Heikki Immonen

APPLICATION OF OBJECT-PROCESS METHODOLOGY IN THE STUDY OF ENTREPRENEURSHIP PROGRAMS IN HIGHER EDUCATION

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Abstract

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An entrepreneurial university is engaged in university entrepreneurship, and entrepreneurship programs are the specific ways universities organize their activities to fulfil this purpose. Due to the lack of a conceptual framework and methodology that can address the complex and multi-scale nature of the phenomenon, the field has remained in a descriptive stage. In this dissertation, to help the field move towards prescriptive theory, a set of eight criteria are defined that the methodology needs to satisfy. It is then shown that object-process methodology (OPM), incorporating insights from systems engineering and complexity science, is capable of conceptually modelling a wide range of university entrepreneurship-related phenomena across multiple scales. The adoption of OPM implies the centrality of stakeholders and stakeholder-related phenomena as key in understanding the formation and survival of entrepreneurship programs.

To validate this insight further and demonstrate the applicability of the OPM framework, three conceptual studies and two empirical studies are designed and completed. Results of the conceptual studies utilizing systems engineering -based methods (stakeholder analysis, functional analysis, and analysis of harnessable phenomena) led to the recognition of *a*. 17 entrepreneurship program stakeholder types with varying expectations, *b*. three main functions (business operating, business developing, and business meta-developing), and three sub-functions (resource acquiring and maintaining, targeting and selecting, and value creating) an entrepreneurship program can have, and *c*. a scale and function-based categorization framework for phenomena a program designer can harness, including the Finnish higher education financial incentive phenomena.

First empirical study observes stakeholder-related patterns in 45 Finnish entrepreneurship programs' value propositions, and the second longitudinal empirical study provides evidence for the importance of the program having stakeholder-matching value offerings in the survival of 117 so-called good practices of entrepreneurship support four to five years after being listed as good practice. This dissertation demonstrates the value of OPM in the study of university entrepreneurship, and the findings can help future researchers to develop prescriptive theories that are practically applicable to entrepreneurship program designers and managers.

Keywords: university entrepreneurship, entrepreneurship programs, object-process methodology

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Heikki Immonen
March 2021
Joensuu, Finland

Contents

1 Introduction

1.1 The background and positioning of the research

A university that has a role as an economic developer, especially via entrepreneurship, is called an *entrepreneurial university* (Audretsch, 2012). An entrepreneurial university is engaged in *university entrepreneurship*, while *entrepreneurship programs* are the specific ways universities organize their activities to fulfil this purpose. The distinction between broader policy and specific programs is important as the emphasis in this dissertation is on specific programs. The broader innovation policy discussions, like ecosystem perspective (Isenberg, 2011; Mason & Brown, 2014), broad-based innovation policy (Edquist et al., 2009; Harmaakorpi et al., 2017), or helix-models (Etzkowitz & Leydesdorff, 2000; Miller et al., 2018b) are important and yet only a backdrop to this dissertation. These broader strokes are excluded from the more detailed discussions beyond the initial literature review as well as later when the implications of the research are discussed. Instead, the perspective adopted in this dissertation emphasizes entrepreneurship programs as designable systems developed to satisfy its stakeholders' often complex and contradicting expectations.

EU views higher education innovation policy and entrepreneurship as one of the keys to future prosperity (EU Commission, 2017). OECD (2015) and World Economic Forum (Dodgson & Gann, 2020) likewise emphasise the role of entrepreneurship in higher education. However, given its current importance, a university's recognized role as an economic actor is not particularly long. Audretsch (2012) describes how the universities in war-time US were recognized as developers of advanced technologies, and how legal reformations, especially the Bayh-Dole Act in 1980, made it easier for companies to benefit from university-born inventions via technology-licensing. As will be discussed later in this dissertation, and as a curious detail, the development of systems engineering practices started from similar large-scale technology development projects of the Second World War (Walden et al., 2015; de Weck, 2015a).

In economics, with the development of the endogenous theory of economic growth, knowledge was added as an economic input alongside labour and capital, explaining the dynamics of economic growth (Romer, 1986). Following this, the concept of knowledge transfer from university to the economic actors has become a central concept in many models of the entrepreneurial university and university entrepreneurship (Rothaermel et al., 2007; Audretsch, 2012). In models describing academics' engagement with the industry, the arrow of knowledge pointing from industry to the university is also recognized (Perkmann et al., 2013; Bradley et al., 2013). From the businesses' side, lead user innovation (Von Hippel, 1986) and open innovation (Chesbrough, 2003) theories evolved to explain the adoption of external innovations. However, all of these knowledge transfer perspectives are mostly excluded from this study and only included as to the extent they serve as an indication of stakeholder expectations and underlying socio-economic phenomena.

Moving to the 21st century, models describing the university as a facilitator and supporter of entrepreneurship and as an entity able to influence a region's so-called entrepreneurship capital started to emerge (Audretsch & Keilbach, 2004; Guerrero et al., 2015). Indeed, it was not enough to just license technologies to existing companies, universities also need to support the creation of new startup companies and spin-offs via specific programs and initiatives (Rothaermel et al., 2007). Culture became a new component, even in the models of technology-transfer (Bradley et al., 2013). However, high-level concepts and models of entrepreneurship capital and entrepreneurial culture are relevant to this study only as far as specific cultural, naturally occurring socio-economic phenomena are usable or beneficial (see below "Means to fulfil a human purpose") to entrepreneurship program designers.

As past descriptive studies of business incubators, accelerators, and other such programs have shown, education and training are an important part of the programs. Indeed, as will be discussed in more detail in this dissertation, new business creation and entrepreneurship education overlap and combine in many ways, including more education-oriented programs with less emphasis on concrete business results, and new business creation programs where training is important only to the extent it helps with the realization of a specific business idea. Even though entrepreneurship education is an important part of this study, typical concepts from entrepreneurship education research such as internal vs. external entrepreneurship (Seikkula-Leino et al., 2010; Lackéus, 2015) and entrepreneurial intentions (Krueger & Carsrud, 1993; Joensuu et al., 2013; Linan & Fayolle, 2015) are not actively used in this study. Instead, findings from these fields are used in a minor way as a method to better understand the role and expectations of specific entrepreneurship program stakeholders.

Finally, there is a large body of literature regarding specific innovation methods, ranging from design thinking (Brown, 2008), to customer need mapping (Betterncourt & Ulwick, 2008), to the behavioural patterns of innovators (Dyer et al., 2009), and new business development approaches, involving uncertainty reduction (McGrath & MacMillan, 1995), hypothesis testing (Ries, 2011), and business model development (Osterwalder & Pigneur, 2010; Christensen et al., 2016). The relevance of these studies to this dissertation is more direct as a method or an approach can be seen as something entrepreneurship programs utilize. To be more specific, using the conceptual framework of this dissertation, methods and approaches can be partially equated with entrepreneurship programs themselves as methods and approaches fit the definition of entrepreneurship programs as "means to fulfil a human purpose" (see below).

Focus of the dissertation

The focus of this dissertation is twofold. The first issue this dissertation addresses is the *methodological and conceptual challenges university entrepreneurship research has due to the overall complexity and multi-stakeholder nature of the phenomena* (Rothaermel et al., 2007; Grimaldi et al., 2011; Ollilla & Middleton, 2011). These challenges have prevented university entrepreneurship research from becoming a fully practical field. To overcome this hurdle, a set of eight criteria will be defined that specify the features a conceptual framework and methodology need to have in order to help the field move forward from the descriptive to a prescriptive stage. As a result, *object-process methodology* (OPM), incorporating insights from systems engineering and complexity science, is introduced as a framework that satisfies all the criteria and can further the research and the future practical application of the research results in the field. This adopted framework then leads to the second focal point of this dissertation, which is understanding *the stakeholders' role in the formation and survival of entrepreneurship programs.* Stakeholders and satisfying their expectations are key to any complex system design process (Lightsey, 2001; Bar-Yam, 2004; Walden et al., 2015; de Weck, 2015a; NASA, 2017).

By adopting this framework, *entrepreneurship programs* can be defined as *purposed systems* that have either been designed or evolved to serve various purposes, that is, *functions*, ranging from *entrepreneurship education* to *new business creation*. Accordingly, entrepreneurship programs in higher education take and have taken many forms, including business incubators and accelerators, entrepreneurship education-oriented programs, technology transfer offices, and support services for student and academic entrepreneurship (Rothaermel et al., 2007; Schmitz et al., 2017).

Means to fulfil a human purpose

The conceptual framework of the dissertation defines all technologies, including social ones, such as legal codes, organizations, and entrepreneurship programs, *as means to fulfil a human purpose* (Arthur, 2009). This definition is in part based on the seminal work of complexity science pioneer and economist W. Brian Arthur, who studied the nature of technology and its evolution. The definition is also aligned with more broadly adopted concepts from systems engineering (see below). Thus, we can also use a parallel definition of an entrepreneurship program as a *system*, that is, a *function-providing object* (Dori, 2016). One of Arthur's discoveries was that all technologies are composed of existing earlier technologies, and accordingly, new technologies emerge as combinations of existing ones. Similarly, a modern business incubator or an accelerator can be seen as a combination of several earlier means, such as formal training modules, early-stage funding agreements, and practices that help startups access resources via a network (Hacket & Dilts, 2005; Pauwels et al., 2016).

Arthur went further in his analysis and discovered that all technologies, including social systems, work only to the extent that they are *able to harness naturally occurring phenomena*. Physical technology, such as a thermometer, works by harnessing the natural phenomenon of materials' dimensional expansion when heated. Likewise, purposed social systems, like entrepreneurship programs, need to harness naturally occurring phenomena, which in this case are socio-economical. For example, the phenomenon of *economies of scale* lowers the cost per user of certain resources, such as facilities, when the same resource is shared by many participants in the same entrepreneurship program (Brúneel et al. 2012). Another example would be the *peer learning effect* and its impact on the attitude and motivation of the participants belonging to the same startup cohort during an intensive four-month long accelerator program (Cohen, 2013).

Both of these fundamental assumptions, 1. entrepreneurship programs are means to fulfil a human purpose and 2. programs need to harness socio-economic phenomena, point to the importance of users, and more broadly, *stakeholders as a central unit of analysis in the study of entrepreneurship programs*. In fact, there has been a small trend towards this direction inside the field in recent years as several papers have studied how stakeholders, such as program sponsors and participants, are connected to the entrepreneurship program value propositions (Bruneel et al., 2012; Pauwels et al., 2016), performance (Cohen et al., 2019), or implemented pedagogical style (Nabi et al., 2012 Lackéus, 2015).

Object-process methodology

The terminology and concepts Arthur used strongly overlap with more broadly used concepts from systems engineering. Accordingly, part of the central argument of this dissertation is that to benefit from Arthur's insights and to manage the complexities of entrepreneurship programs, a methodology and formalism that utilizes the decades of practices and knowhow of systems engineering should be adopted. Specifically, this dissertation introduces a novel ontology and methodological approach to the field by adopting *object-process methodology* (OPM) as the conceptual framework and methodology of study. OPM has been utilized earlier in fields as distant as cell biology (Dori & Choder, 2007), Mars mission planning (Do, 2016), and business process improvement (Casebolt et al., 2020). Earlier, the author of this dissertation also implemented it in the study and analysis of a single entrepreneurship program (Immonen, 2019a). In this dissertation, OPM is utilized in three conceptual and two empirical studies related to the stakeholders' role in the formation and survival of entrepreneurship programs.

Object-process methodology belongs to a branch of systems engineering called model-based systems engineering. It is itself a universal ontology and a new ISO 19450 standard. As a dual-channel modelling language, it can be used to represent systems of any type in both written and visual form. OPM is based on a small set of ontologically fundamental concepts: *objects*, *processes*, and the *relationships* between these two. Most basic symbols of OPM are shown in Figure 1.1. The rectangle symbolizes objects, while processes are represented with ellipses, and relationships between these are shown with arrows and lines of various types. *Physical* objects and processes are distinguished from *informational* ones with a grey shadow. (de Weck, 2015c; Dori, 2016)

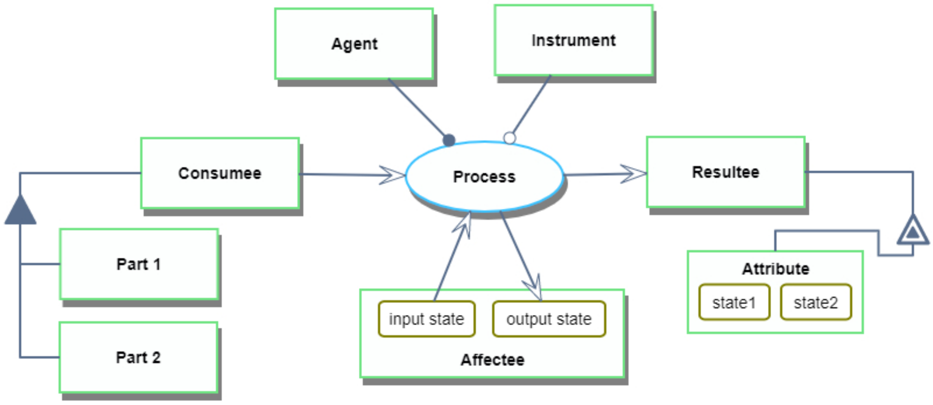

Figure 1.1: Basic symbols in OPM.

