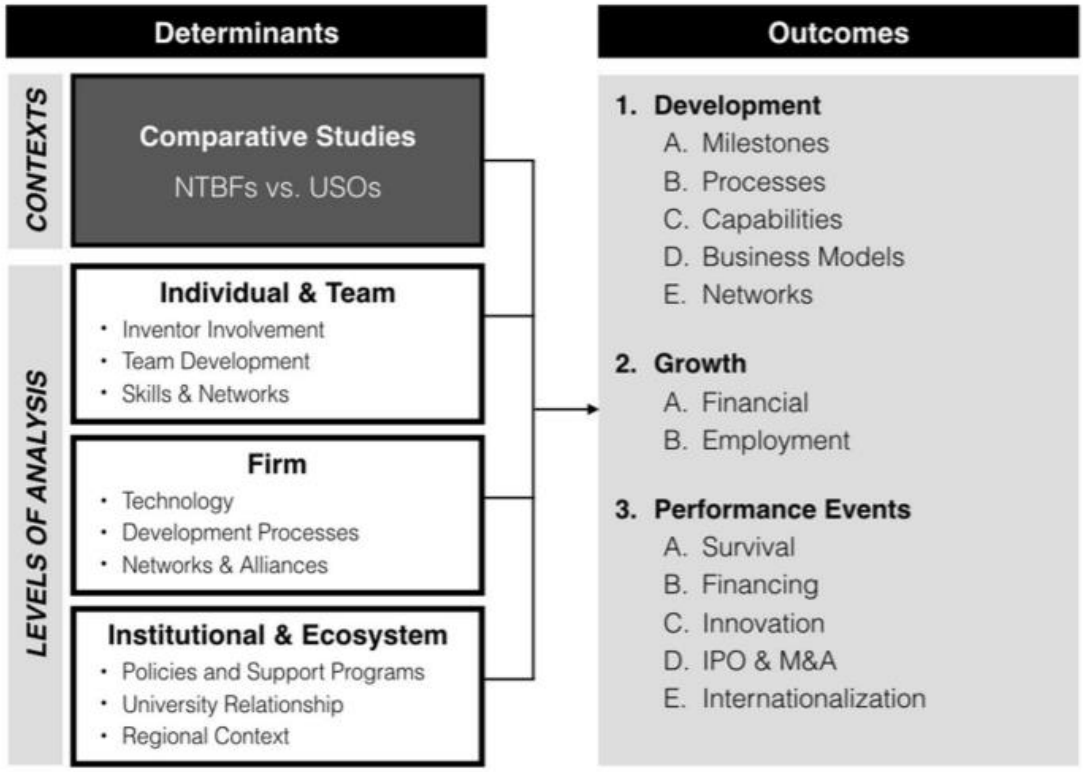

Figure 1: Conceptual framework by Mathisen and Rasmussen (2019)

The first level of analysis refers to individual- and team level determinants affecting USO GDP. They state that USOs typically start with a high level of academic expertise but a low level of business expertise (Mathisen and Rasmussen, 2019). The literature regarding individual- and team level determinants can be separated into three different topics (Mathisen and Rasmussen, 2019). Inventor involvement seems to play and important role since they provide a linkage with academia. USOs are likely to be founded by 'star scientists' since this helps with acquiring resources. However, academic founders often lack commercial experience. Therefore Mathisen and Rasmussen (2019) state that team development is also an important factor. For the development of USOs multidisciplinary teams with both academic and commercial knowledge need to be established. They also state that shortcomings at the individual level can be compensated by developing a good team. The third factor influencing individual- and team level determinants Mathisen and Rasmussen (2019) discovered in the literature are skills and networks. Different actors can provide skills and networks for the USO which makes this an important factor.

The second level of analysis refers to firm level determinants affecting USO GDP. Mathisen and Rasmussen (2019) identify three factors that influence this firm level. The first factor they highlight is technology. USOs are innovative firms that tend to commercialize both scientific

inventions and more tacit knowledge. Mathisen and Rasmussen (2019) state that the technological basis is very important for USOs, although only a very few studies have researched this. The second factor is the development process of the USO (Mathisen and Rasmussen (2019). This factor relates to critical junctures and how the USOs develops passing through these phases and milestones (Mathisen and Rasmussen 2019; Vohora, Lockett and Wright, 2002). The third factor Mathisen and Rasmussen (2019) identify is the influence of networks and alliances. These networks and alliances seem to be crucial for USO performance. Partnerships in general seem to be valuable because they can provide the USO with resources and complementary assets (Mathisen and Rasmussen, 2019)

The third level of analysis refers to institutional- and ecosystem- level determinants affecting USO GDP. The literature regarding this topic looks at the influence of institutional and environmental characteristics on the creation of USOs. The first factor they identify are policies and support programs. Governments and universities have set up structures to support the creation of USOs. However, these policies seem to influence the type of USOs that are eligible for funding. If the support system is very selective this will have influence on the amount of USOs created (Mathisen and Rasmussen, 2019) . The second factor Mathisen and Rasmussen (2019) identify relates to the university relationship. Many USOs seem to maintain a tight relationship with their parent university. This relationship with the university seems to depend on several points such as: shared history, social networks, original research team and the support of TTOs (Mathisen and Rasmussen, 2019). The third factor identified by Mathisen and Rasmussen (2019) relates to the regional context. USOs are a part of the surrounding ecosystem. These ecosystems have complex interactions among universities, governments, industries and capital providers (Mathisen and Rasmussen, 2019). Some universities have successful entrepreneurial ecosystems and a long history of commercializing scientific research (Mathisen and Rasmussen, 2019).

