Off to a Great Start: Early-Stage Success Factors in University Spin-Off Commercialization

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ABSTRACT

University spin-offs are ventures that are developed within a university and are based on academic research, with the purpose of commercializing an innovative technology. University spin-offs are ventures with economic significance as they are a vehicle for transferring new technology to the industry. They are expected to enhance economic development. Although the importance of USO commercialization has been recognized, the amount of spin-outs that are able to generate sustainable and impactful solutions, in the long run, remains small. This research builds on a framework categorizing five phases of development that University spin-offs transition through. There is a lack of understanding of which characteristics contribute to USO success in the early stages of development. This research aims to determine what influential characteristics exist in the early stages and how they contribute to an increased likelihood of long-term success. For this study, a range of interviews is conducted with highly knowledgeable and experienced entrepreneurs that managed to create a successful University spin-off. The results of this study show that a high level of entrepreneurial competencies, access to valuable business networks, and the exploitation of a technology based on a market pull are factors that contribute to long-term USO success.

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1. INTRODUCTION

The importance of creating successful university spin-offs has increasingly been recognized in recent years. (Perkmann et. al, 2013; Colombo et al, 2019; Elhorst & Faems, 2021)This is because academic spin-off firms perform a range of important functions. According to Geenhuizen & Soetanto (2009, p 671) these functions include being 'a vehicle for technology transfer and technology commercialization, a way to produce direct income for universities (rent of laboratories), a source of employment, a way to strengthen the relationships with the local business community and, particularly in depressed areas, a way to contribute to restructuring regional economies'. Mathisen & Rasmussen (2019) state that University spin-offs are firms with an economic significance as they form 'an important mechanism for transferring new technology to the industry'. 'By creating new knowledge-based employment, tax revenues and indirect effects through the dissemination of new technology they improve the absorptive capacity of a region'. (Mathisen & Rasmussen, 2019) They are therefore expected to enhance economic development. University spin-offs offer the prospect of commercializing research that may otherwise have remained undeveloped.

University spin-offs are used as a strategy to market innovations that are produced as a result of academic research. 'By their nature, university spin-offs are exposed to risky endeavours and often fail in achieving an adequate level of performance.'(Poponi et al., 2017) 'There has been a rapid increase in technology-based economic development initiatives, focused mainly on stimulating technological entrepreneurship in universities via patenting, licensing, start-up creation, and university-industry partnerships. (Grimaldi et. al, 2011 p. 1045). These efforts are directed toward the commercialization of new research developed by academic scientists. Despite the increased focus on stimulating the development of entrepreneurship within the academic field, the amount of spin-offs that turn out to be successful in the long run remains small. Although the number of university spin-offs has increased in the previous years, the majority of these ventures have shown limited growth (Fini et al., 2016). Therefore, 'the creation of university spin-outs represents a potentially important yet under-developed possibility to create wealth from the commercialization of academic reserach.' (Vohora et. al, 2004, 148).

The challenges associated with new high-tech ventures have been widely researched and documented. The 'liability of newness' that finds its origin in the inexperience of the entrepreneur and the novelty of the venture is a common difficulty faced by the majority of new high-tech ventures. The field of university spin-offs, however, is more complicated than the regular innovative start-up. 'The development of university spin-offs raises new entrepreneurial challenges beyond those faced by new high-tech ventures in general.'(Vohora et. al, 2014. p147). The complexity of university spin-off development calls for an elaborate process evaluation. Vohora et al (2014) developed an overview of the 5 phases that a university spin-off experiences in its development. This research prioritizes the importance of developments within the early phases. The early phases of development are especially important because the identification of projects with limited growth prospects and a high likelihood of failure can save investments in both money and time. This is important for the entrepreneur and other stakeholders. Missed opportunity costs can be prevented if successful identification of failing projects happens early in the process.

Prior literature has researched different success factors in the later stages of the commercialization process of USOs. However, there still exists a lack of understanding of success factors in the early stages of development, and the impact of interplay of these factors. Despite an increasing amount of scholarly attention, the vast majority of existing research in the field of USO success is based on quantitative data analysis methods. For example, the study of Hossinger, Block, Chen, and Werner (2021) researched which characteristics increase the likelihood of completing venture creation activities using OLS regression. Similarly, the study by Prokop et al. (2019) investigate key determinants of USO survival in an empirical setting. Yet, this research aims to expand the previously conducted research and contribute novel insights focusing on more in-depth understanding of underlying mechanisms of USO development in early-stages of development. Hence, the following research question will be examined:

Which early-stage characteristics increase the likelihood of long-term university spin-off success?