Central to OPM is the separation of objects and processes. Objects are the stable side of existence (or potentially in existence) that can be observed and measured, while processes are the transformations and changes that take place. Processes cannot be observed directly but only indirectly in how they change the objects. The three fundamental types of processes are *consumption* (where an object gets consumed), *creation* (where an object is created), and *transformation* (where the state of an object is transformed). Using OPM, entrepreneurship programs are seen as systems (objects) that enable a purpose-fulfilling process, that is, a *function*, to take place. This purpose can be, for example, the creation of a new business or the licensing of a technology to a startup company (Bradley et al., 2013).

Complexity and scale management are achieved in OPM by allowing researchers or designers to zoom in to the model and add or reduce details when needed (Dori, 2016). A detailed introduction to OPM and systems engineering and its use in the study of university entrepreneurship and entrepreneurship programs is provided later in this dissertation.

1.2 Motivation of the dissertation

This dissertation is motivated by the *conflicting nature of evidence regarding the impact of university entrepreneurship, entrepreneurship education, and the recent unexpected results regarding entrepreneurship itself*. Indeed, even though the value of innovative entrepreneurship is undisputed (Wong et al., 2005; Van Praag & Versloot, 2007) and universities' involvement is a growing trend (Hofer & Potter, 2010), the approaches that are being implemented on the basis of the current level of understanding in a university context seem to produce only mixed results. Ideally, a causally sound and practically applicable theory would enable entrepreneurship program designers and managers to design programs that produce clear results, which is not the case at the moment.

With the goal of understanding entrepreneurial success better, recent findings by MIT's Pierre Azoulay and his co-authors (Azoulay et al., 2020) convincingly bust the so-called young entrepreneur myth, which states that young people with their creativity and energy are the best and most potential candidates for entrepreneurs. Large portions of university entrepreneurship, especially with the emphasis on entrepreneurship education, have been based on this common idea that more young people should become entrepreneurs (Guerrero et al., 2015, Dodgson & Gann, 2020). Findings by Azoulay et al. show that entrepreneurial success is, up to a point, positively correlated with age, meaning that the younger a person is, the poorer the chances of succeeding entrepreneurially. Using business survival and business performance data and demographic data of US entrepreneurs, Azoulay et al. discovered that it is, in fact, middle-aged people with prior industry experience in the field of their new business endeavour that are most likely to succeed. This finding holds also for fast-growing high-tech industries.

Regarding universities' role in the growth of regional companies, Brown and Mason (2014), in their empirical paper, and Mason and Brown (2014), in their report to the OECD, show that average universities actually seem to have only a fairly small role in the growth and creation of new businesses. Most new growth seems to be based on corporate spin-offs and innovations emerging from the interactions with the customers and end-users rather than from high-tech technology licensing. When it comes to specific programs, authors such as Hacket and Dilts (2004) and Winston-Smith and Hannigan (2015) report that the impact of accelerators or incubators is small and unclear. They are not particularly good job creators on the regional level and the impact on the participating startups is not clear. Hallen et al. (2014) explain the situation as a difficulty in designing a proper accelerator because the data and models are so highly skewed by a few top performers. Likewise, entrepreneurship education seems to be able to generate only a very modest impact (Martin et al., 2013; Nabi et al., 2017).

In summary, the obvious disparity between the goals of university entrepreneurship and the actual economic results is a key motivator behind this dissertation.

1.3 The research problem and research questions

The research problem this dissertation is hoping to solve is *the lack of methodology and framework that can address the stakeholder-induced complexities of the university entrepreneurship phenomena*. It is this mismatch between the complexity and the methodology that has prevented the field from moving beyond descriptive theory.

Using the process of theory building by Christensen (2006) and Christensen and Carlile (2009), it can be argued that the stage in which the field of university entrepreneurship and entrepreneurship program research have remained is the descriptive and inductive stage of theory. The field has failed to move beyond descriptive studies and correlative models. In their major review of the field, Rothaermel et al. (2007) claim that the field could even be characterized as *atheoretical*, which is confirmed by Schmitz et al. (2017) ten years later. As it is, recent major studies and reviews by authors such as Bruneel et al. (2012), Pauwels et al. (2016), Miranda et al. (2018), and Cohen et al. (2019) have been satisfied mostly with classifying various forms of business incubation or acceleration. Even in the best cases, studies have only been reporting how certain features of these programs, such as the use of external mentors, correlates with accelerator performance.

The reason for the current state of affairs and the field's failure to move forward can be found by reviewing the relevant literature. Several reviewers and authors report that it is, in fact, the high complexity and multi-scale and multi-stakeholder nature of university entrepreneurship that has prevented past researchers from developing a more practical understanding (Rothaermel et al., 2007; Grimaldi et al., 2011; Schmitz et al., 2017; Miller et al., 2018). Thus, in this dissertation it is argued that the problem at its core is, in fact, methodological and conceptual.

On one hand, the complexity is seen in the plurality of stakeholders ranging from students to academics to entrepreneurs, corporations, governments, investors, and many other actors. It is also evident in the diversity of goals and objectives starting from the three separate missions of the university itself: research, education, and economic development (Rothaermel et al., 2007). Furthermore, the scale of these impacts and dynamics to be modelled ranges from the micro-actions of the individual to the long-term evolution of the economy, with many levels of spatial and temporal scale in between, including the group, team, startup, faculty, cohort, market, entrepreneurial ecosystem, local economy, national economy, and global economy. Based on the current problematic state of the research, the first research question becomes the following:

1. What conceptual framework and methodology can help university entrepreneurship research transform from descriptive to prescriptive?

This question is further specified in Chapter 2 by defining the eight criteria the conceptual framework and methodology need to satisfy. Following this, the argumentation for the suitability of object-process methodology as a conceptual framework and a toolset and as an answer to the first research question is provided in Chapter 3 by showing how this framework satisfies each of the eight criteria. More evidence for the validity of the object-process methodology is provided further in the dissertation by implementing it in three literature-based conceptual studies and two empirical studies. As discussed earlier, the OPM framework incorporating insights from Arthur and others indicates that *understanding the role of stakeholders' in university entrepreneurship* is key to developing a better theory. Thus, the second research question is:

2. Are stakeholders' expectations and the stakeholder-based socio-economic phenomena associated with the programs key to understanding the formation and survival of entrepreneurship programs?

To answer this question, it must be viewed through the lens of the adopted conceptual framework. In systems engineering, the stakeholder-specific information and the bits of knowledge that guide the design choices and define the system's purpose are called *stakeholder expectations* (de Weck, 2015a; NASA, 2017). The framework indicates that if the purposes a system was designed to fulfil do not match its stakeholders' expectations or the system does not properly harness the socio-economic phenomena associated with the stakeholders, the system is bound to fail. Thus, the second question can be decomposed into three specific questions, which, when answered, can help answer the second research question. Research questions 3 to 5 are:

3. What are the expectations of entrepreneurship program stakeholders?
4. Is there any universal purpose or purposes all entrepreneurship programs share? If so, what would those be?
5. What phenomena can be harnessed to fulfil said purposes?

The focus of this dissertation is further narrowed down by focusing on entrepreneurship programs in higher education in the Finnish context. Thus, the answers given will be more valid in this context. The detailed background to research question one will be provided in Chapter 2 and the logic of research questions 2 to 5 is laid out in detail in Chapter 3.

1.4 Aim of the research

The overall aim of this research is to *successfully implement a new conceptual framework and methodology in the study of entrepreneurship programs in a way that yields elements of a prescriptive theory which can explain entrepreneurship program formation and survival*. The term *prescriptive theory* is based on Christensen and Carlile (2009) and their process of theory building. Prescriptive theory follows descriptive theory, and according to Christensen and Carlile, first starts as a predictive theory and then evolves via improvements caused by anomalies into a highly practical circumstance-specific theory, which practitioners, managers, engineers, and designers can utilize. When theory is at this advanced stage, it provides guidance by stating that if you are in situation A and you want to reach B, you should do C.

In the current state of research, entrepreneurship program designers and managers cannot make robust theory-based design choices. Thus, the aim of the field as a whole should be taking the leap from inductively derived descriptive theory to prescriptive theory based on explanations of cause and effect. The purpose of this dissertation is to aid in this transition by implementing a novel framework, that is, OPM, to handle the stakeholder-related complexities of the field, and in doing so, to produce findings that explain observable forms and survival of entrepreneurship programs in higher education.

As the focus of this dissertation is on entrepreneurship programs in the Finnish higher education context, the additional goal of this study is to provide specific contextual information and knowledge that is useful for practitioners and future researchers of entrepreneurship programs in the Finnish context.

1.5 Research approach

From a general research design perspective, this dissertation is a *combination of literature-based conceptual theory building work and an empirical case-study-based research combining both qualitative and quantitative methods*. Considerable effort is put into demonstrating the validity of adopting OPM as a useful framework and methodology for the study of university entrepreneurship and entrepreneurship programs. The argument in support of OPM is presented in this dissertation by:

1. defining the eight criteria based on past research a new framework needs to satisfy and by showing how OPM, incorporating insights from systems engineering and complexity science, satisfies all the criteria
2. implementing OPM in a set of literature-based conceptual studies as a theory-building method and as a practically applicable tool for understanding stakeholders' expectations, deriving programs' purposes from those expectations, and as a tool for analysing stakeholder-related complex socio-economic phenomena
3. using OPM as an inductive content analysis tool in both qualitative and quantitative empirical studies (multiple case study and longitudinal study)
4. showing that the patterns in the empirical observations of real entrepreneurship programs in the Finnish higher education context match the literature-based conceptual findings developed by using OPM.

Ontologically this dissertation rests on OPM, a universal ontology, which is in line with the minimal ontology principle:

> If a system can be specified at the same level of accuracy and detail by two languages of different ontology sizes, the language with the smaller size is preferable to the one with the larger size, provided that the specification comprehensibility of the former is at least comparable with that of the latter. (Dori, 2016, p. 77)

As everything in OPM can be modelled using the basic concepts of objects, processes, and relationships between these two, OPM is conceptually as simple as possible. Being a formal dual-channel modelling language, OPM is well-suited to pruning theories of conceptual ambiguity and, for example, in facilitating communication between stakeholders and designers (Dori, 2016). The author of this study has experimented with using OPM earlier in the modelling of a single entrepreneurship program (Immonen, 2019a).

The **epistemological** background of this dissertation is defined by the process of theory building by Christensen and Carlile (2009). Christensen and Carlile define theory “as a body of understanding” (p. 240). In OPM, theories are represented as models. Relationships between cause and effect are easy to model as the flow of time is directly captured by the models (Dori, 2016). Thus, the assessment of the validity of OPM models, that is, theories, and their evolution is explained by the process of theory building by Christensen and Carlile, which states that in the end the validity of knowledge rests on experiments and on various theories’ ability to produce practically applicable guidance. A quick overview of the theory-building process was provided in this introduction, and a more detailed description is provided after the literature review in the latter part of Chapter 2.

Table 1.1 summarizes the research approach used in this dissertation specified for every research question. Chapters and numbers in parenthesis signify the chapters where the findings, that is, the answer to the research question, are provided.

Table 1.1: Research questions and summaries of research approaches.

Research question	Summary of research approach
1. What conceptual framework and methodology can help university entrepreneurship research to transform from descriptive to prescriptive?	Answered by: 1. defining eight criteria the framework and methodology must satisfy (Chapter 2), 2. then providing literature-based evidence and rationale showing that object-process methodology satisfies all the criteria (Chapter 3), and 3. demonstrating the applicability of the methodology by implementing it in three conceptual and two empirical studies. (Chapters 5 & 6)
2. Are stakeholders’ expectations and the stakeholder-based socio-economic phenomena associated with the programs key to understanding the formation and survival of entrepreneurship programs?	Answered in Chapter 6 by conducting one empirical multiple case study and one longitudinal study (sample sizes 45 and 117), utilizing both qualitative and quantitative methods. A set of variables is synthesized from the qualitative data, and the patterns in the data are observed quantitatively. Finally, patterns are compared to the conceptual findings, resulting in answers to research questions 3 to 5.
3. What are the expectations of entrepreneurship program stakeholders?	Answered by implementing stakeholder analysis: generating a list of stakeholders based on existing literature, finding stakeholder-specific information, and converting literature findings into simple OPM models. Results are supplemented with information regarding the Finnish higher education context. (Chapter 5)
4. Is there any universal purpose or purposes all entrepreneurship programs share? If so, what would those be?	Answered by implementing functional analysis: developing higher-level OPM models from the simpler models (a form of conceptual cross-sectional study) that specify programs’ main functions, doing a round of functional decomposition to uncover a set of sub-functions for each main function, and finally analysing the dynamics between the sub-functions. Together the main functions and sub-functions define the potential purposes of entrepreneurship programs. (Chapter 5)
5. What phenomena can be harnessed to fulfil said purposes?	Answered by conducting an analysis of harnessable phenomena: analysing levels of scale across derived main functions, conducting a literature search to find suitable research-based phenomena, categorizing found phenomena based on associated function and scale of that function, and finally developing a context-specific model of the Finnish higher education incentive structure. (Chapter 5)

In reference to research questions 3 to 5, the conceptual part of this study is based on the analysis of tens of past studies that have focused on the various aspects of entrepreneurship programs' stakeholder types and their expectations. OPM is used to model and observe shared patterns in past stakeholder research findings so that universal entrepreneurship program functions (purposes) can be derived and stakeholder-related phenomena analysed.