The literature review conducted Mathisen and Rasmussen (2019) is in line with the findings of previous research conducted by Miranda, Chomorro and Rubio (2017) who identified almost the same three main streams in the literature. Miranda, Chomorro and Rubio (2017) identify the following three streams in the literature. The first stream relates to individual level research. The second stream relates to firm-level research. The third stream relates to institutional context research. Miranda, Chomorro and Rubio (2017) also describe three sub-classifications within the before mentioned literature streams. These sub-classifications describe whether the conducted research focusses on the characteristics of USOs, the antecedents or factors

influencing entrepreneurial intention or the outcomes. According to Miranda, Chomorro and Rubio (2017) the largest part of the literature is focusses on the institutional context research, namely 42.5%. Firm-level research represents 30.6% of the literature and individual level research 26.9%. With regards to the firm-level it is clearly visible that there has been paid very limited attention to antecedents and outcomes.

2.4 Firm-level characteristics and their effect on USO funding

2.4.1 Radicalness of technology and the effect on USO funding

Radical technologies are able to create value across a wide range of industries and applications and therefore have a large market potential (Maine and Garnsey, 2006). Well known examples of radical innovations are for example the Iphone, which formed the basis for the smartphone as we know nowadays and Netflix which reformed the movie rental business. A radical technology can be defined as a technology that is able to deliver dramatically better product performance, lower production costs or both of these aspects (Maine and Garnsey, 2006). Academic entrepreneurs are found to be more likely to pursue radical technology development compared to managers from established firms. Since radical technologies draw upon new technical skills they tend to destroy the current capabilities, something that is not yet established within an USO (Shane, 2001). This is also emphasized by Stephan (2014) who states that USOs are superior in introducing radical innovations. Some scholars state that ventures employing radical technologies are able to outperform their competitors because these radical technologies help them to differentiate themselves from others and provide them with more options for the commercialisation of their technology (Schmidt, Walter and Walter, 2013; Ye, Wu, Hao and Chen, 2019).

However, there are also scholars that state the opposite. Considering the embryonic state of radical technologies ventures face high levels of technology and market uncertainty (Schmidt, Walter and Walter, 2013). These uncertainties consume time and resources, aspects that USOs often lack. Radical technologies often require higher amounts of investment which can create difficulties for the obtainment of funding, under the classical view, because of information asymmetry and agency costs (Khan, Shah and Rizwan, 2019). However, Radicic (2021) states that financial barriers are not perceived as a limiting factor for the development of radical technologies. This is also emphasized by Khan, Shah and Rizwan (2019) who state that financing constraints are stronger for incremental innovations compared to radical innovations and that financial constraints are not limiting radical innovations.

As previously stated we assume that governments seek to identify investments which are able to yield social, private or financial returns (Rasmussen and Sørheim, 2012). When we combine the fact that radical technologies are more likely to be founded within universities and that there is no limiting factor because of financial constraints one could assume that USOs who pursue more radical technologies could potentially yield higher revenues. Because of this larger potential revenue we assume that USOs who pursue radical technologies are more likely to receive governmental funding. In order to test this assumption the following hypothesis has been formulated:

H_1: *USOs who develop radical technologies are more likely to receive governmental funding*

This hypothesis will be tested based on the classifications mentioned in the matrix developed by Shestakov and Poliarush (2019) as shown in figure 2.

2.4.2 Technology readiness level and the effect on USO funding

Nowadays the technology readiness level (TRL) scale is used in a wide range of industries, it assist in managing risk, communicating development progress and specifying deliverables (Tomaschek, Olechowski, Eppinger and Joglekar, 2016). The TRL scale is often used as a tool for decision making when it comes to financing research, development and innovations which are publicly funded. The TRL scale discussed above is also used in the EU Horizon 2020 work programme for decision making with regards to public investments. (Bruno et al., 2020).

Wright, Lockett, Claryse and Binks (2006) state that non-USO investors emphasise the need for a prototype in order to assess the viability of a technology. USO investors invest at an earlier stage compared to non-USO investors and therefore focus more on achieving a proof of concept. Without the resources to establish a proof of concept it is unlikely that the USO receives funding by non-USO investors. This is also emphasized by Mankins (2009) who states that it is very unlikely that venture capitalist would invest in TRL below level 3. Mankins (2009) also states that both industry and governmental investments are common sources of finance for technologies between TRL 3-8.

According to Upadhyayula, Gadhamshetty, Shanmugam, Souihi, and Tysklind (2018) innovative technologies face two ‘valleys of death’ during their development from TRL 1-9. This valley of death refers to a funding gap where an USO has difficulties with attracting funding. The first valley of death occurs at TRL 5-6 and is referred to as the technology valley of death. The second valley of death occurs at TRL 7 and is referred to as the commercialization valley of death (Upadhyayula et al., 2018). Governmental funding programs are designed to

overcome this funding gap (Rasmussen & Sørheim, 2012). This is also emphasised by the NWO (2022) who state that 'Financing is needed to bridge the divide between the research and the market. The programme Take-off bridges this funding gap in the early phase of an undertaking.' Therefore we assume that USOs who have a more advanced TRL are more likely to obtain funding. In order to test these assumptions the following hypothesis have been formulated:

H_2: *USOs with a more advanced technology readiness level (TRL) are more likely to receive governmental funding*