After the identification of which early-stage characteristics contribute to the likelihood of USO success, an additional main question is being examined. This second question is about how these early-stage characteristics can increase the likelihood of long-term USO success.

This research can function as a base for further research on USO success in the early phases of development. It can support academic entrepreneurs in identifying the necessary characteristics that will likely influence their chances of creating long-term success. The ultimate purpose of this research is to increase the likelihood of university spin-offs positively contributing to society as a whole.

2. THEORETICAL FRAMEWORK

There is an increasing number of scholarly works on the topic of university spin-offs and key performance determinants. These studies show a variety of definitions of the concept. According to Vohora et al (2004) the University spin-off is 'a company founded by employees of the university around a central technological innovation which had initially been developed at the university' (p. 149). Geenhuizen & Soetanto (2009) define the concept of university spin-offs as 'being created with the objective of commercially exploiting a new technology developed within a university.' (p. 671). This definition is supported by Siegel & Wright (2015) who add to this definition by stating that 'the motivation of a University Spin-off is the commercialization of science and other forms of university technology transfer' (p 582). Rasmussen & Wright (2015) narrowly define university spin-off ventures as 'firms that exploit intellectual property or patented inventions generated from university research' (p. 783). Concepts that are often repeated in frequently used definitions include 'innovation', 'university', 'commercial exploitation', and 'technology transfer'. For this research, university spin-offs are conceptualized as : 'Ventures that are developed within a university and are based on academic research, with the purpose of commercializing an innovative technology.' In addition, terms such as 'Academic spin-off firm', and 'University spin-out', will be simultaneously used in this research.

2.1 USO development phases

This research builds upon the findings of Vohora et. al (2004) about the phases of university spin-off development. The findings from this research, based on empirical evidence, suggest that USOs develop non-linearly through five phases. These phases are the 'research stage', the 'opportunity stage', the 'pre-organization stage', the 're-orientation stage', and the 'sustainable returns stage'. At each phase a specific difficulty needs to be overcome in order for the USO to be able to transition to the follow-up phase. These transition difficulties are defined by Vohora et. al (2004) as 'critical junctures'. With each phase the USO's differ in terms of resources, capabilities and social capital.

2.1.1 The research phase

The research phase marks the beginning of the development process where valuable intellectual property is created that generates a potential opportunity to commercialize later on in the process. Existing research shows that high-tech USOs are often created by more prosperous scientists and that obtaining intellectual property protection is difficult for inventors active in areas where they are not experts.

The critical juncture that is present at this stage is 'opportunity recognition'. An opportunity is a solution that satisfies an unfulfilled market need. The ability to recognize an opportunity requires 'the ability to synthesize scientific knowledge with an understanding of markets that is enhanced significantly by higher levels of social capital in the form of partnerships, linkages and other network interactions' (Vohora et. al, 2004. p 160). According to Vohora et. al universities and academics possess significant technological knowledge, however insufficient knowledge of market requirements, and an inability to adequately forecast profits that could arise from the innovation. In order for the USOs to proceed to the next phase, they need to develop a commercially feasible offering. (Vohora et.al 2004 p. 160).

2.1.2 The opportunity framing phase

During this phase, the recognized opportunity is evaluated to determine whether it has sufficient potential to pursue the commercialization process. The screening process involves an evaluation for technological validity and performance. (Vohora et. al, 2004 p. 151). After this, a commercial opportunity is framed by identifying market segments and target customers. Research shows that USOs 'have a lack of understanding of how to generate optimal returns from commercial exploitation and an inexperience in framing scientific discoveries in relation to creating commercial value from them' (Vohora et. al, 2004 p. 151).