In the empirical part, one multiple case study and one longitudinal study are performed. In the first study, a sample of 45 Finnish entrepreneurship programs is analysed both qualitatively and quantitatively to observe whether or not the programs' stakeholders' influence can be seen in the programs' value propositions as presented on their websites. In the second study, the survival of a set of 117 so-called good practices in entrepreneurship support in Finnish higher education are observed four to five years after they have been named as good practices in a report by the Ministry of Culture and Education (Viljamaa, 2016). The characteristics of the practices that survived and those that did not are compared to the conceptual findings.

1.6 Scope and limitations

The scope and limitations of this research vary for each research question and result. The stakeholder analysis has universal country-independent components, but it is also to some extent focused on the higher education scene in Finland. Earlier research, or the literature analysis it is based on, is not all-encompassing, which to some extent limits the reliability of the conceptual findings. On the other hand, the functional analysis will be in its scope as general as possible, and it remains without any country- or culture-specific details. Finally, the analysis of harnessable phenomena is partly based on the unique incentive structures in the Finnish higher education environment and partly on the universal phenomena associated with the entrepreneurial process as reported in the literature. The literature review of said phenomena is in no way all-encompassing but limited to select, influential past findings.

The two empirical studies are limited by the fact that the two samples consist of entrepreneurship programs and good practices of entrepreneurship support from Finnish universities and universities of applied sciences. As the sample sizes are relatively small, 46 and 117, given the low number of entrepreneurship programs in Finland, quantitative patterns are not conclusive. As such, results cannot be generalized beyond the Finnish higher education context.

1.7 Contribution

There are several ways this dissertation contributes to the study of entrepreneurship programs and university entrepreneurship. First, by defining entrepreneurship programs as purposed systems, a new conceptual framework centred around object-process methodology is introduced to the field. Second, the applicability of object-process methodology and specific systems engineering techniques in the study and design of entrepreneurship programs is demonstrated by implementing it in several small conceptual and empirical studies.

Thus, this dissertation produces conceptual literature-based findings regarding the stakeholder expectations of entrepreneurship programs, the universal purposes entrepreneurship programs can have, and the phenomena programs can harness to fulfil those purposes. Together these conceptual findings provide a general framework for practitioners to base their design choices on. Fourth, the dissertation also provides empirical evidence on the centrality of stakeholders' expectations and stakeholder-associated phenomena on the formation and survival of entrepreneurship programs.

And finally, this dissertation collects new information and knowledge about the current state and characteristics of entrepreneurship programs in Finnish universities and universities of applied sciences.

1.8 Structure of the dissertation

This dissertation is divided into eight main chapters. After the introduction, in Chapter 2, the current state and the descriptive state of the current entrepreneurship program literature is reviewed by emphasizing major past reviews and other impactful studies. On the basis of this review and the model of theory building by Christensen and Carlile, the complexity of the phenomena is recognized as the culprit for the descriptive stage of the research. It is then argued that by adopting a proper methodology, the theory can become prescriptive and practically applicable. Eight criteria are defined which said framework and methodology need to satisfy.

In Chapter 3, entrepreneurship programs are defined as purposed systems based on the conceptual OPM framework and findings by Arthur. The details of how the framework and methodology satisfy each of the eight criteria are provided. Then, by adopting this framework, the centrality of stakeholders in university entrepreneurship is recognized and a roadmap for studying their role and impact is drawn. In Chapter 4, methodological details of the three conceptual studies and the two empirical studies are described. First, three techniques from systems engineering used in the conceptual analysis are described. These are stakeholder analysis, functional analysis, and analysis of harnessable phenomena. Second, the steps implemented in the two empirical studies are provided.

In Chapter 5, the conceptual findings, that is, the results of the stakeholder analysis, the functional analysis, and the analysis of harnessable phenomena, are presented. The findings are presented in the form of a table as well as OPM models with corresponding descriptions in the text. Chapter 6 presents the empirical findings from one case study and one longitudinal study, which had sample sizes of 45 and 117.

In Chapter 7, the theoretical and practical implications of the research are discussed along with the assessment of the quality of the research. The quality is assessed from the perspective of reliability, replicability, and validity. Finally, in Chapter 8, the results are summarized, future studies are suggested, and concluding remarks are given.

2 Entrepreneurship programs and higher education

In this chapter, the current state and the state of art university entrepreneurship and entrepreneurship program research is reviewed. After the overall review, the problems and the specific challenges the field is facing are discussed, which then leads to the definition of the first research question.

The literature review was based on a process where a set of initial papers was acquired by conducting a search for papers with Google Scholar using the keywords "*entrepreneurial university*", "*university technology / knowledge transfer*", "*business incubators / accelerators*", and "*entrepreneurship education*" along with the additional search term "*university*". The articles were then selected for further review based on the article titles, the number of citations, and the contents of the abstract. Emphasis was placed on major reviews and meta-analyses when possible. Finally, this initial group of papers was then reviewed in detail.

After completing this initial round of reviews, a second set of papers was acquired by conducting additional searches regarding specific questions revealed by the initial round of reviews and by studying the papers that had cited papers from the initial set. The combined results of these two rounds of literature review are presented next.

Entrepreneurship education and new business creation

Entrepreneurship programs in higher education are the main subject of this dissertation. The importance of entrepreneurship itself was already discussed in the Introduction. Entrepreneurship programs can be placed under the broad umbrella of university entrepreneurship and the even more broad umbrella of universities' so-called third mission, economic development. According to Bradley et al. (2013), commercialized university-discovered technologies are an important economic growth factor. "Technology transfer activities, which were once practiced mainly by such elite universities as MIT, Stanford University and the University of California system, are now nationwide" (Bradley et al., 2013, p. 571).

In this literature review, it is recognized that the field is conceptually divided into two major areas: knowledge transfer via new business creation mechanisms and entrepreneurship education. The term "university entrepreneurship" is used to describe both of these areas together. A university that engages in university entrepreneurship is called an entrepreneurial university. Entrepreneurship programs are specific interventions where new business creation and entrepreneurship education are put to action. Figure 2.1 illustrates the relationship of these concepts. While economic development is the goal, knowledge transfer via new business creation and entrepreneurship education are the two major university entrepreneurship approaches for reaching this goal. The first one being more direct, while the second one is more indirect.

The diagram in Figure 2.1 is modelled using OPM, and it is read as follows: an "entrepreneurial university" handles the "university entrepreneurship" process, which transforms "economy" from the "initial" state to an "improved" state. The "entrepreneurship program" is part of an "entrepreneurial university". It handles the "entrepreneurship education" and "knowledge transfer & new business creation" processes. Both of these processes are specialized forms of "university entrepreneurship". "Entrepreneurship education" yields "competent people" who can also handle the "knowledge transfer & new business creation" process.

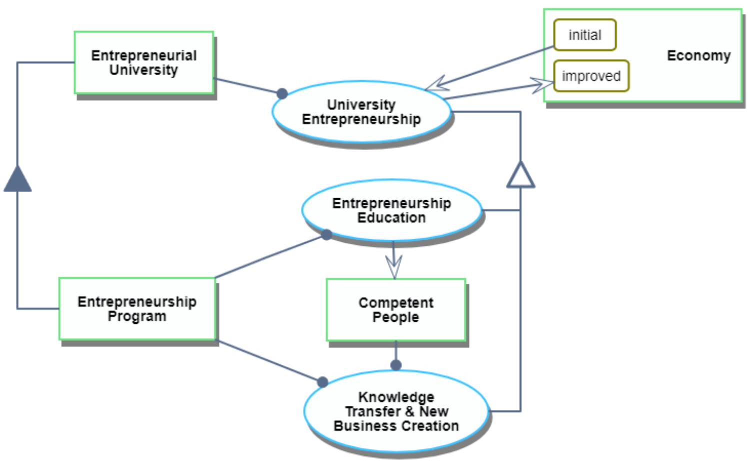

Figure 2.1: Entrepreneurial university, university entrepreneurship, and entrepreneurship programs.

Under this definition university entrepreneurship is about new firm creation and firm growth based on new knowledge generated at the university, as well as about entrepreneurship education, which in turn is about creating people who enable new firm creation and firm growth. Schmitz et al. (2017) report that these two perspectives are not studied enough. They also report that even though many entrepreneurship education approaches can on a conceptual basis affect the innovation and entrepreneurship output of a university, this relationship is not studied in the literature. Thus, it was made sure that both of these themes were included in the review.

2.1 Entrepreneurial university — university entrepreneurship

This section looks at the broad definitions, history, and assumed importance of the entrepreneurial university and university entrepreneurship concepts. An entrepreneurial university is a new form of university that includes economic development alongside education and research (Rothaermel et al., 2007). According to Audretsch (2012), this third mission was linked to newish economic thinking where the key to economic growth and improvement of living standards was the creation and utilization of knowledge alongside the more traditional factors of growth — capital and labour.

In the nineties, Gibbons et al. (1995) conceptualized university-based knowledge production under two categories: mode 1 and mode 2. Where mode 1 is about basic research aiming for universal principles, mode 2 represents applied research aiming for applicable and useful knowledge. Miller et al. (2018) use mode 2 as a conceptual umbrella describing the knowledge and technology commercialization in university technology transfer (UTT), that is, university entrepreneurship. Gibbons et al. (1995) define mode 2 knowledge production as applied research performed by universities, which produces practical and commercializable technologies. Mode 2 can be seen as the main function of the entrepreneurial university. What was once seen as the domain of technology transfer offices (TTOs) and similar organizational units is now being viewed as a much more complex and layered phenomenon (Bradley et al., 2013). Grimaldi et al. (2011) add that a university can also have the role of a social critic.

Guerrero et al. (2015) agree on the three missions: research, teaching, and entrepreneurship. However, according to Guerrero et al., the list of missions has recently expanded to include activities that aim at developing entrepreneurial culture at various levels of the university and region, alongside the already acknowledged activities of new venture creation and commercialization of research, etc. Guerrero et al. emphasize that the entrepreneurial university provides the entrepreneurial context for the entrepreneurial activities of its students and personnel. As one of the latest definitions, Schmitz et al. defined an entrepreneurial university as “a university that embraces the missions of creating, disseminating and applying knowledge for economic and social development, in addition to pursuing a better sustainability for itself” (Schmitz et al., 2017, p. 385). This definition also reflects the broadening of the definition of what type of knowledge can be created for economic and societal benefits.

Broadly speaking, all the economy-influencing activities that an entrepreneurial university engages in will be called university entrepreneurship. Rothaermel et al. define the broad phenomenon of university entrepreneurship as all types of entrepreneurial activities by the university, including such as “patenting, licensing, creating new firms, facilitating technology transfer through incubators and science parks, and facilitating regional economic development” (Rothaermel et al., 2007, p. 692).

Also, Rothaermel et al. report that the field of university entrepreneurship is overall very fragmented. Ten years later, Schmitz et al. (2017), in their literature review of innovation and entrepreneurship in the academic setting, report that this situation stills remains.

Entrepreneurial university and knowledge transfer

How the selected papers examine the phenomenon of an entrepreneurial university from the perspective of the universities' role in the larger economic context was laid out by Guerrero et al. (2016). A research university is a source of knowledge. According to Guerrero et al., this perspective rests on the endogenous growth theory by Romer (1986), wherein the university produces new knowledge that leads to new economic growth via spin-offs, licensing, graduates, publications, etc. (Guerrero et al., 2016). Here a university is the source of new knowledge and innovations. The phenomenon of knowledge being moved away from the university core and utilized in the society is called knowledge transfer or technology transfer. In the traditional models, the process of technology transfer always started from the point where an invention was made by the researchers (Bradley et al., 2013). The research itself could have been publicly or privately funded.

A complete framework of how knowledge flows are created, transferred, and captured was developed by Rothaermel et al. (2007). It placed the new-technology-creating entrepreneurial university at the core. The utilization of the advances is made possible by intermediaries, such as technology transfer offices, in the second sphere. In the third sphere, new firm creation based on these technologies takes place, helped along by incubators and science parks, among others. In the out-most conceptual layer, according to Rothaermel et al., research has focused on firm growth as part of the environment the university interacts with, which can be such as company development via innovation networks, for example. Finally, all four levels interact with each other as an evolving system.

For Audretsch (2012) the key issue with the third mission is how the investments and the results of basic research as well as applied R&D targeting major problems in the society become utilized. Knowledge and technologies need to penetrate the so-called knowledge filter, which lies between the research and the economy. According to Audretsch (2012), these spill-over mechanisms include technology-transfer offices, science parks, proof of concept centres, etc. Audretsch continues that beyond this layer of spill-over mechanisms lies the broader society and economy, with organizations and mechanisms aimed at facilitating the absorption of the knowledge and technologies coming from the university.

Entrepreneurial university and entrepreneurial context

According to Guerrero et al. (2016), another important theme is the entrepreneurial university as a driver for or creator of entrepreneurial contexts. This is contrasted with the theme wherein the university is an innovation driver, that is, a producer of new knowledge and innovations that are commercialized. This line of thinking was originated by Audretsch and Keilbach (2004), who proposed that the economic output of regions is affected by the so-called entrepreneurship capital, which they defined as the number of startups per capita. The results they presented provide some correlative evidence.