2.4.3 Identification of technology competency leverage and the effect on USO funding

Technologies are often applicable to use in a range of markets. However, many technologies are underutilized and consequently not all value is extracted from them (Danneels, 2007). According to Keinz and Marhold (2021) one technology can have the ability to underly many different products and therefore it can be the basis for various market applications, for example sensors which are incorporated in many different products and industries nowadays. Start-ups seem to have a limited understanding about the markets where their technology might generate value and therefore fail to identify potential market opportunities for applying their technologies (Gruber, 2008; Sandner, Dufter and Geibel, 2016). However, building a portfolio of market opportunities through technology competency leveraging activities ,before actually entering a market, could help a start-ups likelihood to thrive (Gruber, 2008)

Technology competency leverage (TCL) is an innovation strategy that refers to the process of searching, evaluating and exploiting new market opportunities for new or existing technologies (Keinz and Marhold, 2021). Technological competences can be leveraged to be used in a range of applications. TCL activities can bear several benefits. First of all, when an existing technology is applied in a new market this increases the return on investment which positively affects the R&D expenditures. Secondly, TCL activities decrease an organization's strategic dependency from generating income through one market (Keinz and Marhold, 2021).

Being able to apply a technology across different markets might be appealing for investors because this provides higher growth perspectives (Keinz and Marhold, 2021). This is also emphasized in prior work by Gruber (2008) who states that entrepreneurs should 'look before they leap' since identifying technological cross-applications could provide start-ups with more favourable funding conditions. Therefore we will research if USOs that plan to leverage their technological competences and identify several potential markets for their technology are more likely to receive funding. Since leveraging technologies provide several benefits as stated by

Keinz and Marhold (2021) we assume that these USOs are more attractive for the government to invest in. In order to test this assumption the following hypothesis has been formulated:

H_3: *USOs that are able to identify multiple markets in order to leverage their technology are more likely to receive governmental funding*

2.4.4 Intellectual property and the effect on USO funding

Intellectual property rights (IPR) and the protection of intellectual property (IP) have become important aspects in the strategy of many corporations, especially since knowledge has become an valuable economic asset (Mets, Leego, Talpsep and Varblame, 2007). IP can be divided into two categories, formal IP and informal IP. Formal IP, for example patents, require legal documentation whereas this is not the case for informal IP (Hellström, Nilsson, Andersson, & Håkanson, 2019). Spin-off companies often face difficulties with regards to creating a competitive advantage when it comes to the protection of their IP, this is mainly caused by their limited access to human- and financial capital (Mets et al., 2007). Research conducted by Häussler, Harhoff and Müller (2009) and Mathisen and Rasmussen (2019) show that patents have a positive effect on USOs that seek to obtain venture capital. In addition Häussler, Harhoff and Müller (2009) state that there is a general agreement that patenting improves the firms performance because they can convey monopolistic market rights, protect the firm from competitors and improve the negotiation position. Although patents serve as a quality indicator of a ventures technology Hoenig and Henkel (2015) and Sandler, Dufter and Geibel (2016) state that this could also be caused by the signalling effect of the patent as a representation of team experience instead of the actual presence of the patent itself. Overall there seems to be a common understanding that patents could provide allot of value for USOs and have a positive effect on attracting venture capital. However, Mets et al. (2007) state that spin-off companies should only use patenting for inventions that could yield a high market value and which are able to be enforced, otherwise it would be better to keep the invention as a trade secret.

When it comes to IPR strategy there seems to be a conflict of interest between universities and venture capitalist (Wright, Lockett, Claryse and Binks, 2006). Universities often prefer to maintain control over the IP, therefore the USOs use licenses instead of acquiring equity. Investors may perceive this as the university trying to maintain ownership and is not willing to share the risk that is involved. In case the USO fails the investor would not benefit from the sales of the IP when the USO uses the licensing structure (Wright et al., 2006). This joint ownership of IP is a factor that leads to venture capitalists rejecting investment proposals (Wright et al., 2006). The government that provides grants to USOs however has other interests

than venture capitalists and therefore this might not affect their decision with regard to granting funding. We assume that the presence of intellectual property rights in the form of a patent has a positive effect on the obtainment of governmental funding. In order to test this assumption the following hypothesis has been formulated:

H_4: *USOs that possess intellectual property rights (IPR) in the form of a patent are more likely to receive governmental funding*

2.4.5 Geographic market segmentation and the effect on USO funding

Market segmentation is a marketing strategy which aims to identify market segments or 'set of buyers'. One of the advantages of market segmentation is that customers within a segment often share homogeneous characteristics and therefore react to the same marketing stimuli (Tynan and Drayton, 1987). Market segmentation can be done based on different bases. There are four segmentation bases that are identified as most commonly used, these are geographic segmentation, demographic segmentation, psychographic segmentation and behavioural segmentation (Goyat, 2009). Buratti, Profumo and Persico (2020) state that USOs need to have a good market orientation in order to survive in a hostile environment and to build a competitive advantage over time. The selection of the right market segments might be particularly important for USO with advanced technologies since they are natural candidates to become 'born global' firms. However, Taheri and van Geenhuizen (2014) describe resource barriers, such as limited financial capital, as a limiting factor for quick internationalization of innovative small firms. They state that having enough resources to 'invest' in internationalization over time is at the heart of the incremental internationalization process. Pettersen and Tobiassen (2012) state that USOs often have advanced technologies which are attractive for global niche markets. One could assume that USOs who focus on an international markets could achieve a higher potential and therefore assume that USOs that focus on an international market are more likely to obtain funding. This is also emphasized by research conducted by Bolzani, Fini and Grimaldi (2016) who state that there is a higher presence of financial shareholders within internationalized USOs compared to non-internationalized USO. Therefore we propose that USOs who focus on international markets are more likely to obtain funding. In order to test this assumption the following hypothesis has been formulated:

H_5: *USOs that focus on an international market are more likely to obtain governmental funding*

2.4.6 Entrepreneurial orientation -risk taking- and the effect on USO funding

Entrepreneurial orientation (EO) refers to a set of constructs that concern the entrepreneurial behaviour, decision making and processes of an organization (McKenny, Short, Ketchen, Payne and Moss, 2018). With regards to entrepreneurial orientation there are five dimension, as established by Lumpkin and Dess (1996) that are commonly accepted: autonomy, competitive aggressiveness, innovativeness, proactiveness and risk taking (Short, Broberg, Cogliser and Brigham, 2009; McKenny et al., 2018).