The critical juncture that the USO is faced with at this stage is 'entrepreneurial commitment'. Entrepreneurial commitment refers to persistence and commitment to the project. It takes the innovation from a vision to an operational venture. 'In USOs, the critical juncture of entrepreneurial commitment arises due to the conflict between the need for a committed venture champion to develop the USO venture and the inability to find an individual with the necessary entrepreneurial capabilities. ' (Vohora et. al, 2004, p. 163)

2.1.3 The pre-organization phase

At this phase strategic plans can be developed and implemented. Research shows that decisions made in this stage had a significant impact on the future success of the USOs because they determine the path of development. (Vohora et. al, 2004 p. 156) The high-impact decisions at this stage increase the importance of entrepreneurial experience and access to networks. The critical juncture identified at this phase is 'credibility'. Credibility is crucial for acquiring resources to start business operations. 'A lack of credibility constrains the entrepreneur's ability to access and acquire key resources: seed finance and human capital. ' (Vohora et. al, 2004 p. 164)

2.1.4 The re-orientation phase

At this phase, the USOs start the process of generating returns by offering value to their target customers. During this phase 'the entrepreneurial teams faced the challenges of continuously identifying, acquiring and integrating resources and then subsequently re-configuring them.' (Vohora et. al, 2004, p.157) Many internal and external changes happen in this phase and managing them is a challenge. The critical juncture that arises at this stage is 'sustainability'. Sustainability refers to the acquiring of entrepreneurial capabilities. These capabilities allow the team to overcome challenges that arise from commitments made during previous phases.

2.1.5 The sustainable returns phase

In the final phase, the USO has accomplished to attain a sustainable flow of returns. This development has been set into place by following a precise business model that solves previous uncertainties. Even though the USO has developed its own commercial identity it will likely retain ties with the university (Vohora et. al, 2004 p. 159).

3. USO SUCCESS DETERMINANTS

3.1 The impact of entrepreneurial competencies on USO success

Gumusay & Bohné (2018) define entrepreneurial competencies as high-level characteristics entailing the possession of knowledge, skills, and specific personality traits that are improvable. 'To be competent means to be able to behave effectively in a particular performance domain, occupation or activity' (Hayton and Kelley, 2006, p. 413). Entrepreneurial competencies are important because 'entrepreneurs require the ability to identify and combine resources and develop unmet opportunities, an ability which can be a primary source of competitive advantage.'(Gumusay & Bohné, 2008, p. 365). Entrepreneurial competencies are crucial during the pre-organization phase. Strategic plans are developed and implemented. Path determinant decisions need to be made, entrepreneurial competencies are therefore of high importance. The impact of two entrepreneurial competencies will be researched, the opportunity development competency and the resource acquisition competency.

The opportunity development competency can be described as 'The ability to seek improvements in the opportunity combined with the ability to alter the opportunity according to new insights' (Rasmussen & Wright, 2015, p.788). The opportunity development competency starts with the capacity to recognize the opportunity, the perception of a business opportunity. Academics are more likely to be technologically oriented than market-oriented. Hence, they have a tendency toward familiar knowledge areas when exploring possible applications for their product or service (Rasmussen & Wright, 2015, p.788). This could possibly contribute to the lack of successful long-term USOs and increases the importance to investigate its impact. A USO that is highly competent in recognizing opportunities can identify more profitable and commercial opportunities. Early recognition of a promising market opportunity can create a competitive advantage which increases the likelihood of success.

Resource acquisition competency is defined as the ability to assemble and organize resources in the early stages of development. Hence, this entrepreneurial competence is the ability of resource leveraging. (Rasmussen & Wright, 2015, p.788) A USO that is highly competent when it comes to resource leveraging is able to overcome part of the liability of newness that entails a lack of internal resources. If a USO is able to acquire all the necessary resources it can proceed with the commercialization process, which increases the likelihood of achieving long-term success.

Proposition 1: A higher degree of entrepreneurial competencies in team members increases the likelihood of USO success.

3.2 The impact of opportunity type exploitation on USO success

For this research, the opportunity type will be categorized as being based on either a market pull or a technology push. A market pull and a technology push are two different sources of innovation. A venture that is technology-push-oriented is set up with the objective to commercialize a specific technology. The innovation that is being commercialized is based on an existing or developing technology. 'This type of strategy often involves a recourse-intensive 'probe and learn' process to market entry, requiring a revised marketing strategy, the implementation of specific upper-management strategies, and a willingness to undermine existing manufacturing capabilities'(Lubik & Minshall, 2013, p.13). Technology-based innovation commercialization is therefore a complicated process that requires high-level marketing skills. As described in the model of Vohora et. al (2004) later in this paper, academics possess significant technological knowledge, but insufficient knowledge of market requirements. A USO that exploits a technology push-based opportunity needs to overcome the problem of insufficient market knowledge. This additional difficulty makes the commercialization process more challenging and therefore decreases the likelihood of long-term success.