Back in 2011, according to Grimaldi et al., the university's role as a facilitator of entrepreneurial opportunities for its students, specifically, was one of the "least recognized roles of the university" (Grimaldi et al., 2011, p. 1047). These opportunities would be facilitated by granting students access to resources and a protected environment. But in 2016, Guerrero et al. explain how several past papers have studied the university's role in raising the likelihood or favourability of entrepreneurial activity. An entrepreneurial culture or linkages and networks to and between other entrepreneurs and venture capitalists are issues Guerrero et al. list as something that universities can affect and thus foster a more favourable context for entrepreneurship.

Growing research at three levels

Research interest as measured in number of articles about university entrepreneurship has increased alongside the global increase in actual entrepreneurship in universities (Rothaermel et al., 2007; Miranda et al., 2018). Schmitz et al. (2017) report in their review of innovation and entrepreneurship in the academic setting an even larger increase in published papers during the ten years after Rothaermel et al. As an additional reason for this increase, Rothaermel et al. (2007) propose that the economy's demand for high technology has allowed university entrepreneurship to grow. This is in line with Arthur (2009), who in his book, *Nature of Technology*, explains how modern technology is increasingly based on scientifically discovered natural phenomena. They are discoveries which require scientific instruments and scientific skills. Examples of such technologies are biotechnology, nanotechnology, and photonics.

In their 2011 paper, Grimaldi et al. used the framework of capabilities and competences as constructs that link these key attributes of universities to the knowledge transfer results and performance. To be exact, they differentiate three levels of inquiry in the literature where these competences or capabilities can manifest themselves: system-level, university-level, and individual-level. For them, the system-level is about legal frameworks and about "governmental actions, institutional configurations, local-context characteristics, etc." (Grimaldi et al., 2011, p. 1048). The university-level is about the internal support mechanisms the university has. In this dissertation, these support mechanisms are defined as entrepreneurship programs. According to Grimaldi et al., the growing interest in the university-level approaches has manifested itself as internal rules and policies which have made it easier for scientists to create new business. As rules limit or enable certain types of behaviour, universities can help desired outcomes to manifest themselves.

Back in 2007 Rothaermel et al. (2007) discovered that the most popular unit of analysis was the university-level, followed by the firm-level analysis, and then the individual-level. In Miranda et al.'s (2018) review of university spin-off literature, the same three categories also emerged. The unit of analysis in university technology transfer literature from the perspective of the triple helix and quadruple helix provides a wider context and a better look at the relationships between the academia, business, government, and the societal-based innovation user stakeholders. Grimaldi et al. (2011) also use a three-level categorization, with the individual, university, and the system as units of analysis. On the other hand, Guerrero et al. (2016) use only two levels to categorize past research into those that focus on the organizational level and those that focus on the individual. The former includes topics similar to Rothaermel, such as TTOs, spin-offs, and incubators, while the latter is about education, entrepreneurial intentions, etc.

To conclude this section, the history of entrepreneurial university as described by Audretsch (2012), Grimaldi et al. (2011), and Geuna and Muscio (2009) is briefly discussed.

Emergence of the entrepreneurial university

In his 2012 paper, Audretsch examines the history of higher education from its early days to its current conception. Audretsch explains how the oldest universities with close linkages to the church were eclipsed in the 19th century by the Humboldt-type universities with an emphasis on “freedom of thought, learning, intellectual exchange, research and scholarship as the salient features of the university” (Audretsch, 2012, p. 315). In an interesting way, Audretsch brings to light another branch of development which was initiated during the same period. In 1862, Abraham Lincoln signed in to the law the so-called Land Grand Act, which provided states with land for agriculture colleges. This led to the development and commercialization of many agriculture-related innovations.

According to Audretsch, another step was taken during the Second World War when the United States government “turned a number of American colleges and universities to produce innovative technological weapon systems” (Audretsch, 2012, p. 316). This change was very successful and seen as an economic boon after the war. Herein it is important to note that the development of systems engineering practices, which will be utilized in this dissertation, rose from these complex technology development projects (de Weck, 2015a). To this author’s knowledge, this connection has not been made earlier in the literature. Audretsch (2012) continues by saying that “an additional strand of academic activity is added around that core with the primary focus on and mandate for providing solutions and applications to major problems confronting society or particular aspects of society” (Audretsch, 2012, p. 317). This way, according to Audretsch, the Humboldtian model started to merge with the view that assumed the university to be a generator of knowledge and technology which could be commercialized to benefit the economy and society at large.

Knowledge needs to pass the so-called knowledge filter. In the US, the Bayh-Dole Act in 1980 was aimed at overcoming this knowledge filter. The act greatly simplified the process of companies getting commercial access to university-born knowledge and technologies (Audretsch, 2012). Grimaldi et al. report that there has been consensus in the literature that this law was “an important trigger for a re-evaluation of the role of the university in the society” (Grimaldi, 2011, p. 1047). In Europe, the UK was the first to start re-thinking its universities, and other countries have followed since (Geuna & Muscio, 2009).

To summarize section 2.1, the recognized significance of universities as economic actors has been growing since the Second World War. Two newer mechanisms explaining the impact of universities commonly mentioned in the literature are universities as producers of new knowledge, which leads to new business, and more recently, universities as entities supporting entrepreneurship.

2.2 Entrepreneurship programs

In this section, the most important types of entrepreneurship programs and associated phenomena are discussed. As visualized in Figure 2.1, entrepreneurship programs are ways in which an entrepreneurial university handles its university entrepreneurship operations.

2.2.1 Academic engagement and entrepreneurship support

In this section, university entrepreneurship and entrepreneurship programs are examined from the viewpoint of individual academics. Literature allocates these into two forms: the engagement of academics with the industry and the engagement of academics in commercialization activities. To an academic, the former form of engagement is more about knowledge transfer and less direct involvement in new business creation, while in the latter version, the academic plays a more active role. It turns out that only commercialization activities experience a boost when there is organizational support, that is, existing entrepreneurship programs.

This section is mostly based on reviewing the findings from a major and highly cited review by Perkmann et al. (2013). However, on occasion findings from other researchers will be highlighted.

Knowledge transfer via academics' engagement with the industry

In the literature, academic engagement is the phenomenon where an academic collaborates with external partners (Cohen et al., 2002). An external partner, such as a firm and specific people inside that firm, can benefit from the academic's expertise, while the academic can gain monetary (consulting, sponsored research) compensation or access to other research-related resources, such as data (Perkmann et al., 2013). Perkmann et al. (2013) state that academic engagement sometimes results in commercialization, thus linking the phenomenon of academic engagement to the narrower phenomena of technology transfer or academic entrepreneurship. Prior engagement can inform the academic of what is valuable, and thus the R&D pursued by the academic ends up producing valuable knowledge. This is also echoed by Bradley et al. (2013).

In their 2011 study of academics' motivations to engage with the industry, D'este and Perkmann had some revealing findings. Using factor analysis, they synthesized four motivational items that can explain various forms of academics' engagement with the industry. D'este and Perkmann's motivational constructs were commercialization, learning, access to in-kind resources, and access to funding. The five types of industry engagement activities studied were joint research, contract research, consulting, spin-offs, and patents. D'este and Perkmann reported that commercialization motivations, that is, personal income, or the desire to gain IPR, were linked with consulting, spin-offs, and patenting, while learning and funding motivations were mostly linked with joint research and contract research. Getting in-kind resources was negatively linked with consulting, spin-offs, and patenting. D'este and Perkmann conclude that spin-offs and patents were a much rarer form of engagement and that the motivation linked with those behaviours form a separate pair of research-related motivations and associated behaviours of joint and contract research.

In their review of past literature, Perkmann et al. (2013) looked at how different individual, organizational, and institutional factors are linked to academic engagement. Of individual variables, seniority, prior government-awarded research grants, industry awarded contracts, and general scientific productivity correlate with academic engagement. Of these, grants, contracts, and scientific productivity are signs of an excellent and successful scientist, and these individuals having more engagement with the industry is no surprise (Perkmann et al., 2013). Those who have, shall receive, which is to say that the results of Perkmann et al. can be interpreted to mean that there is evidence of positive feedback loops in terms of success and emergence of new opportunities.

Beyond these individual determinants, Perkmann et al. highlight only the importance of the academic being in an applied discipline as a predictor of engagement. Organizational support, which can be viewed as a form of an entrepreneurship program, was irrelevant for engagement. According to Perkmann et al., a peculiar finding is that academics in academically high-quality departments are less likely to engage in collaboration, which could be explained with the fact that when an academic is well-funded, there is little motivation from the academic's side to gain extra funding via industry-collaboration.

Academic entrepreneurship and willingness to commercialize

Grimaldi et al. (2011) see academic entrepreneurship as dependent on an academic's internal willingness and external incentives. Grimaldi et al. reason that the task of motivation is especially challenging because "professors chose to work in the university because they were not attracted to working in the corporate sector" (Grimaldi, 2011, p. 1050). How much of this is rationalizing by an individual academic about the current state of affairs and how much of it reflects true choice is a good question. In their 2013 review, Perkmann et al. also looked into what factors predict academic engagement in commercialization activities, including entrepreneurship. Prior experience with commercialization, scientific productivity, scientific quality of their institution, organizational support, experience in commercialization, and peer engagement in commercialization all predicted an academic's involvement with commercialization. As with the non-entrepreneurial academic engagement, being in an applied field predicts commercialization activities.

In an interesting way, organizational support for commercialization, that is, entrepreneurship programs, including entrepreneurship, seem to matter, except for academic engagement (Perkmann et al., 2013). Perkmann at al. show that while academic engagement is mostly performed by individuals regardless of organizational support, commercialization and entrepreneurship seems to be more dependent on these support systems. This line of thinking was discussed earlier also by Grimaldi et al. (2011), who saw that these organizational support structures and activities or capabilities would make entrepreneurship incentives more efficient. When something is made easier or more reachable, the likelihood of doing it increases (Fogg, 2009). On the other hand, as suggested earlier, academic engagement and projects with the industry allow an academic to continue a more predictable research career and salary-earning. The entrepreneurial path is a clear deviation from this trajectory, leading to different outcomes and type of career. In this case, making things easier would probably not make a great difference.

To summarize, support for academic engagement and commercialization can be seen as a form of entrepreneurship program. According to the research, only the latter activity seems to be impacted by the support. In the next section, the practice and phenomena of technology transfer will be looked at in detail.

2.2.2 Technology transfer offices

In this dissertation, a technology transfer office (TTO) is defined as a specialized form of entrepreneurship program. Audretsch (2012) explains how TTOs are one of the key spill-over mechanisms aimed at penetrating the so-called knowledge filter which prevents knowledge and technologies developed in universities from being commercialized and utilized in the economy. According to Grimaldi et al. (2011), the Bayh-Dole legislation in 1980 resulted in the creation of technology transfer offices in all major research universities in the US. This was followed by a similar development in Europe (Geuna & Muscio, 2009).

Rothaermel et al. state that the most general and widely accepted view of technology transfer offices is that they are a formal “gateway for university inventions” (Rothaermel et al., 2007, p. 748). They also report that researchers focusing on TTOs view TTOs’ performance as a crucial factor which defines the university’s entrepreneurship. Rothaermel et al. report that commonly accepted performance measures of TTOs include the number of licensing agreements and the amount of licensing revenues. Rothaermel et al. also suggest that the inclusion of other measures, such as the number of invention disclosures and sponsored research agreements, are a sign of researchers starting to adopt a view of TTOs as embedded in a complex system with a feedback-loop with its environment.

What makes a good TTO? In their review of knowledge transfer office (KTO) literature, Geuna and Muscio (2009) distilled a few more established findings from the literature regarding the success of KTO operations and people handling them: management experience in working with KTO people, offices need to be big enough to be effective, preference for regional rather than university-specific offices, inventors, that is, the scientists, need to be involved in the early stages, and scientists need to have certain characteristics and enough social capital.

Traditional TTO model

The traditional model synthesized by Bradley et al. (2013) decomposes TTOs to nine steps (steps eight and nine are two different optional possibilities): 1. a university scientist makes a discovery, 2. the scientist discloses the invention to a TTO, 3. the TTO evaluates the invention and decides whether or not to patent, 4. patent applications, 5. marketing the technology to firms and/or entrepreneurs, 6. negotiate licensing agreements/royalties/equity stake, etc., 7. license the technology, and 8. existing firms adapt and use the technology, or 9. spin-offs and startup companies use the technology.

If we use the four-sphere conceptual categorization of university entrepreneurship by Rothaermel et al. (2007), step one could be placed in the domain of entrepreneurial university and in the production of applicable knowledge, while steps eight and nine belong to the sphere of new firm creation and the broader environmental context.

Of these nine steps, steps three and eight/nine are the most complex and challenging (Bradley et al., 2013). According to Bradley et al., the evaluation process (step three) typically includes many different aspects, including assessment of revenue potential, licensing potential, academic field of the invention, competitiveness, and extensibility. All of these aspects by themselves are difficult and complex issues. On the other hand, step eight is more like an organic, evolving long-term process, which typically requires continued collaboration between the faculty and the company that licensed the technology (Bradley et al., 2013) in order to develop something that is actually ready for the market.