Risk taking is described as a key factor in the origin of EO by Linton and Kask (2017) who state that: "the roots of entrepreneurial orientation are related to the fact that entrepreneurial firms are more inclined to take risks than other types of firms." Risk taking is affiliated with other variables within this research, such as radicalness of technologies, and therefore included instead of the other dimensions of entrepreneurial orientation. McKenny et al. (2018) describe risk taking as the firms willingness to take bold action in the face of uncertainty. Risk can take on many forms and it is important to state that there is a distinction between 'risk' and 'uncertainty' (Putniņš and Sauka, 2019). 'Risk' is referred to a situation where probabilities of outcomes are known or can be calculated based on past data whereas in the case of 'uncertainty' these probabilities are unknown (Putniņš and Sauka, 2019). When we refer to 'risk-taking' in entrepreneurship we regard both 'risk' and 'uncertainty'.

Vaznyte and Andries (2019) argue that a start-up's level of EO affects the costs and benefits that are associated with external debt and equity capital and therefore this also has an effect on the financing form of the start-up. Start-up's with high levels of EO are more likely to pursue high risk projects with chances of very high returns and are aggressive in pursuing these opportunities. However, Vaznyte and Andries (2019) also state that first debt financers providing a loan or credit do not benefit from these high returns made by pursuing high risk projects and may therefore avoid funding these risky and innovative start-ups. This makes it more difficult for start-ups with high levels of EO to obtain external capital. Therefore Vaznyte and Andries (2019) state that this is mainly a limitation for innovative start-ups. Whereas private enterprises and venture capitalist focus on profits that are gained and are therefore risk-averse this does not always applies for the state that grants public funding. Public organizations can gain by focussing on spill overs that emerge from wealth creation and which deliver 'social returns' (Laplane and Mazzucato, 2020). Therefore we assume that the government that provides grants is less risk-averse and that USOs that show higher signs of risk taking are more

likely to obtain governmental funding. In order to test this assumption the following hypothesis has been formulated:

H_6: *USOs that show higher levels of risk taking are more likely to receive governmental funding*

3. Methodology

3.1 Research context

In order to address our problem statement a quantitative study will be performed. This will be done based on an aggregated-sample of Dutch university spin-off projects participating in the funding programme by the Dutch Research Council (NWO). The NWO is a Dutch research council which provides funds for universities and institutes. On an annual basis the NWO invests almost 1 billion euros into curiosity-driven research, research related to societal challenges and research infrastructure (Dutch research counsil, 2021). The mission of the NWO is to advance world class scientific research which provides scientific and societal impact. Besides direct government funding the NWO also has a specific budget for academic entrepreneurs and starters from the university of applied science in the form of the 'take-off' program. This program consists of two parts, a feasibility study and early stage routes (NWO | Take-off, 2021).

3.2 Data collection

In order to conduct a qualitative analysis and test our proposed hypotheses this study will use a fully aggregated and anonymized data set. This data will be collected using content analysis based on proposals that are filed by USOs for the valorisation grant between 2007 and 2014. The proposals that are filed for the valorisation grant contain a wide range of information such as proposed solutions, innovative aspects, commercial information and projects planning's. The data that is needed to answer our hypothesis is extracted from these proposals and categorized according to the variables as described above. In total, information from 123 proposals was collected. Because of missing values or in order to achieve the best model fit 109 were incorporated into the data-set, out of these 109 proposals 44 USOs obtained funding. This data-set will be the basis for our data-analysis which will be described in the next chapters.

3.3 Measurements

3.3.1 Dependent variables

The dependent variable for this study will be the obtainment of funding by an USO. This variable is dichotomous and therefore a scale from 0 till 1 will be used. The 0 will represent

USOs that did not receive funding. The 1 will represent USOs that were successful in obtaining funding.

3.3.2 Independent variables

3.3.2.1 Radicalness of technology

In order to assess the effect of the variable 'radicalness of technology' on the obtainment of funding the classifications described by Shestakov and Poliarush (2019) will be used. We define radical innovations as innovations that involve fundamental changes in a technology, which are new to the industry and which are able to yield substantial new benefits (Lennerts, Schulze and Tomczak, 2020). Incremental innovation are defined as innovations that only made minor adjustments or improvements to an already existing products, these innovations may be new for the company but are not new in the market (Lennerts, Schulze and Tomczak, 2020). Based on the classification by Shetakov and Poliarush (2019) we will measure this variable on a categorical level and investigate which type of innovations are most likely to get funded.