Market-pull-oriented ventures develop solutions to address expressed market needs in existing market segments that are specified in advance. (Lubik & Minshall, 2013, p.13) This strategy for commercialization starts with a clear vision of customer requirements and the target market segment. Therefore the need for high-level marketing skills decreases. This decreased need for market knowledge in combination with a less complicated commercialization process creates a higher likelihood of USO success.

The measurement of this variable assumes that the technology is feasible enough. In case the technology is not feasible, neither a market push nor market pull will have an effect on USO success. Therefore the following hypothesis is lined up:

Proposition 2: In case the technology is feasible, opportunity exploitation based on a market push increases the likelihood of USO success.

3.3 The impact of the quality of accessible business networks on USO success

Building networks and legitimacy provide access to resources. Universities and support actors are well placed to assist in accessing and acquiring these resources. (Rasmussen, Mosey, & Wright, 2011 p. 1341). According to Poponi et al. (2017), the creation of business networks and the possibility to enter relationships are important factors in university spin-off success. Ventures that are able to enter wide-reaching networks benefit from considerably larger amounts of knowledge, diverse perspectives, and the exchange of technology. The need to build networks is based primarily on market access (Poponi et al., 2017). 'The presence of a network is able to compensate for the inadequateness of investments in R&D and the vulnerability of university spin-offs, usually small enterprises, in the face of competitive changes'(Poponi et al., 2017). Business networks are conceptualized as networks through which the USOs have access to create commercial relationships. Although having access to high-quality business networks is crucial throughout the whole development process, the role of business networks is most significant in the pre-organization phase. Because the critical juncture of credibility needs to be overcome. Having strong business networks increases a USO's credibility which is needed to acquire necessary resources. Ultimately, this should increase the likelihood of long-term USO success.

Proposition 3: A higher quality of accessible business networks has a positive effect on USO success

4. RESEARCH DESIGN

4.1 Research context

The subject of this study is USO projects. This research tries to understand which success factors are relevant in achieving long-term success for these USO projects. The overarching goal of University spin-outs often reaches beyond monetary gains. The objectives are often to address grand business challenges, contribute to achieving sustainable development goals and solve societal issues. (sdgs, 2015)

As stated before, university spin-offs perform a range of important functions and have economic significance. Hence, USOs are selected as the subject of this paper. More specifically, USOs created at Dutch universities are being investigated. The reason for this specification lies in the strategies and practices of Dutch Universities in supporting entrepreneurship, along with the context of government policy. The Dutch government stresses a value creation agenda, which includes the support of knowledge exchange activities. 'Most higher education institutions in the Netherlands provide learning environments that support the development of entrepreneurial mindsets and competencies of their students.'(OECD Skills Studies, 2018) A large amount of Dutch universities provide effective support to start-ups and have entrepreneurship researchers on their staff. 'Furthermore, the reputation and networks that their alma mater offers can help start-ups to access resources for business growth' (OECD Skills Studies, 2018). Dutch Universities offer the required infrastructure to launch businesses, therefore this context is most useful to analyse University spin-offs.

4.2 Data collection

For this research, a series of interviews with team members of Dutch USOs is conducted. The interviews are semi-structured, therefore only a limited amount of predetermined questions are prepared in line with the theoretical constructs of interest, and the remaining questions will be dependent on the course of the conversation. Semi-structured interviews allow for objective comparison between interviewees while providing the opportunity for spontaneous exploration of topics. Besides identifying relevant success factors in the USO commercialization process, this study also entails the investigation of how these characteristics impact USO success. Conducting interviews is a data collection method that allows for a deeper understanding of the interplay of these factors. This technique allows for information based on social cues to be uncovered. An in-depth understanding of the USO commercialization process can be created, thus expanding the knowledge of this specific phenomenon. (Saunders et al., 2009)

4.3 Definition of constructs

4.3.1 USO success

USO success is in this study understood as the ability to survive and grow in the market. Therefore, University spin-off success is not expressed in monetary terms in this research. The reason for this is that for some founders the ability to positively impact the world is the definition of a successful business. It depends on the intention of the entrepreneur to determine what success means. This research will consider a University spin-off successful if it has been able to survive in the market for at least five years. The reason for this cut-off point is that after five years survival is no longer a highly critical issue. (Robinson & Min, 2008)