An improved model of technology transfer

Bradley et al. (2013) point out that the traditional model does not accurately reflect the reality of TT processes. According to them, these limitations fall into two main categories, inaccuracies and inadequacies. The inaccuracies include strict linearity and oversimplification, composition, one-size-fits-all, and overemphasis on patents. The inadequacies are formal vs. informal mechanisms, organizational culture, and reward systems. Bradley et al. (2013) propose a new dynamic model of TT that better addresses these limitations. Their new model has 14 sub-processes or steps that interact with each other in a non-linear manner. In Bradley et al.'s model, the end points are the same: technology can end up being commercialized via existing firms or spin-offs and startup companies.

Perhaps the biggest deviation from the traditional model is that Bradley et al. recognize a path where the new idea or invention is not disclosed to TTOs. Instead, the TT happens informally via talks and meetings, joint publications, technical assistance, etc. Whether the TT happens via informal or formal TT processes is, according to Bradley et al., influenced by the university reward systems and culture. This is in line with the specific part of the main argument of this dissertation, which states that it is the stakeholders who define the purpose and the relevant harnessable socio-economic phenomena. The model also acknowledges that the sources of new knowledge, that is, scientific discoveries, are not just individual researchers, but also students and research teams. The interactions between the researchers and the existing companies, that is, the second end point of TT processes, are titled academic-industry collaboration (or engagement, which we discussed in the previous section). This creates a feedback loop from the end point to the source.

Figure 2.2 presents an OPM model of the technology transfer process based on Bradley et al. (2013). The decision to disclose or not by the maker of the scientific discovery initiates either a formal or informal process of technology transfer. Both of these processes can lead to the technology being used by spin-off companies or by existing firms. A feedback loop in the form of the academy-industry collaborating with existing firms and the process of discovery-making is a sign of a complex system (Siegenfield & Bar-Yam, 2020).

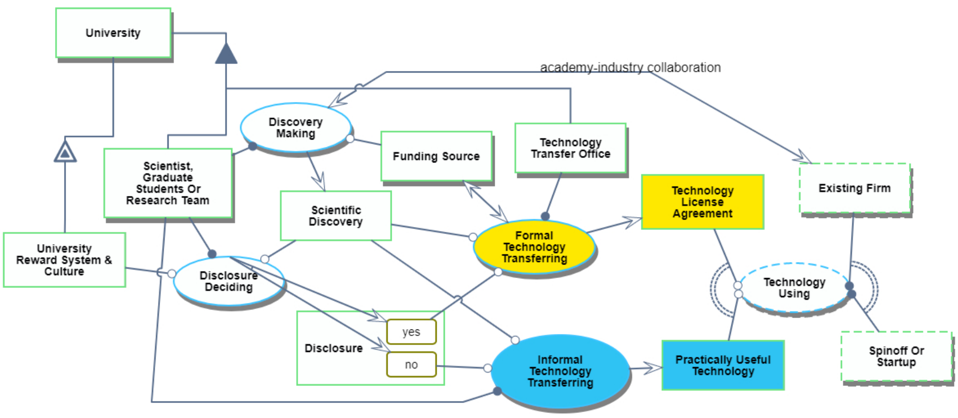

Figure 2.2: Zoomed-out version of Bradley et al.'s (2013) model of technology transfer using OPM.

Bradley et al.'s (2013) new model improves the general understanding of TT processes. The strengths are the inclusion of the informal technology transfer pathway and the feedback-loop between firms and researchers in the form of academy-industry collaboration. However, the model has a missing link. It does not provide many details about the technology-using process itself.

Open Innovation view

Henry Chesbrough's concept *open innovation* (Chesbrough, 2003) can be seen to reflect the company and industry side of TTOs. For a company, open innovation is about "purposive inflows and outflows of knowledge" (Chesbrough and Bogers, 2014, p. 10). According to Chesbrough and Bogers, open innovation consists of three mechanisms: inbound, outbound, and coupled innovation. Inbound refers to a situation wherein a company gains access to outside knowledge via in-licensing IP, funding startup companies, collaborating with intermediaries, etc. The origins of an invention can be in a university lab or with "lead users" (von Hippel, 1986), but it takes a company to convert and scale the invention into a business. The second type, the outbound innovation, refers to the mechanism wherein the company out-licenses or donates IP or technology. The third mechanism, the coupled innovation, describes a partnership-like relationship where the parties, for example, gain access to each other's IPs. (Chesbrough and Bogers, 2014)

The third mechanism is close to Bradley et al.'s (2013) *collaborative view* of technology transfer, wherein knowledge is communicated via internet-based platforms. This knowledge can be IP, tacit knowledge and knowhow, or research problems. Bradley et al. report that such platforms have been used and co-developed by large corporations and universities. One of the functions of such platforms is the generation of future R&D collaboration in the form of projects and commercialization of technologies via the companies.

For university entrepreneurship, all types of open innovation mechanisms can be seen to play a role. A university can be seen as playing the part of a source of knowledge in a company's inbound open innovation strategy as universities are an external source of knowledge (in the form of IP) for a company. See Figure 2.3 for an illustration of the linkage between technology transfer and open innovation

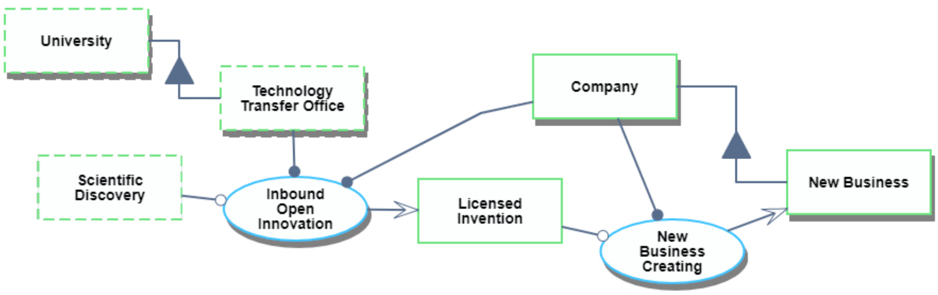

Figure 2.3: A combination of the university-based technology transfer model and the open innovation perspective.

To summarize this section, when the open innovation lens is used, the university R&D made available by TTOs is just one of the sources of new knowledge for a company. The core of innovation, scaling, and making business out of inventions lies within companies themselves. In the next section, some of the key findings related to business incubators and accelerators, that is, entrepreneurship programs, with a focus on new business creation will be reviewed.

2.2.3 **Incubators and accelerators**

Incubator and accelerators are a widely studied topic — with or without university-involvement. Thus, this section is not limited only to findings directly linked to universities. Rothaermel et al. (2007) see new firm creation as the third major sphere of university entrepreneurship. It is the process of creating new companies, such as spin-offs. According to Rothaermel et al., the most common performance measures attributed to these processes are related to the amount of VC funding, IPO, survival/failure, revenues, and growth. Bradley et al. (2013) point out that for a university, new firm creation is often plan B when commercialization does not move forward with existing companies via licensing.

In Rothaermel et al.'s review, past researchers have proposed many factors affecting these performance measures, including university policies, incubation models, the technology to be commercialized, TTOs, faculty competence, founders and teams, investor availability, network structure, and external conditions such as market opportunity. When a new firm is created based on the knowledge created as part of the university's R&D, the firm is called a spin-off company (Miranda et al., 2018). Intermediaries are the organizations that operate "between start-ups and a complex landscape of resources" (Cohen et al., 2019, p. 2). Incubators, accelerators, and angel investors among others belong to this category.

Incubators

According to Bruneel et al. (2012), the purpose of business incubators (BI) is the stimulation of new business creation. Hacket and Dilts (2004) define an incubator as:

> a shared office space facility that seeks to provide its incubatees with a strategic, value-adding intervention system (i.e. business incubation) of monitoring and business assistance. This system controls and links resources with the objective of facilitating the successful new venture development of the incubatees while simultaneously containing the cost of their potential failure. (Hacket and Dilts, 2004, p. 57)

Hacket and Dilts add that incubators consist of not just the specific physical facility and key staff but also include the broader environment and community of the university, industry, professional and investor contacts, etc.

At first, during the 60s and 70s, the incubator phenomenon was slow-growing in the US, but with new laws governing and opening basic research commercialization along with other certain market opportunities, the incubator became more and more popular (Hacket & Dilts, 2004). According to Hacket and Dilts, the first incubator development guidebooks were published during the 80s, as interest in incubators grew. They explain that during the 90s, the incubator was seen as a miracle-maker, although this ended with the market crash of the year 2000.

Incubators have a similar overall purpose as accelerators, but they are different in their approaches, as reported by Cohen (2013). Cohen explains that most of the incubators are non-profit and a sizeable proportion of them are associated with universities and serve as a tool for commercialization of university-generated knowledge. Incubation programs' participating ventures spend typically one to five years in the program, receive education on an ad hoc basis, and provide access to HR, legal, intellectual property, and other services. They also introduce their participants to financiers. Mentorship is minimal. It is common that incubator tenants pay rent for office space and other fees. As a practice, incubators are an older approach to new firm creation than accelerators. (Cohen, 2013)

In their study of 127 incubators, Allen and McCluskey (1991) recognized four types of incubators: for-property development incubator, non-profit development corporation incubator, academic incubator, and for-profit seed capital incubator. Furthermore, Allen and McCluskey looked at the objectives of each incubator type and recognized the differing goals of each type. Bruneel et al. (2012) studied BIs from the perspective of the BIs' value proposition. Bruneel et al.'s work is significant in the sense that it shows how the needs or expectations of various stakeholders are reflected in the value propositions of these programs. What Bruneel et al. (2012) did was to separate BI generations based on the value proposition of each generation. First generation BIs established throughout the 1950s and 80s had a value proposition based on offering nascent firms access to facilities, office spaces, meeting rooms, etc. A new company with minimal revenues would find its tasks easier when the (fixed) costs associated with physical facilities and related services were reduced.

Second generation BIs started to emerge during the 1980s, and they added a second key element to the BIs' value proposition (Bruneel et al., 2012). This was the inclusion of business support services in the form of training and coaching related to business management and similar issues. As a result, young companies would learn and acquire the necessary skills and business practices faster. Third generation BIs from the 90s onwards included a third element to the BI value proposition. BIs began to provide their tenants access to different external resources, knowledge, and legitimacy via the BI's networks. This is in line with how Cohen (2013) describes the current forms of incubators (and accelerators) make introductions to financiers and link firms to experienced entrepreneurs, professionals, and external service providers. Acquired knowledge and up-to-date information helps the company to survive (Bruneel et al., 2012). Unlike Cohen (2013), Bruneel et al. also mention that BIs can gain access to partnerships that bring legitimacy to new companies via their networks.

Interestingly, in their study of how the value propositions of different generation BIs had evolved over time, Bruneel et al. (2012) found no differences in their current publicly communicated official offerings. This means that all BIs representing more or less all generations offered infrastructure, business support, and access to networks. The BIs studied also had similarly poorly defined and vague selection and exit policies. However, when Bruneel et al. studied the value propositions from the perspective of BIs' tenants, new patterns emerged. All incubator tenants they interviewed used the provided facilities, but only the tenants of third generation BIs fully utilized the "business support" and "access to networks" parts of the value proposition. Only some tenants of the first and second generation BIs used these other two elements of the value proposition.

One seemingly contradictory finding by Bruneel et al. (2012) is that even though third generation BIs offer business support in the form of coaching and mentoring and provide access to professional service providers and seed or venture capital, their tenant companies are two times more likely to be established by serial entrepreneurs compared to older generation BIs, which offer business support and where networks play a smaller role. Perhaps serial entrepreneurs better understand the value of these other services, like Bruneel et al. suggest. However, it can also be that because third generation BIs depend on external funding, they have to limit the number of the teams they accept into their program. And because the business ideas still have a lot of uncertainty, the selection process emphasizes past entrepreneurial experience. Older generation BIs, which base their income mostly on rent, are more likely to accept companies that are more established and can thus pay rent, regardless of their teams' backgrounds.

As a form of criticism towards incubation, Cohen (2013) suggests that a long duration can result in harmful co-dependency with the incubator as ventures are shielded from market forces. With accelerators, Cohen sees a short time-span also as a benefit when the business idea fails. The entrepreneurs can move on to another opportunity more quickly. Cohen also reports that as some relationships develop between entrepreneurs in a long-duration incubation program, in accelerators the intensity and the fact that entrepreneurs start and end the program at the same time results "in uncommonly strong bonds and communal identity between the founders". Next, accelerators, a relatively new form of business incubation, will be looked at.

Accelerators

Hathaway (2016b) reports that the emergence of accelerators has coincided with the boom in startups and venture capital. Y Combinator was the first accelerator founded in 2005, and TechStars was founded in 2006 (Hathaway, 2016a). Hathaway (2016a) also reports that the number of accelerators increased exponentially between 2008 and 2014. According to Cohen, accelerators "…help ventures define and build their initial products, identify promising customer segments, and secure resources, including capital and employees" (Cohen, 2013, p. 19).