1. Incremental innovation: incremental technology and/or incremental business model
2. Semi-radical innovation: incremental technology and radical/disruptive business-model
3. Semi-radical innovation: disruptive/breakthrough technology and incremental business-model
4. Radical innovation: disruptive/breakthrough technology and radical/disruptive business-model

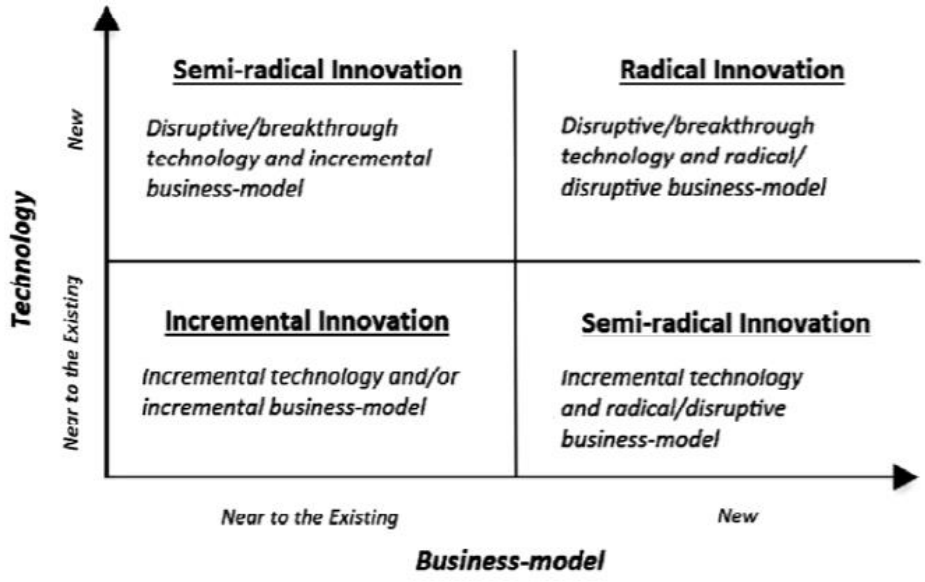

Figure 2: Classification matrix by Shetakov and Poliarush (2019)

3.2.2 Technology readiness level

The technology readiness level (TRL) system is a method originally designed by NASA. This method is designed to estimate the maturity of a technology (Straub, 2015). In order to assess the effect of the variable 'technology readiness level' on the obtainment of funding the scale proposed by the EU horizon work programme 2020 will be used. The TRL system initially consisted of 7 layers, later an additional 2 layers where added. TRLs levels 1-3 contain the initial stages of a technology. There is a formulation of the proof of concept. TRLs 4-6 consist of the validation and demonstration phases. TRL 7 consist the final stage of prototyping. TRL 8 and 9 consist pre-market and market launch condition of a technology (Bruno et al., 2020).

This variable will treated as a ordinal variable with the following categories. TRL 1-3 will be represented by a 1. TRL 4-5 will be represented by a 2. TRL 6-9 will be represented by a 3. We assume that the higher the TRL the higher the likelihood of obtaining funding by an USO.

3.2.3 Intellectual property

In order to assess the effect of the variable 'intellectual property' on the obtainment of funding 0 will represent a negative influence for USOs that did not file a patent or USOs that filed a patent but where the patent has not been granted yet. 1 will represent a positive influence where the USO has already been granted a patent.

3.2.4 Technology leverage competency

In order to assess the effect of the variable 'technology leverage competency' on the obtainment of funding a measurement range from 1 till 4 will be used. We assume that there is positive relation between technology leverage competency and funding. Therefore we assume that USOs that are able to identify applications to leverage their technology are more likely to get funded. The scales that will be used to measure this variable are as follows:

1. No identification of potential leverage
2. Limited identification of potential leverage (1 or 2 potential markets to leverage existing technology)
3. Moderate identification of potential leverage (3 or 4 potential markets to leverage existing technology)
4. High identification of potential leverage (5 or more potential markets to leverage existing technology)

3.2.5 Geographical market segmentation

In order to assess the effect of the variable 'geographical market segmentation' on the obtainment of funding we will make a binary variable. 0 will represent a negative effect for USOs that only focus on domestic markets. 1 will represent a positive effect for USOs that focus on the global market.

3.2.6 Risk-taking

In order to assess the effect of the variable 'risk taking' on the obtainment of funding we will be using computer-aided text analysis (CATA). We will investigate the degree to which 'risk-taking' is described in the proposals that are filed for the valorisation grant. CATA is an useful analysis technique because of the ability to process large samples with high speeds and reliabilities (Short et al., 2009). We will be using a validated word list from the study by Short et al. (2009) that describes 37 synonyms for 'risk-taking'. This list will be complemented with new words that are more likely to be used by Dutch entrepreneurs. A complete list of synonyms can be found in appendix 1. This variable will measured on a scale level. The maximum amount of words regarding risk taking that were found in the proposals will be counted as a 1. The other cases are represented by a number that reflects the proportion of the words found in contrast to the maximum amount of words to describe risk taking.

Table 1 provides an overview of all the variables and measurements.

Variable	**Measurement**
Radicalness of technology	1. Incremental innovation: incremental technology and/or incremental business model 2. Semi-radical innovation: incremental technology and radical/disruptive business-model 3. Semi-radical innovation: disruptive/breakthrough technology and incremental business-model 4. Radical innovation: disruptive/breakthrough technology and radical/disruptive business-model
Technology readiness level	1. Technology readiness levels 1-3 2. Technology readiness level 4-5 3. Technology readiness levels 6-9
Technology leverage competency	1. No identification of potential leverage 2. Limited identification of potential leverage (1 or 2 potential markets to leverage existing technology) 3. Moderate identification of potential leverage (3 or 4 potential markets to leverage existing technology) 4. High identification of potential leverage (5 or more potential markets to leverage existing technology)
Risk taking	maximum amount of words regarding risk taking represented by a 1. Other cases are represented by a number between 0-1 based on the proportion in relation to the maximum amount of word
Intellectual property (Patents)	0. No patent 1. Patent granted
Geographic market segmentation	0. Domestic markets 1. International markets

Table 1: Variables and measurements

3.3.3 Control variables

3.3.1 Universities

The universities where the researchers that apply for the valorisation grant will function as a control variable during this research. Based on the amount of applications the following categories were established. 1 represents the university of Delft. 2 represents the university of Eindhoven. 3 represents the university of Twente and 4 represents a combination of the remaining universities.