4.3.2 Entrepreneurial competencies

The entrepreneurial competency that captures the most important skill in the early stages of development is the opportunity development competency. As stated earlier this is defined as 'the ability to seek improvements in the opportunity combined with the ability to alter the opportunity according to new insights'(Rasmussen & Wright, 2015, p.788). The assessment for this variable will be separated into two sub-variables: market knowledge and flexibility. Market knowledge is defined as the ability to perform an adequate assessment of potential in and of markets. Flexibility is defined as the ability of the entrepreneur to quickly make changes in the development process based on external incentives. The understanding of the opportunity development competency is made more comprehensive by measuring it with multiple sub-constructs. The ability to identify a need in the market without the ability to be flexible enough to adjust to this need does not allow for adequate opportunity development. And vice versa, being flexible without an opportunity to adjust too does not facilitate opportunity development. Therefore, using sub-constructs to measure this variable is necessary. In order to establish the competency of opportunity development, both market knowledge and flexibility need to be present.

4.3.3 Opportunity type

Before the measurement of the opportunity type, technological feasibility is established. Technological feasibility is assumed when both the sensitivity to errors and the ease of use by the intended user are at a satisfactory level. To determine the sensitivity to errors the presumption is made that no product is entirely free of error. Therefore the sensitivity to errors is labeled acceptable if the product works outside of the lab in a robust and consistent way. In the assessment of the ease of use by the intended users, the presumption is made that the intended users possess the basic required knowledge and skills to handle the product.

The dichotomous variable 'opportunity type' has two values, market-pull or technology-push. As mentioned earlier in this report, a venture that is based on a technology push is initiated by technological developments after which demand in the market is created. A venture that is market-pull based is initiated by the identification of a specific market need after which a solution is developed.

4.3.4 Accessibility of business networks

The measurement of this variable builds on the research conducted by Abbas et al (2019). The access to business networks is based on partnerships with customers, alliances with other businesses, and ties to the University. Therefore, the accessibility of business networks is measured by multiple sub-variables such as entrepreneurial supplier interaction, entrepreneurial customer interaction, entrepreneurial competitor interaction, and partnerships with the University. The measurements include factors such as building partnerships, sharing knowledge, and the existence of structured agreements.

4.4 Data analysis

Qualitative data collection methods tend to generate a substantial amount of data. Therefore, transcripts are generated from the interview audio recordings. Content analysis is used to analyze these transcripts. In this research, content analysis is conducted by generating meaningful data units and classifying these units. The classification of these data units is used to understand the extent to which propositions are supported or contradicted. Throughout the content analysis, a combination of deductive inductive reasoning is applied. First, the collected insights are examined in line with the proposed theoretical constructs and their expected interplay by assessing the logic, depth and overall reasoning of the interviewees. Then, because of the semi-structured nature of the interviews, the possibility of discussing factors that are not part of the initial theoretical framework exists. These additional insights are analyzed using a combination of axial and selective coding.

5. RESULTS

The overall objective of this qualitative study is to investigate which factors are relevant in achieving USO success and how these factors facilitate this success. The data resulting from the interviews is sufficient to validate the theoretical framework. The propositions of the framework are supported and extended with new insights.

5.1 Entrepreneurial competencies

The sub-variable market knowledge is measured as the entrepreneur's ability to detect an opportunity in the market. The sub-variable flexibility is measured as the entrepreneur's ability to alter and improve the product based on new insights. These insights can originate from the technology, the market, or a combination of both. Table 1 shows the results of these measurements.

Table 1

		The ability to detect an opportunity in the market	Flexibility in terms of altering and improving the product based on new insights
USO 1		Confirmed	Confirmed
USO 2		Confirmed	Confirmed
USO 3		Confirmed	Confirmed
USO 4		Confirmed	Confirmed
USO 5		Not confirmed	Confirmed
USO 6		Confirmed	Confirmed

These results show that the majority of entrepreneurs of successful USOs were able to identify an opportunity in the market based on a specific market desire. And all of the entrepreneurs of USOs confirmed to be flexible. One of the entrepreneurs mentioned that 'the path that we took was not the only option we had. We choose the option that was the best fit with our resources. Any other resources we try to gain.' From this statement, the insight is gained that the ability to leverage and combine resources is an additional relevant entrepreneurial competence. The ability to leverage resources is defined as the systematic assessment of the use and potential of existing resources and the identification of the need for additional resources. Leveraging resources can be helpful to build a solution that provides the best market fit.