The two authors, Cohen (2013) and Hathaway (2016a), define the distinguishing features of accelerators, as compared to incubators, as the following: short program duration (e.g. 3 months) ending with a demo-day, cohort-based participation, based on cyclical competitive selection focus on early-stage ventures, and providing seminar-based education and intensive mentorship via a pool of mentors. Also, most accelerators are built on an investment business model, meaning that the accelerator generates income from investments made in the participating ventures.

However, as non-profit accelerators also exist, the need to invest in the participating companies is not included in the definition by Hathaway (2016a). Hathaway emphasizes that despite these unique features, accelerators are often “mistakenly lumped in with other institutions supporting early-stage startups, such as incubators, angel investors, and early-stage venture capitalists” (Hathaway, 2016b, p. 1). What Hathaway (2016a) reports is that less than a third of accelerators claiming or claimed to be accelerators fit the above-mentioned narrower definition. Pauwels et al. (2016) provide an explanation for this by pointing out that accelerators represent a new generation of business incubation, and thus there is no need to build unnecessary contrast between incubators and accelerators. The 2019 definition of accelerators by Cohen et al. is “a fixed-term, cohort-based program for startups, including mentorship and/or educational components, that culminates in a graduation event” (Cohen et al., 2019, p. 2).

Pauwels et al. (2016) studied leading European accelerators and distilled five accelerator design elements that typically vary and set the various approaches apart from each other. They differ from each other at the level of the program package, strategic focus, selection process, funding structure, and alumni relations. The program package can include items such as mentoring services, training programs, demo days, and location services. The strategic focus defines the types of businesses the accelerator focuses on, that is, the specific sector or geographic area. The selection process approaches include team focus, online open call, and sometimes the use of external screening. The funding structure, which Pauwels et al. define to be a key element, describes how the accelerator funds its activities. The fifth and last element is the method in which accelerators manage their alumni relations.

Some accelerators provide funding for the accepted startups at the beginning of the programs, with the goal of allowing the startups to complete the required experimentation during the program but not much beyond it (Cohen et al., 2019). Cohen et al. (2019) point out that the accelerators themselves are not homogenous when looked at through different design dimensions. Yet, past research has treated accelerators as more or less identical, which is obviously not true, as the paper by Pauwels et al. (2016) demonstrates. According to Cohen et al. (2019), accelerators vary in terms of the type of founders, founding sponsors, or stakeholders, and design elements, including the size of cohort, program duration, inclusion of external mentors, etc.

Even though Cohen et al. (2019) did not compare accelerator participants with the corresponding accelerators’ value propositions, they discovered a relationship between the programs' manager and sponsor types and design choices. This points to a similar dynamic as with Bruneel et al. (2012), who saw a link between the program's value proposition and the limitations imposed on it by the available funding.

Other approaches

According to Cohen (2013), business angels have partially similar roles to incubators and accelerators. They provide funding like most accelerators, and the selection process is competitive, although not cyclical. However, like incubators, participation is not cohort-based and there is not much mentorship besides participating in the board meetings. Angels do not typically organize any formal education. All in all, angel investors' help in the ventures is the least structured, compared to incubators and accelerators. Hathaway (2016a) builds on Cohen's work (Cohen, 2013) on accelerators and claims that most of the so-called accelerators actually form a fourth category that would be better categorized as business angel services, that is, provision of capital and some additional services, such as physical office space and support services. Hathaway reports that for these hybrid players program durations are somewhere between actual accelerators (three to six months) and incubators (one to five years).

Proof of concept (POC) programs are entities that could be seen as being improved versions of TTOs with more emphasis on new business creation. According to Bradley et al., POC centres are units that aim to reduce the commercial uncertainty associated with university-based invention by providing "seed funding, business and advisory services, incubator space, and market research" (Bradley et al., 2013, p. 626). The purpose is to make the startup or technology licensing more attractive to investors. Traditional TTOs play a role in working out IP issues and connections with outside investors. In this sense, from a functional perspective, POC programs or centres do not differ much from many incubator or accelerator programs.

Gulbranson and Audretsch (2008) share their advice regarding POC programs:

> … the creation of a new proof of concept center must be located in a university that (1) produces innovative and marketable technology, (2) is not adverse to collaboration with external networks and groups, and (3) has technology transfer offices that are willing to work with a center to assist in the commercialization process. Furthermore, locating the center in the engineering school, at least initially, allows the center to focus its efforts on research that has a greater likelihood of translation into products. (Gulbranson & Audretsch, 2008, p. 257)

To summarize, the literature on incubators and accelerators has raised many important perspectives, including the effect of program stakeholders on program value propositions, and explanations of how said programs deliver their value. The next section highlights some findings regarding the entrepreneurship program as an actor in the innovation ecosystem.

2.2.4 Programs as part of innovation ecosystem

Rothaermel et al. (2007) reported that one area of past university entrepreneurship research has focused on how the university's environmental context affects the performance of firms and the development of entrepreneurial activity. This context will be referred to here as the innovation ecosystem. According to Rothaermel et al., up to 2007 researchers had decomposed this context into various elements and variables, such as innovation networks, science parks, incubators, and proximity to universities.

Hathaway (2016a) describes the innovation ecosystem as a complex network of interactions between its members that includes entrepreneurs, investors, suppliers, universities, large businesses, and other support organizations. Hathaway emphasizes that because innovation-driven startup companies are a source economic growth and because private capital is attracted by these opportunities, regional actors should realize the importance of ecosystem factors affecting the creation and growth of such startups.

In their systematic literature review, Miller et al. (2018b) document how so-called triple helix and quadruple helix models emerged as descriptions of this wider environmental context. The helix models are based on the idea that there exist major types of institutional actors in the ecosystem and then modelling their interactions. While a triple helix model has three types of actors, that is, academia, business, and government, the quadruple helix adds a fourth actor called the societal-based innovation user stakeholders (Carayannis and Campbell, 2009). Miller et al. report that the discussion of university technology transfer is transitioning from triple to quadruple helix thinking.

Guerrero et al. (2016) link together the university as a driver of innovation and entrepreneurship embedded in the regional social and economic ecosystem. They represent the line of thinking which acknowledges that an economically successful ecosystem consists of a plurality of actors playing different roles and where a set of various entrepreneurship and innovation processes happen. Guerrero et al. propose that the role of universities has become more important as universities have started to become these so-called entrepreneurial universities. This means that universities have been adopting more roles and tasks in their regional innovation and entrepreneurship ecosystem beyond the traditional roles of teaching and research.

To summarize, if we separate form from function, the ecosystem perspective becomes a question of which actor is taking on which role in the ecosystem. Figure 2.3 illustrates one type of interaction between the actors in the ecosystem. In this process, both scientific discovery and the conversion of discoveries into applicable forms are handled by both universities and companies. As different actors have different expectations and needs, not all configurations are equally adept. In the next section, some of the latest discussions regarding entrepreneurship education are looked at.

2.2.5 Entrepreneurship education programs

Martin et al. (2013) observe from literature that entrepreneurship education and training has globally increased within higher education. The likely reason being that entrepreneurship education is also seen as a tool for economic growth (Lackeús, 2015). But if new business creation has a more direct role in economic growth, entrepreneurship education's role is more indirect (see Figure 2.1). Entrepreneurship education can be the main function or intermittent function of an entrepreneurship program. Maritz and Brown (2013) expand the framework by Alberti et al. (2004) and report that the literature on entrepreneurship education programs (EPP) recognizes seven components or attributes that form ten relationships: context, outcomes, objectives, assessment, content, pedagogy, and audiences. Each of these components has a variety of options that together reveal the diversity of possible EPPs.

In their meta-analysis of entrepreneurship education (EE) outcomes, Martin et al. (2013) specify two main forms of EE, training-focused and academic-focused. In his entrepreneurship education background paper for OECD, Lackéus (2015) presents a three-part categorization based on literature where the field of entrepreneurship education is divided along an axis that has personal development at one end and business focus at the other end. The personal development focus is about *educating through entrepreneurship*, while the business focus is *educating about entrepreneurship*. In the middle of the axis is located *educating for entrepreneurship*.

According to Lackéus, the research states that on the business-focus side of education, the learning content is mostly knowledge-based, while the personal development focus has more emphasis on skills and attitudes. The middle ground includes all three competence areas. Lackéus shows how past research has brought conceptual clarity to the issue by placing various education approaches on the axis. Community outreach at the primary school level represents a clear personal development focus, while elective business courses at the university-level have a knowledge-based business focus. In the middle are mini companies common at the secondary school level and entrepreneurship programs and growth programs for business owners at the higher education and work life training levels. (Lackéus, 2015)

Nabi et al. (2017) categorize entrepreneurship education (EE) based on used pedagogical approaches. Their categorization is based on the three teaching models by Béchard and Grégoire (2005): supply model, demand model, and competence model. The supply model is about traditional transfer of knowledge approaches. The demand model is about more constructivist learning, various activities, and real-life cases. The competence model takes place when students are starting up real businesses or working on real-life problems in the industry, and the learning happens also by consulting external experts. Nabi et al. also use two hybrid models, that is, supply-demand and demand-competence. (Nabi et al., 2017)

We can see that the classification of Béchard and Grégoire (2005) overlaps with Lackéus (2015), even though Lackéus did not cite the work of Béchard and Grégoire. The supply model seems to overlap with the business focus-oriented approaches, or educating about entrepreneurship. The demand model mostly overlaps with the personal development focus, or educating through entrepreneurship, although there is also some overlap with the competence model. The competence model mostly overlaps with the middle ground in Lackéus' classification, or educating for entrepreneurship.

Education provided by accelerators and incubators (Cohen, 2013) belongs in the education-for-entrepreneurship category. Interestingly, the teaching-model accelerators use can also be traditionally seminar-based (Cohen et al., 2019), that is, they can follow the supply model and are not necessarily only based on mentorship and receiving advice from outside experts, which would correspond with the demand and competence models. This would suggest that the teaching-model-based categorization of EE developed by Béchard and Grégoire (2005) and used by Nabi et al. (2017) is a separate dimension from the classification used by Lackéus (2015).

It seems that Lackéus' categories are actually a mixture or learning objectives and teaching methods. Educating through entrepreneurship is a pedagogical choice, while educating about entrepreneurship is about the learning goals, which are, in this case, general business theories. In the meanwhile, educating for entrepreneurship focuses more on what is needed by the development of the actual startup the student is involved with, which, again, concerns what should be learned.

Some might find it ironic to observe how accelerator programs, if seen as evolved versions of incubators or angel investing, look very much like education programs with cohorts and seminar-based education (Cohen, 2013). This would seem to contradict the common claim that the traditional lecture-based approach is the key reason why the school system does not generate creative individuals, that is, entrepreneurs (Robinson, 2007). Given this, it seems that entrepreneurship education would be better categorized using at least two axes. The first one being the learning content or subject-matter to be learned, and the second one being the teaching or learning model. Figure 2.4 is a two-dimensional model with three pedagogical categories and three types of outcomes based on Lackeús (2015), Béchard and Grégoire (2005), Nabi et al. (2017), and the dynamic version of human capital theory of EE by Martin et al. (2013), where the investments (pedagogy) will lead to development of assets (competences), which in turn will enable the desired outcomes (impact).

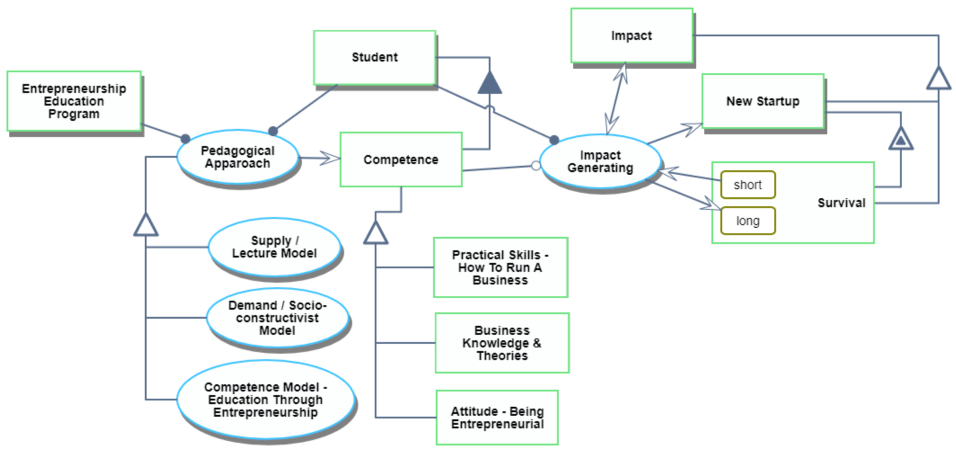

Figure 2.4: An entrepreneurship education model with choices between three pedagogical approaches and three types of competences which enable the generation of desired impacts.

This type of categorization hints at a systems approach, where separating the form from function, or the method from the goal, is important. One suggested way to use the model in figure 2.4 is to start from the end by first defining the desired impact, then asking which competences would lead to the desired impact, and then asking what would be the best teaching model to enable the development of these competences. Next, a brief look is taken at what Shane et al. (2003), Martin et al. (2013), and Lackéus (2015) say about entrepreneurial competences.