3.3.2 Number of applicants

The total number of people, or in other words the team size, that are associated with the project that is filed for the valorisation grant will function as a control variable. This variable will be treated as a continuous variable. We expect the relationship between the number of applicants and the obtainment of funding to be linear.

3.3.3 Number of publications

The total number of publications by the persons who file for the valorisation grant will function as a control variable. This variable will be treated as a continuous variable. Since the number of publications can function as a sign of experience and possession of knowledge we expect a positive effect of the total number of publications on the obtainment of governmental funding. The data for this control variable is retrieved from Web of Science and Scopus.

3.3.4 Professor status

The status of the persons that filed for the valorisation grant will function as control variable. This variable is dichotomous, 0 will represents applicants that do not have the professor status. 1 will represent applicants that are professors. Professors are considered knowledgeable people within their field of expertise and therefore we expect that being a professor and filing for the valorisation grant will have positive effect on the obtainment of funding.

3.4 Data analysis

Binary logistic regression was used as a statistical test to analyse our data. This method was chosen because we have a dichotomous dependant variable which is predicted by various independent variables. Harrell (2015) states that binary logistic regression is generally preferred to analyse data which states the probability of Y=1 given X as the values of the predictors. Before the analysis was performed the assumptions that need to be fulfilled in order to carry out binary logistic regression where checked. These assumptions include, 1) the dependant variable must be dichotomous, 2) independent variables should not be highly correlated with

each other, 3) errors should not be correlated and 4) the data must be checked for outliers (Senaviratna and Cooray, 2019). These assumptions were all fulfilled and therefore the results of the analysis can be found in chapter 4.

4. Results

The results of the correlation analysis can be found in table 2. The correlation matrix was used to explore the degree of relationship between two variables, this can be either a positive or negative relationship (Senthilnathan, 2019). Coefficients between the independent variables of above 0.7 are considered as a sign of multi-collinearity and will therefore be excluded from the regression analysis (Senthilnathan, 2019). The correlation analysis shows no signs of such multi-collinearity and therefore all variables are included.

The results of the binary logistic regression can be found in table 3. In the first model only the control variables were included. In the subsequent models one of the independent variables were added. The last model includes all the control variables as well as all the independent variables. When we look at the Nagelkerke R squared in the results we can see that model 8 explains most of the variation in the dependant variable. Therefore the results of this research will be based on model 8.

In hypothesis 1 we proposed that the development of radical technologies by USOs has a positive effect on the likelihood of obtaining governmental funding. Model 8 shows a positive and significant effect of radical technologies in combination with a radical business model on the obtainment of funding ($B= 2.408$; $p < 0.05$). We can only find support for our hypothesis on this specific category level. Therefore we conclude that hypothesis 1 is partially accepted.

Hypothesis 2 proposed that USOs that have a more advanced TRL have a higher likelihood to obtain governmental funding. Based on model 8 the results signal a positive effect of TRL on the likelihood to obtain governmental funding. However, this effect is not significant. Therefore hypothesis 2 cannot be accepted and is rejected. Our findings with regards to hypothesis 2 are not in line with what we expected

Our third hypothesis proposed that USOs who are able to identify multiple markets in order to leverage their technology are more likely to obtain governmental funding. In contradiction to our hypothesis our results signal a negative effect of TLC on the likelihood to obtain governmental funding. Therefore hypothesis 3 cannot be accepted and is rejected. The results of hypothesis 3 are not in line with our expectations.

In hypothesis 4 we proposed that USOs who possess intellectual property rights in the form of a patent have a positive effect on the likelihood of obtaining governmental funding. Model 8 shows a positive and significant effect of possessing a patent on the obtainment of funding (B=1,089; $p < 0.05$). Therefore we conclude that hypothesis 4 is confirmed. The results of hypothesis 4 are in line with what we hypothesized

Hypothesis 5 proposed that USOs who focus on the international market have a higher likelihood to obtain governmental funding. Based on model 8 we see a positive effect of international orientation on the obtainment of funding, however this effect is not significant. Therefore hypothesis 5 cannot be accepted and is rejected.

Our last hypothesis, hypothesis 6 proposed that USOs who show higher signs of risk taking in their proposals have a higher likelihood to obtain governmental funding. Based on model 8 we see a positive effect of risk taking on the obtainment of funding, however this effect is not significant. Therefore hypothesis 6 cannot be accepted and is rejected.

N= 109	Minimum	Maximum	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
[1] Radicalness of technology	0	4	1.98	1.085	1									
[2] Technology readiness level	0	3	1.88	.773	.061	1								
[3] Technology leverage compentency	0	4	2.13	1.066	.142	-.107	1							
[4] Intellectual property	0	1	0.29	.456	-.103	-.029	-.087	1						
[5] Geographic market segmentation	0	1	0.94	.235	-.066	.049	.164	.007	1					
[6] Risk-taking	0	1	0.15	.124	-.003	-.044	.099	-.179	.033	1				
[7] University	1	4	2.06	1.246	.029	.414	.250**	-.062	.020	.157	1			
[8] Total Publications	2	521	99.19	106.685	.030	.066	.050	.080	.125	.226*	.009	1		
[9] Number of projects members	1	10	3.58	1.470	-.106	-.129	.110	-.084	-.044	.139	-.057	-.002	1	
[10] Professor as applicant	0	1	0.35	.480	-.039	.147	.047	.039	.112	.165	.130	.134	-.021	1