An interesting statement that was made regarding the flexibility of USOs is the following: 'At the start of building a spin-off, you need to be as flexible as possible. It usually takes years until you get to the point where you can consider yourself stable.' This statement emphasizes the importance of early-stage flexibility. In the early stages, new information and insights are acquired every day. The importance of being flexible while adapting to these new insights is expressed with the following statement of another entrepreneur: 'if you are not flexible you might be too late. Things might get expensive if you are resistant to change, especially in the beginning.' This statement indicates that flexibility can contribute to competitive advantage. It also supports the notion mentioned earlier, that adapting a product in the early stages of development can save the entrepreneur a considerable amount of money compared to when it is done in later stages.

The results of USO 5 show that although market competencies might contribute to the likelihood of success, it is not indispensable. The entrepreneur of this USO mentioned that they discovered a technology by accident, without active search beforehand. After this discovery there turned out to be a demand for this technology. This indicates that a high desirability and quality of a technology can cancel out the need for market knowledge of the entrepreneur. This is an example of a unique individual trajectory that has proven to be successful despite lacking a factor that is suspected to contribute to success.

These results show that the majority of the entrepreneurs held high-level opportunity development competencies. They were able to substantiate the importance of flexibility and market knowledge with in-depth argumentation. Therefore these findings support the proposition that a high level of entrepreneurial competencies in team members increases the likelihood of USO success. However, the support of this proposition is not completely straightforward. The proposition appears more complex than initially expected as the results show the possibility to achieve success without the detection of an opportunity in the market beforehand.

5.2 Opportunity type

Before measuring the opportunity type, the technological feasibility of the product needs to be established. The establishment of technological feasibility in all USOs is important to provide a fair basis for comparison of the effect of the opportunity type. The product or service is in this research considered technically feasible if the level of sensitivity to errors and the ease of use by the intended users is of an acceptable level. In the determination of the sensitivity to errors, the presumption is made that no product is 100% free of error. Therefore the sensitivity to errors is labeled acceptable if the product works outside of the lab in a robust and consistent way. In the determination of the ease of use by the intended users, the presumption is made that the intended users possess the basic required knowledge and skills to handle the product.

Table 2

	Sensitivity to errors	Ease of use by intended users	Establishment of technological feasibility
USO 1	Acceptable	Acceptable	Yes
USO 2	Acceptable	Acceptable	Yes
USO 3	Acceptable	Acceptable	Yes
USO 4	Acceptable	Acceptable	Yes
USO 5	Acceptable	Acceptable	Yes
USO 6	Not applicable	Not applicable	Not applicable

Table 2 shows that five out of six USOs have a technologically feasible product. USO 6 conducts business in the service industry, therefore the measurement of technological feasibility is not applicable and automatically makes this USO fit for this research. All USOs are suitable for research into the opportunity type on which the USOs are based.

Table 3

USO 1	Market pull-based
USO 2	Market pull-based
USO 3	Market pull-based
USO 4	Market pull-based
USO 5	Technology push-based
USO 6	Market pull-based

This table shows that the majority of successful USOs based their product or service on a market-pull-based opportunity. As mentioned earlier, it is expected that exploiting a market-pull-based product or service can cancel out the need for high-level marketing skills. It is therefore expected to simplify the commercialization process. This has increased relevance in USOs because academics tend to be technology-oriented but often lack high-level marketing skills. This notion is supported by the following statement made by one of the entrepreneurs: 'It would be possible to create a product without pre-existing demand and subsequently create demand in the market but this will be more challenging. In my experience, the fact that there was a pre-existing demand for our product made the commercialization easier.' This notion was supported in a separate interview by another entrepreneur with the following statement: 'It is more difficult when you base your product on technology and you have to translate it into a product, service or solution for a potential customer. I believe this process to be more complicated.'

These results show substantial support for the proposition that opportunity exploitation based on a market push increases the likelihood of USO success. The overall quality of the answers illustrates that the entrepreneurs supporting this proposition were able to state in-depth arguments on the increased complexity that comes with exploiting a technology push-based opportunity as opposed to a market-pull-based opportunity. However, the results also show evidence that it is not essential to exploit an opportunity for which a pre-existing market need is identified to

achieve success. Since one of the entrepreneurs proved to be successful despite exploiting a technology push-based opportunity. Therefore the support of the proposition is not completely straightforward.

5.3 Accessibility of business networks

The accessibility of business networks is measured with five sub-variables. The first four sub-variables establish the presence of partnerships with suppliers, customers, competitors, and the University in the development process. The last sub-variable establishes the presence of structured agreements. Structured agreements are defined as legally binding agreements confirmed in written documents. The presence of structured agreements is confirmed when the entrepreneurs were in the possession of at least one of the following documents to ensure agreements: contracts, license agreements, and non-disclosure agreements.