Entrepreneurial competences

Lackéus (2015) recognizes two major categories to define entrepreneurship in the literature. The narrow category is about new business creation and growth. On the other hand, the wide category of entrepreneurship is about "personal development, creativity, self-reliance, initiative taking, action orientation that is, becoming entrepreneurial" (Lackéus, 2015). These are reflected in the competences that define entrepreneurship. If entrepreneurial education is seen as a process, then what competences are created or improved as a result? Lackéus (2015) presents entrepreneurial competences under three categories: knowledge, skills, and attitudes.

According to Lackéus, these competences "affect the willingness and ability to perform the entrepreneurial job of new value creation" (Lackéus, 2015, p. 12). The knowledge competences include models and theories of, for example, entrepreneurship, creative business generation, finance, marketing, etc. The skills are practical, enabling the performing of various tasks, such as business plan creation, marketing research, team management, and personal time-management. Shane et al. (2003) have knowledge and skills mapped as cognitive factors affecting the entrepreneurial process.

Attitudes belong in non-cognitive competences, which have several sub-themes such as entrepreneurial passion, self-efficacy, entrepreneurial identity, and uncertainty tolerance. Shane et al. (2003) categorize these items under the title of entrepreneurial motivation. Lackéus sees that entrepreneurship education has the capacity to improve these attitudes as important issues, yet he reports it to be poorly researched. Martin et al. (2013) also included three types of different human capital assets, that is, competences, related to entrepreneurship. The first being knowledge and skills related to entrepreneurship and entrepreneurial processes, opportunity recognition, etc. The second, positive perception of entrepreneurship and, for example, self-efficacy for entrepreneurship. Third, the intention to become an entrepreneur.

Venture creation programs

An interesting opportunity to study the phenomena of entrepreneurship and higher education are the so-called venture creation programs (VCP). Ollila and Middleton (2011) report the case of Chalmers School of Entrepreneurship where an incubation process is integrated into a two-year master's degree program. In their 2011 paper, Ollila and Middleton frame the Chalmers' approach as a way of doing entrepreneurship education while generating new ventures based on university R&D.

The Chalmers approach is a combination of two organizations: the business school and the CSE Incubation & Holding company. The latter will get an ownership-stake of the ventures launched during the program. In the program, students begin with more traditional-style studies and then move on to working with select startup projects with the goal of launching the venture successfully. Teaching and learning is also emphasized in this second case, where it is integrated to the venture creation process. (Ollila and Middleton, 2011)

Pedagogically the approach used at Chalmers is similar to Nabi et al.'s (2017) supply methods in the first part and competence methods in the latter part. Using Láckeus' (2015) categories, the early parts are on the side of educating for and about entrepreneurship while the latter part of the program is more about educating through and for entrepreneurship. Ollila and Middleton frame the venture creation approach as a new pedagogical approach with distinct characteristics from what they call conventional education and the so-called enterprising approach by Gibb (1996). Some of the key aspects of the venture creation approach, according to Ollila and Middleton, are major focus on reflection-in-action, learning sessions emerging from venture-related activities, learning objectives emerging through reflection, mistakes are encouraged, and a combination of problem and solution focus. However, the fact that the learning objectives emerge from reflection is challenging for the integrity and consistency of the degree itself. Láckeus and Middleton (2015) use the same case together with several other venture creation programs, but in this they emphasize the venture creation program being a new way to combine technology transfer and the commercialization of university R&D results with entrepreneurship education.

What makes VCP so interesting is that they are said to be a point where two of the three main missions of an entrepreneurial university, education and economic development or entrepreneurship, come together in a seemingly synergistic way. Successful venture creation will bring direct economic results while developed entrepreneurial competences and networks can bring benefits to the individual and society regardless of the success of the initial ventures. However, at the same time, it ought to be recognized that from a functional perspective, VCPs are very close to modern business incubators or accelerators. All of them engage in new venture creation, training, and resource acquisition via network building. The outcome-related difference is that VCPs can grant formal study credits or degrees to the participants.

All in all, the improvement of the so-called entrepreneurial competences is a central component in entrepreneurship education research. Interestingly enough, entrepreneurship education programs based on students trying to start or run their own business are conceptually close to incubators or accelerators.

To summarize section 2.2, entrepreneurship programs can take many forms, including academic engagement and commercialization support, technology transfer offices, incubators and accelerators, and entrepreneurship education. On the other hand, these programs can be viewed from many perspectives. When the point of view is from within the universities, the economic importance is highlighted, but while viewed from the perspective of existing companies and the larger innovation ecosystem, the role is seen as somewhat less central. Regardless of the exact importance, the first element of the overall argument of this dissertation, that is, that entrepreneurship is valued and the university is expected to support entrepreneurship via entrepreneurship programs, can be considered well supported by the literature.

2.3 Problems with existing literature

This part of Chapter 2 details the problem faced by the current university and entrepreneurship program research. The current state of the research is defined as descriptive based on Christensen and Carlile (2009). It is then argued that it is the lack of a methodology that could manage the complexity and multi-scale nature of the university entrepreneurship phenomena that has prevented the field from moving to a prescriptive stage. Additional literature research was carried out when a specific topic required clarification.

2.3.1 Controversial role of universities

This sub-section discusses the controversial role of universities and entrepreneurship programs from various perspectives, including the role of the whole university, the impact of incubators and accelerators, the impact of entrepreneurship education, and the dissolvement of the young entrepreneurs myth.

Economic impact of universities

The following pages discuss findings related to the economic impact of universities. The discussion is started by a detailed review of a recent correlative study by Guerrero et al. (2015) as this is a good opportunity to highlight some of the problems. In their review of the past research regarding the economic impact of universities, Guerrero et al. (2015) report that most of the past research has focused on measuring simple outputs such as university earnings or patent revenues. Studies looking at the impact on the level of the whole economy, such as the effect on GDP, have been few in numbers.

In their 2015 study, Guerrero et al. claim to have discovered that the teaching and research activities of universities have a significant impact on regional economic output two years later. The economic output was measured as GVA, that is, as gross value added, which is a similar concept to GDP (Kenton, 2019). The effects Guerrero et al. observed were greater for research outcomes than for teaching outcomes. Entrepreneurship outcomes were the third group of independent variables, which Guerrero et al. reported to have a similar overall impact as research outcomes.

The measure Guerrero et al. used for the quality of teaching activities was the employment rate of graduates. For research outcomes the measure was a collection of five variables: value of research collaborations, research contracts, consultancy, facilities income, and IP income per staff. For entrepreneurship the variables were the ratio of active spin-offs to a country’s population with HEI ownership, without HEI ownership, with staff ownership, and with graduated ownership.

The results were split between a focus group called the Russel group, which is a group of 24 prestigious entrepreneurial universities such as Oxford and Cambridge (Russell Group, n.a.), and a control group, that is, a group of universities that have more modest research results. Guerrero et al. discovered that the effects from research outcomes and entrepreneurship outcomes were larger for these 24 Russell group universities than for universities in the control group.

What makes these results problematic is that these correlations between a university’s actions and local economic growth could easily be interpreted as an indication of opposite cause and effect. That it is the universities that benefit from the large economy and not the opposite. To control for this possibility, Guerrero et al. used the universities’ expenditures per student and the relationship of local economic output per capita one year earlier to these expenditures. The logic being that in places with larger economy the universities would also have access to more funding. However, these timespans are likely too short, as new business creation and major technological advancements can take years or even decades (Arthur, 2009).

Simply expressed, the results of Guerrero et al. mean that a region including a university with a high number of active spin-off companies or research-related income per staff had likely a high economic output two years later when measured as GVA. Even with the two-year lag it can be asked whether the university's research collaboration with industry and spin-off numbers actually better reflect the effect of a strong economy on universities or vice versa. Regional economy with high GVA can be expected to have successful industries willing to invest in research collaboration. Also, stronger local economies can be expected to have more investors and venture capital that is then invested into spin-offs (Bar-Yam, 2018). So, as Guerrero et al. themselves note, the results were not based on dynamic long-term modelling, which leaves the causality in question.

A more in-depth question is what makes the Russell group universities more "entrepreneurial". One could easily point out that universities such as Cambridge or Oxford are able to select their students from a much larger pool of applicants than an average university that is part of the control group. This would yield a similar mechanism as with the most popular accelerators in the sense that the Russell group of universities can select the best and most talented students much like the most popular accelerators (Cohen et al., 2019) can select the most promising candidate teams. It can be that the most talented will generate the greatest impact, regardless or even despite any action a university will take.

Also, since the spin-off numbers used by Guerrero et al. were not adjusted for the size of the university, the results can become even more meaningless. According to statistics (Russell Group, n.a.), a Russell group university has on average about 17,000 undergraduates, while a non-Russell group HEI in UK has about 9,800 undergraduates. For post-graduates the difference is even bigger: 8,000 and 2,800 per HEI, respectively. The non-Russell group number was calculated by subtracting the Russell group numbers from the numbers of all UK universities (Universities UK, n.a.). It is only natural that a large university will yield a larger absolute number of spin-offs.

As a general methodological issue, Grimaldi et al. (2011) mention the issue of different impact measures being dominated by the few most successful universities and forms of technology or knowledge transfer. This hints at underlying complex dynamics including positive feedbacks (Siegenfield & Bar-Yam, 2020) and, for example, winner-takes-it-all type of behaviour at the system level, both of which have been reported also in citation patterns (Chatterjee et al., 2016) and entrepreneurial outcomes (Crawford et al., 2015).

As a matter of fact, when the focal point of research was companies and new businesses themselves, Brown and Mason (2014) showed that the role of university-based technology licensing and similar high-tech support was much less important when compared to seizing the practical economic and innovation opportunities emerging from the day-to-day production challenges and engagement with customers.

Economic impact of spin-offs, BIs, accelerators

Hacket and Dilts (2004) reviewed past research and reported that incubators are not very effective job creators, although there is a measurable effect. However, incubators are more cost effective than programs which aim to attract outside companies to the region. In their review Miranda et al. (2018) looked at the outcomes of academic spin-offs. At the individual level of an academic, they report that there is a link between entrepreneurship and academic productivity as well as entrepreneurship and financial income or promotion possibilities, although the evidence is not clear or significant. For teaching quality there is a positive link. Miranda et al. report that the most significant consequence is the positive effect on the reputation of the researcher. Of the impact on firm survival, Miranda et al. report that past research has found no significant difference in the outcomes of academic spin-off firms when compared to other startups. At the level of local/regional economy, Miranda et al. report that there are no conclusive results.

When comparing the performance of two top accelerators to angel-investor groups, Winston-Smith and Hannigan (2015) found out that accelerators increase the speed of exit by acquisition or by quitting. They also discovered that in the short-term, accelerators increase the speed of follow-on funding, but in the longer term, decrease the speed of the next round of follow-on funding. Curiously, Hathaway (2016a) did not mention this longer-term decrease of speed in his short review of accelerator effectiveness literature (2016a). Hallen et al. (2014) found that top accelerators have a measurable impact on the speed of how fast participating startups reach certain development milestones. As the positive impact is measurable only for top accelerators, Hallen et al. say that "variance in the impact of accelerators highlights the difficulty of configuring an effective accelerator" (Hallen et al., 2014, p. 6).

After studying the influence of an accelerator on regional financial activity, Fehder and Hochberg (2015) suggest that for metropolitan statistical areas, the existence of an accelerator increases the early-stage financial activities of that geographical area. This effect also included companies not part of the accelerators themselves. Hathaway (2016a) summarizes his review by saying that besides the positive effects of top accelerators, the impact on new firm survival and growth is not clear and can even be negative.

When accelerator companies are compared to the companies of the alumni of top universities, interesting details are revealed. Hathaway (2016a) reports that the more than 5,000 startups that had received very early-stage investment from accelerators raised a total of 19.5 billion dollars during the 2005–2015 period. Hathaway calculates an average investment of 3.7 million per startup, but this is not a particularly useful measure as the distribution of funding is typically highly skewed (Crawford et al., 2015), meaning that a select few very attractive startups capture the lion's share of investments.

On the other hand, Black et al. (2017) report that between 2006–2016 the alumni of one university alone, the Massachusetts Institute of Technology (MIT), produced 695 companies, which raised a total of 12.8 billion dollars of capital. This was the third best performance after Stanford University and the University of California, Berkeley. For the sake of comparison, this corresponds to 18 million per company. How many of the MIT startups were part of accelerators is unclear. As Crawford et al. (2015) point out, these numbers are highly skewed in the sense that few very successful companies produce much of the variance. Nevertheless, the startups of the alumni of top universities seemed to have bigger success stories compared to the startups of all accelerators.

In their 2019 study, Cohen et al. used three proxies as a measurement for the performance of accelerators. The three variables were funding raised, valuation attained, and meeting a $500K funding threshold. Cohen et al. do acknowledge that the startup performance proxies they use are highly skewed, and to counter this effect, they use logarithmic values. For example, using their sample, it can be calculated that a single company represented 53% of the combined pre-accelerator revenue. So, as Cohen et al. also suggest, even a single, very successful accelerator, with enough startups to its name, can skew the results.

In their quest to explain their findings, Cohen et al. comment that accelerators with poorer startup valuation and revenue outcomes reflect government-related accelerators' broader economic development goals. They argue that startups are not selected only "based on the profit potential of their business ideas as a venture investment" (Cohen et al., 2019, p. 30). In fact, Hacket and Dilts (2004) describe how the importance of the selection process has been recognized in the research since the 80s.