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

** correlation is significant at the 0.01 level (2-tailed)

Table 2: Descriptive statistics and correlation matrix

N= 109	1		2		3		4		5		6		7		8	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Variable name																
[1.1] Incremental innovation: incremental technology and/or incremental business model			-	-											-	-
[1.2]. Semi-radical innovation: incremental technology and radical/disruptive business-model			-.191	1.343											-.073	1.375
[1.3]. Semi-radical innovation: disruptive/breakthrough technology and incremental business-model			.066	.456											.197	.482
[1.4]. Radical innovation: disruptive/breakthrough technology and radical/disruptive business-model			1.913*	.936											2.408*	1.035
[2] Technology readiness level					.152	.285									.273	.309
[3] Technology leverage compentency							-.027	.209							-.118	.227
[4] Intellectual property									.786	.465					1.089*	.513
[5] Geographic market segmentation											.394	.925			.818	1.006
[6] Risk taking													.615	1.903	1.566	2.072
[7.1] University of Eindhoven	-.978	.623	-1.147	.0659	-.959	.624	-.974	.624	-1.085	.635	-1.005	.626	-1.015	.635	-1.376	.682
[7.2] University of Twente	.443	.764	.522	.774	.553	.787	.474	.792	.677	.782	.454	.773	.438	.765	1.200	.874
[7.3] Other Universities	-.256	.526	-.321	.547	-.236	.529	-.251	.528	-.295	.533	-.277	.529	-.289	.536	-.462	.585
[8] Total Publications	.001	.002	.002	.002	.001	.002	.001	.002	.001	.002	.001	.002	.001	.002	.001	.002
[9] Number of projects members	-.247	.157	-.228	.159	-.235	.159	-.254	.158	-.244	.161	-.246	.156	-.255	.158	-.196	.171
[10] Professor as applicant	1.042	.438	1.134*	.452	1.004*	.0443	1.046*	.439	1.056*	.444	1.023*	.439	1.019*	.443	.993*	.479
Constant	.072	.661	-.175	.716	-.257	.907	.113	.732	-.173	.693	-.280	1.059	.047	.666	-1.877	1.443
Nagelkerke R	.136		.186		.139		.136		.167		0.138		.137		.249	
Hosmer and Lemeshow Test	.075		.811		.298		.066		.351		0.093		.376		.558	
-2 Log Likelihood	133.858		129.287		133.574		133.841		130.975		133.669		133.751		123.281	

* correlation is significant at the 0.05 level (2-tailed)
** correlation is significant at the 0.01 level (2-tailed)

Table 3: Binary logistic regression model for dependant variable: obtainment of USO funding

5. Discussion and conclusion

Throughout the years many researchers tried identifying elements that contribute towards USO funding success. These studies can be categorized within various literature streams: the individual level, the institutional level and the firm level (Miranda, Chamorro and Rubio, 2017; Mathisen and Rasmussen, 2019). This study focussed on the firm level research with special attention on technological determinants. During this research we tried to identify, mainly technological, determinants that contribute towards the success of USOs in the obtainment of governmental funding. This research direction was chosen because researchers called upon action towards filling the gap within this literature stream (Druilhe and Garnsey, 2004; Miranda, Chamorro and Rubio, 2017; Mathisen and Rasmussen, 2019).

Our analysis showed us that there is a positive and significant effect of radical technologies, in combination with radical business models, on the obtainment of governmental funding. Meaning that radical innovations are more likely to receive governmental funding. These findings are in line with our hypothesis and can be explained by the statements of Shane (2001) and Stephan (2014) who stated that USOs are superior in introducing radical technologies since they haven't established specific capabilities yet. Our findings could also be explained by research results from Schmidt, Walter and Walter (2013) and Ye et al. (2019) who stated that radical technologies help ventures with differentiating themselves and provide more options for commercialization, which is attractive for investors. Khan, Shah and Rizwan (2019) stated that radical technologies often require larger investments which could create difficulties with regards to the obtainment of funding. In addition, based on the finding by Schmidt, Walter and Walter (2013) radical technologies could also expect difficulties with the obtainment of funding because of their embryonic state and high levels of technological and market uncertainty. The before mentioned findings are not in line with the findings of this research and do not seem to influence governmental funding decision making in our research context. Differences may be explained by the fact that the previous studies focussed on venture capital investments whereas this study focussed on governmental grants.

Higher technology readiness levels do seem to have a positive effect on the obtainment of governmental funding, although this effect was not proven to be significant. Technologies that have a higher TRL are already further developed and therefore have less uncertainties compared to technologies with lower TRL. Upadhyayula et al. (2018) stated that innovative technologies

face two ‘valleys of death’ during TRL phase 1-9, namely in TRL 5-6 and in TRL 7. Rasmussen and Sørheim (2012) explained that governmental funding, such as the valorisation grant, are aimed specifically at overcoming these valleys of deaths. Based on this research it is not possible to draw a clear conclusion on the fact if the valorisation grant fulfils his role in overcoming this funding gap.

Contrary to what we hypothesized there does not seem to be a significant and positive effect of technology competency leveraging activities on the obtainment of governmental funding. Instead we found a negative effect of TRL activities on the obtainment of governmental funding, meaning that USOs that identified several potential markets for their technology are less likely to obtain funding. Our findings contradict statements made by Gruber (2008) and Keinz and Marhold (2021) that being able to leverage technologies and use them for several markets is favourable when a start-up want to attract funding. Perhaps this could be caused because investors, in our case the NWO, regard the identification of several markets as a ‘stuck in the middle’ strategy. According to Porter’s generic strategy a company that attempt a generalist position risks being outcompeted by specialists (Adner, Ruiz-Aliseda and Zemsky, 2016). This lack of a clear focus could potentially discourage investors.