Table 4

	Knowledge sharing/partnerships with suppliers	Knowledge sharing/ partnerships with customers	Knowledge sharing/partnerships with competitors	Knowledge sharing/partnerships with the University of Twente	Presence of structured agreements
USO1	Yes	Yes	No	Yes	Yes
USO2	Yes	Yes	No	Yes	Yes
USO3	Yes	Yes	No	Yes	Yes
USO4	Yes	Yes	No	Yes	Yes
USO5	No	Yes	No	Yes	Yes
USO6	No	Yes	No	Yes	No

The results in table 4 show that the majority of the entrepreneur participated in partnerships with suppliers. And all of the entrepreneurs of successful USOs confirmed to have partnerships with both the university and with customers. The unanimity of these results in combination with the strong argumentation for why these networks are important makes these factors very relevant. One of the entrepreneurs mentioned that building networks in the early phases of the process can bring you long-term relationships. These long-term relationships can help with venturing operations also after the first critical years. From this statement the insight is gained that establishing networks early on can help to overcome difficulties in the later phases of development, eventually increasing the likelihood of a successful commercialization process.

Partnerships with the University were explained as a particularly important source of competitive advantage because they provide the USO with the ability to minimize research and development costs. The statement was made that participating heavily in university research programs allows the USO to outsource research and development activities without the need to spend time and money on them. The USO only needs to provide these University research groups with knowledge. It was said that these collaborations were essential to creating a research and development shell around the company.

Another interesting observation that can be made from the results is that none of the entrepreneurs had partnerships with competitors. From this observation, the insight is gained that networks with competitors cannot be identified as a success factor in the USO development process. Argumentation against participating in competitor networks explained that these networks include knowledge-sharing activities. When competing in an innovative field the uniqueness of the product is often the source of competitive advantage. Sharing knowledge with competing ventures therefore can remove this source of competitive advantage.

From the results and in-depth argumentation on the specific partnerships the proposition stating that a higher quality of accessible business networks has a positive effect on USO success is supported. However, caution needs to be taken because only certain partnerships in the network positively contribute to success. Partnerships with competitors are not included in this network.

6. DISCUSSION

It has become evident that University spin-offs have economic significance as they form a mechanism for transferring innovative technology to the industry. They offer the potential to enhance economic development. (Mathisen & Rasmussen, 2019). However, they often fail to achieve an adequate level of performance. (Poponi et al., 2017) Therefore the need for a clear understanding of the university spin-off commercialization process has increased in recent years. Prior research has uncovered insights into factors that impact University spin-off success. Yet, there is a lack of understanding of characteristics that are relevant in the early stages of development. This research aimed to identify early-stage characteristics that increase the likelihood of achieving USO success. For this purpose, a set of interviews has been conducted with six owners of successful University spin-offs originating at Dutch Universities.

The results show that a high level of entrepreneurial competencies increases the likelihood of USO success. This finding supports the research conducted by Gumusay & Bohné (2008) that stated that entrepreneurial competencies can be a primary source of competitive advantage. These entrepreneurial competencies are especially important during the pre-organization phase. High-impact decisions need to be made in the pre-organization phase which increases the importance of flexibility of the entrepreneur. Flexibility is important to avoid path dependency. An inability or reluctance to change due to a situation of path dependency can lead the USO to a less optimal commercialization process. The ability to be flexible allows the entrepreneur to exploit the most optimal opportunities while reacting to the most recent insights in technology and market developments resulting in a higher chance of long-term success. Besides flexibility, the ability to detect an opportunity in the

market also has a positive effect on USO success. An entrepreneur that is highly competent in detecting market opportunities can profit from early market entry advantages. Early detection of promising market opportunities can therefore be a source of competitive advantage. The results however are not completely straightforward. It has been found that once the technology that is being exploited is perceived as highly desirable by the market, it is not necessary to detect a specific market opportunity. A highly desirable product automatically creates demand in the market and therefore cancels out the need for a high degree of market knowledge. As described in the model of Vohora (2004) academics possess significant technological knowledge, but often insufficient knowledge of market requirements. Therefore it is helpful for entrepreneurs to exploit an opportunity based on a pre-existing demand in the market. This type of opportunity is based on a market pull and reduces the need for a high degree of market knowledge.

At this same stage, the possibility to access business networks is increasingly important according to Vohora (2004). The results of this paper support this finding by Vohora. In the pre-organization phase, the critical juncture 'credibility' needs to be overcome. Being credible is crucial for acquiring resources (Vohora et al., 2004). Entrepreneurs that enter wide-reaching business networks benefit from considerably larger amounts of knowledge, diverse perspectives, and the exchange of technology. Therefore, these partnerships increase the perceived credibility of the University spin-off and facilitate access to externally acquired resources. Partnerships with suppliers, customers, and the University have proven to be relevant in achieving USO success. Partnerships with competitors were intentionally declined by the entrepreneurs to avoid knowledge-sharing activities with competing firms. Therefore, networks with competitors did not positively contribute to USO success. To avoid the inability of the entrepreneur to continue its operations due to a lack of resources, which is a common difficulty start-ups, there is another factor that has been shown to be important besides access to credible partnerships. This additional factor is the ability to leverage resources. An entrepreneur that is highly competent in leveraging resources can compensate for an initial lack of internal or external resources by getting the most from the available resources. Therefore, leveraging resources is another factor that can help to overcome the problem of insufficient resources that is often present in the early phases due to the liability of newness.

To conclude, entrepreneurs can use the finding derived from this research to evaluate the characteristics they have or need to acquire for increasing the likelihood of achieving long-term success. Active evaluation of their current situation based on these findings enables them to improve the performance of their University spin-off.

7. THEORETICAL AND PRACTICAL IMPLICATIONS

This paper contributes to existing literature streams on academic entrepreneurship by providing new insights into characteristics in early-stage development that contribute to long-term USO success. The most important implication for entrepreneurs is that participating in credible business networks in combination with a high degree of entrepreneurial competencies influences the likelihood of completing a successful commercialization process. And therefore, increasing the likelihood of survival in the market. This supports the finding by Vohora (2004) stating that entrepreneurial competencies and access to networks are important factors in acquiring key resources. Additional information from the interviews shows that special emphasis is placed on the importance of the ability to leverage resources, indicating that this is an important factor in USO success. The ability to efficiently leverage resources reduces the need for a widespread business network in acquiring external resources. Other specific findings indicate that business networks positively contribute to success if the partnerships are with suppliers, customers, or the University. This supports the findings by Rasmussen, Mosey & Wright (2011) that state that Universities are well placed to assist in accessing and acquiring resources. And the findings by Poponi et al. (2017) that state that business networks are important factors in university spin-off success. Partnerships with competitors are emphasized to negatively affect USO success as sharing knowledge with competing firms will eliminate the competitive advantage that comes with having exclusive access to a specific technology. An implication that is specific for entrepreneurs that exploit an opportunity based on a market pull is that they have the advantage of an easier commercialization process. And therefore they do not need high-level market knowledge. This also indicates that entrepreneurs that exploit a technology-push-based opportunity need higher marketing skills to successfully commercialize their technology.

8. LIMITATIONS

Limitations became apparent at different stages in the process of this research. The interviews were conducted with highly knowledgeable and experienced entrepreneurs. This makes the data relatively reliable. However, the nature of the qualitative research method does not provide the opportunity to empirically test causal effects. This study does not quantitatively establish the causal relationships that are proposed. The scope of the study is limited to developments in the early phases of the commercialization process. Therefore it does not account for later phases in the development process. Also, this study includes only a limited amount of USO characteristics and therefore the study does not account for all the other characteristics that affect the development process. So despite the fact that the research is relatively comprehensive, it does not include all the relevant factors. Furthermore, the focus of this paper lies with Dutch USOs, which implies that the results are only relevant in the context of the Dutch education system. The results do not apply to USO development in other countries and can therefore not be generalized.

9. FUTURE RESEARCH

Future research can build on this study by including unsuccessful University projects in the analysis of success factors. In this paper, only USOs that have proven to successfully commercialize their technology and survive in the market have been researched. Including University projects that failed to commercialize their project in addition to successful USOs might lead to different insights. Furthermore, future research might repeat this study using quantitative research methods to empirically test the proposed causal effects. Another interesting research topic for future research is to investigate which factors are relevant in solving societal issues by USOs.

This research study is conducted in the context of Dutch technical universities with a strong entrepreneurial ecosystem, where student entrepreneurship is on the rise. Hence, this study calls for future research examining the impact of proposed entrepreneurial competencies on the regional economic and societal impact of student-USOs. Lastly, future research can replicate this study in other institutional settings or other countries.

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