In line with our hypothesis the presence of IPR in the form of a patent has a positive and significant effect on the obtainment of governmental funding. These findings complement and support previous work by Häussler, Harhoff and Müller (2009) and Mathisen and Rasmussen (2019) who stated that patents have a positive effect on USOs that seek to obtain venture capital. Although we confirmed our hypothesis it is still unclear in which way patents contribute towards positive funding decisions. As previously stated the positive influence of patents could also be caused by the signalling effects of the patent as a representation of team experience and competency instead of the actual presence of the patent itself (Hoenig and Henkel, 2015; Sandler, Duftler and Geibel, 2016).

We found a positive effect of international market segmentation on the obtainment of governmental funding, although this effect is not significant. These findings are in line with our hypothesis and support previous work by Buratti, Profumo and Persico (2020) who stated that USOs are often naturally ‘born global’ firms with advanced technologies and therefore need to focus on international niche markets. Resource barriers such as limited financial capital, as described by Taheri and van Geenhuizen (2014) do not seem to limit the internationalization for USOs within our sample.

Finally, we found a positive effect of the description of risk taking on the obtainment of governmental funding. This effect does not seem to be significant although it is in line with our hypothesis. As stated by Vaznyte and Andries (2019) first debt financers providing a loan or credit do not benefit from these high returns made by pursuing high risk projects and may therefore avoid funding these risky and innovative start-ups. However, in our case our findings seem to be in line with the statements of Laplane and Mazzucato (2020) who stated that public organizations gain benefits by focussing on spill overs that emerge from wealth creation and which deliver 'social returns'. Therefore we assume that public organizations, such as the NWO, are less risk averse and are more likely to pursue high risk projects compared to first debt financers.

6. Implications

The results of this study will have implications on several levels. First of all, for academics, the results of this study will contribute towards filling the gap in the literature regarding the topic of firm-level determinants and their influence on the obtainment of funding by USOs. This study complements on earlier work by Druilhe and Garnsey (2004), Miranda, Chamorro and Rubio (2017) and Mathisen and Rasmussen (2019) who all stated that there has been paid limited attention to firm-level determinants such as technological factors. The results of this study are beneficial for academics who seek to obtain a better understanding about the influence of technological factors and their effects on USO funding.

For academic entrepreneurs the results of this study will be interesting with regards to some of the variables that we researched. This study showed that USOs with radical technologies and USOs who possess intellectual property rights in the form of a patent are more likely to obtain funding. Academic entrepreneurs who wish to establish an USO, and are looking to obtain funding, should take this into account. In other words, academic entrepreneurs will improve their odds of obtaining governmental funding when they develop radical technologies and possess a patent. Therefore this research contributes towards their decision making process and indicate important factors for the obtainment of funding.

For policymakers the results of this study will contribute towards the understanding of their own funding process. When the results of this study are combined with research regarding the survival rate of USOs policymakers will be better able to determine which valorisation grants are worthwhile. As stated by Rasmussen and Sørheim (2012) governmental funding programs are highly experimental. Governmenents face difficulties and are often unable to identify USOs

that are able to deliver social, private or financial returns (Rasmussen and Sørheim, 2012). The results of this research contributed towards obtaining more insights regarding fundings success. Since funding is one of the main restriction in the creation of successful USOs and forms the basis for the development of the USO policymakers will benefit from this knowledge.

7. Limitations and future research

During the execution of this research several limitations were encountered. The first limitation of this research is affiliated with biases in the data collection. During the data collection some of the variables left open more room for interpretation compared to the others. This is mainly the case for the variables radicalness of technology and technology readiness level. In order to improve the reliability of this research it would be meaningful if future researchers independently collected data regarding these variables and to see how the results compare to each other.

This research is driven by a deductive empirical approach and used quantitative analytical techniques. However, the process of USO development and commercialization is more complex. Therefore it would be beneficial to complement our findings with more qualitative and in-depth research such as case studies and interviews in order to obtain new insights. The variables that we used within this research were treated as we would do within a linear model. However, it is likely that there will be an interplay between different success determinants influencing the obtainment of funding, therefore our findings might be limited. Because we did not explore these underlying mechanisms and the interplay between variables we could be missing important information. For future researchers it would be interesting to explore these configurational interactions between variables and incorporate them within a larger dataset. Therefore we propose that future researchers try to identify novel configurations of USO success determinants that lead to USO funding success.

Although this study focussed on the influence of, mainly technological, determinants on the obtainment of governmental funding there are also other interesting research directions. Since obtaining funding serves no higher purpose if the USO do not thrive and develop it would be useful to research the effect of our determinants on the USO survival rate. This would be an interesting research direction because USOs that survive are able to generate social wealth and have economic impact.

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10. Appendix

8.1 Risk-taking synonyms

Validated synonyms for 'risk-taking' as described by Short et al. (2009)

Adventuresome, adventurous, audacious, bet, bold, bold-spirited, brash, brave, chance, chancy, courageous, danger, dangerous, dare, daredevil, daring, dauntless, dicey, enterprising, fearless, gamble, gutsy, headlong, incautious, intrepid, plunge, precarious, rash, reckless, risk, risky, stake, temerity, uncertain, venture, venturesome, wager

Additional synonyms

Threat, possibility, prospect, speculation, uncertainty, hazard, likelihood, probability, speculation, leap in the dark, peril, menace, jeopardy, stand a chance of, take the risk of, dare, endanger, jeopardize, imperil, take a chance on, put in jeopardy, expose to danger