The incubators' approach to new firm creation has been criticized (Cohen, 2013). According to her, incubators do not expose their participants enough to market forces and signals, which prevents their early adaptation and leads to the development of non-viable businesses. She also suggests that, while incubators are mostly non-profit, with accelerators the goal of creating successful businesses and the accelerators' economic motivations are better aligned as accelerators typically invest in their tenants. Beside aligned motivation, if accelerators' managers and sponsors' own survival is directly based on the quality of their approach, over time poor accelerators will disappear, preventing them from sharing and propagating their poor approach and negative impact on the accelerator participants. This is what Taleb (2018) calls "skin in the game".

Grimaldi et al. (2011) point out that it is very much possible that an accelerator with incompetent managers or mentors can do more harm than good. In medicine, for each condition, there are typically only a few effective treatments (Bar-Yam, 2004). Selecting the wrong treatment will bring harm in the form of side-effects without any of the benefits. Imagine having chemotherapy to treat a migraine.

Impact of entrepreneurship education

Martin et al. (2013) report that in the past, more narrative reviews of entrepreneurship education have produced conflicting findings regarding the EE and entrepreneurship outcomes. In their meta-analysis, they included three types of entrepreneurship outcomes: nascent behaviour, startup, and entrepreneurship performance.

Martin et al. discovered small correlations of about 0.2 between EE and entrepreneurship-related assets, that is, which show that EE is to some extent able to increase entrepreneurship competences. The correlation was slightly higher for knowledge and skills and slightly lower, about 0.1, for perceptions and intentions. Between EE and entrepreneurial outcomes, the overall correlation was about 0.16. For the startup category, the correlation was about 0.12, and for entrepreneurship performance it was about 0.17. Martin et al. also discovered that the academic type of EE was correlated slightly more with entrepreneurship outcomes than training-based EE.

In their 2017 review of literature about entrepreneurship education in higher education, Nabi et al. use an impact classification system based on Jack & Anderson (1998). Because access to the original paper was limited, the description of the impact model is based on Nabi et al. The model classifies various impact measures along a temporal dimension, where level 1: measures during an EE program; level 2: pre- and post-program measures; level 3: zero to five years post-program; level 4: three to 10 years post-program, and level 5: 10+ years post-program. At the longest time-intervals, the impact measures are related, for example, to overall contributions to society and economy, while at levels 1 and 2 the measures are more subjective, such as intentions and attitudes. In the middle (levels 3 and 4), the measures are related, for example, to the number of startups and their survival. (Nabi et al., 2017)

When analysing the relationship between pedagogical approaches used in EE and the impact measures, Nabi et al. discovered that for supply and supply-demand models the results were mixed or positive for various, mostly lower-level, impact measures. For demand and demand-competence pedagogies, Nabi et al. reported a pattern of mostly positive links with lower-level impact measures. Finally, for competence pedagogies, the results are only indicative due to the low number of published papers. These papers report positive connections for all levels from 2 to 5. The definition of competence-model pedagogy looks very much like what happens in many accelerators and incubators, such as seeking consultation from external experts. However, these results would seem to contradict the findings of Martin et al. (2013), who reported that the academic-style EE, that is, the supply model, had slightly higher correlation with entrepreneurship performance outcomes than training-style EE.

The explanation offered by Martin et al. is that academic-style education focuses more on universal concepts needed in more ambiguous real-life contexts. This explanation is curious as here the difference would be more in the learning content, that is, the targeted competences, and not in the pedagogies or style of education. Thus, it seems that future research should differentiate the educational approach from the learning content, that is, targeted skills or knowledge, as Martin et al. also suggest, and what was modelled in Figure 2.4. There might be many teaching approaches that could be adopted to teach someone to swim, but if the style of swimming does not keep the swimmer afloat, the teaching style is irrelevant.

Taken together, the results from past research (Nabi et al., 2017; Martin et al., 2013) do not demonstrate a strong relationship with many impact measures. At the very least, the results are mixed, although many researchers want to see positive signals in them. Studies have observed some positive connections between startup creation and growth impact measures, thus giving some confirmation of Schmitz et al.'s (2017) suggestions made on the conceptual basis that entrepreneurship education plays an important role in the entrepreneurial university. However, they do not provide a clear answer as to whether incubator-like pedagogies or academic-style approaches work better.

At least three explanations for the conflicting results between the relationship of EE and EE outcomes can be imagined. The first and simplest explanation is that the competences learned in an EE are not actually competences in the real business environment. In other words, the knowledge passed on is not valid. An excellent education system can still teach the wrong skills. Second, as many knowledge and skill assets and competences enable more than just one opportunity, an improvement of these assets would naturally open up new opportunities. Thus, the relative desirability of starting a new business might stay the same or even be reduced as new and better-salaried positions also open up.

Third, as many entrepreneurship competences are competences of evaluation and analysis, these skills could enable a student to realize that there actually are no new business creation opportunities given her other assets and the local market. A quick and efficient tracker and hunter will still not bring home anything if there are no prey-animals in the forest. This third explanation is in line with Joensuu et al. (2013), who offered an explanation for why entrepreneurial intentions dropped during higher education studies.

The young entrepreneurs myth

Recent results by Azoulay et al. (2020) place exceptional pressure on university entrepreneurship advocates. Using demographic data that covers all business founders in the US, Azoulay et al. studied how the age of business founders affects the likelihood of success of new business ventures. They discovered that the highest likelihood of success was for founders between 40 and 50 years old. The younger the founders were, the worse were the chances of launching a successful business. The result holds for fast-growing high-tech companies as well. As Azoulay et al. say, these results debunk the young entrepreneur myth.

However, perhaps this reality is already present in past studies. How would the findings of Ollila and Middleton (2011) regarding venture creation programs be interpreted in the light of Azoulay et al.'s results? Taken at face-value, the venture creation program (VCP) case presented by Ollila and Middleton (2011) and Láckeus and Middleton (2015) seems to be on the side of the young entrepreneurs myth. The case used to exemplify VCP in the Chalmers School of Entrepreneurship has master's degree students launching new ventures. However, the details tell a different story. According to Ollila and Middleton, the inventions and intellectual property that form the basis of the future ventures are selected, evaluated, and prepared by professionals working for the incubator. On the other hand, the researcher(s) who made the original invention is kept in the process to ensure "continued contribution to development of the venture idea" (Ollila & Middleton, 2011, p. 169).

The core of any business is its value proposition, which is a combination of customer need and the unique benefit-bringing solution that stands out from the competition (Osterwalder & Pigneur, 2010; Christensen et al., 2016a). From this point of view, the business professionals at CSE understand markets, need, and potential customers, while the researcher has the knowledge of the technology, that is, the solution. So, what is left for the so-called young entrepreneurs to do but tweak the business model and resource acquisition, which are both also aided by teachers and incubator staff? It seems that young people can be part of success when in a highly *prosthetic* environment.

This perspective is also supported by the fact that third generation business incubators and accelerators are all also offering training, mentoring, networking, and help with resource acquisition (Bruneel et al., 2012; Cohen, 2013) and that they actively seek to select their participants based on the business potential and the teams' competences that match the task at hand. Von Hippel's (1986) work on lead-user innovation revealed that innovators, who are at the same time the most demanding users of their innovations and who have the means for building and modifying the products they use, produce successful innovations at a much higher rate than non-leading users or companies that are not engaged with lead-users.

Yet, results by Perkmann et al. (2013) reveal that the young academic loses to an older academic when the amount of academic engagement with the industry is used as a yard stick. As a phenomenon, this seems to be a close relative with the unravelling of the young startup founders myth. A senior academic has more consulting gigs, sponsored research, and contract research with the industry than their younger colleagues.

The case of VCPs brings forth a more complex question. Where exactly is this so-called *entrepreneurship* located? It is as if it is not necessarily hidden in the actions of any single individual, but it can also exist as a *distributed* phenomenon. Are there other examples of distributed entrepreneurship? It can be argued that in the everyday of the corporations of the world, where the creation and commercialization of inventions is a process with many participants, entrepreneurship is a distributed phenomenon.

In summary of section 2.3.1, it can be noted that the impact of universities as a whole, and also the impact of individual entrepreneurship programs, such as accelerators and entrepreneurship education programs, is controversial. These findings together with the recent results by Azoulay et al. (2020) indicate that there is room for improvement in the current understanding.

2.3.2 From descriptive to prescriptive theory

In the previous sub-section, it was shown that universities and individual programs' role in economic development and entrepreneurship is both controversial and lacking. In this sub-section, it is argued that the reason for the current state of the matter is that the research on university entrepreneurship has remained in the descriptive state or simply atheoretical. It is then argued that the solution is to take further steps to push the field from descriptive theory to prescriptive theory so that in the future new programs can be designed with predictable outcomes.

State of the research and the need for its improvement

According to Rothaermel et al. (2007), most of the university entrepreneurship research has been atheoretical. Those theories that existed were based mostly on either network theory from sociology or had a resource-based view of the firm from strategic management. In fact, the fragmented nature of the literature has persisted for ten years, as confirmed by Schmitz et al. They report that the field is still "under-theorized… requiring more systematic and holistic studies" (Schmitz et al., 2017, p. 385).

For new firm creation, Pauwels et al. (2016) call for more research regarding the impact of accelerators and how they affect the participating startups and the entrepreneurial actions taken by the startups. Miranda et al. (2018) mention the creation of academic spin-offs and economic indicators at the national level as a research opportunity, including how different institutions moderate this connection. They call for future research to evaluate the effectiveness of entrepreneurship support programs.

According to Pauwels et al. (2016), business incubator and accelerator literature does not explain the evolution and the heterogeneity of their operations. The shifting needs of new companies have been offered as one explanation for the changes in incubation value proposition (Bruneel et al., 2012), while others have emphasized the needs of the entities funding the incubation or accelerator programs (Pauwels et al., 2016). Cohen et al. (2019) also call for more research regarding the business models of accelerators. Specifically, they acknowledge that a revenue model based on equity stakes of the participating startups is often too uncertain and long-term. Thus, accelerators need to gain revenue from elsewhere as well. However, Cohen et al. are of the opinion that accelerators will not willingly share this data.

For entrepreneurship education, Nabi et al. (2017) highlight several themes for further research, including the poor linkage between entrepreneurial intentions and actualized entrepreneurial behaviour. An explanation concerning why ambitious intentions do not always lead to the creation of new startups is required. Another issue is the role of various individual background and contextual factors affecting the outcomes, including past exposure to EE and culture-related factors. Martin et al. (2013) found that all papers studying the impact of entrepreneurship education in a rigorous manner have taken place since 2003, which would indicate a positive direction for the quality of the research. Martin et al. encourage future studies to continue on this rigorous path.

Together these suggestions and calls for more research strongly indicate that university entrepreneurship theories are in the descriptive state in theory evolution. Christensen (2006) and Christensen and Carlile (2009) describe theory building as consisting of two main stages, descriptive theory building and prescriptive theory building.

Descriptive theory building

According to Christensen and Carlile (2009), descriptive theory building is a preliminary process that is needed before being able to develop a prescriptive theory. Based on findings of reviewers such as Rothaermel et al. (2007) or Schmitz et al. (2017) presented above, in can be argued that entrepreneurship program research, or more generally university entrepreneurship research, is at this stage. Descriptive theory building (Christensen, 2006) has four steps: 1. observation, 2. classification, 3. defining relationships, and 4. model testing and improving. The first three steps of descriptive theory building could also be seen as inductive inquiry, where theory is generated out of observations (Bell et al., 2019). In systems engineering, this stage can also be called reverse engineering (Dori, 2016).

Initially, in the observation stage researchers "…carefully observe phenomena and describe and measure what they see" (Christensen & Carlile, 2009, p. 241). As a result of these observations, constructs are developed that allow researchers to agree on what they are seeing. In this dissertation it is interpreted that in relation to object-process methodology, observation and construct building can be likened to researcher modelling his observations as specific objects and processes (see Figure 2.5).

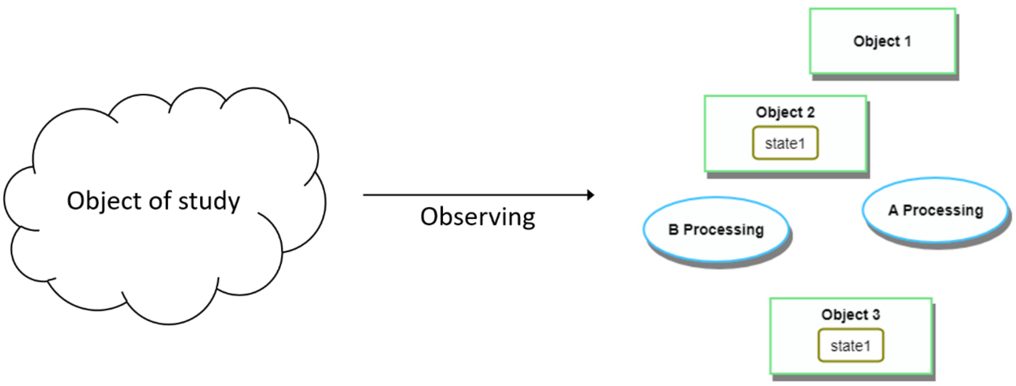

Figure 2.5: The observation step of the descriptive theory building stage.

For example, Pauwels et al. (2016) had a sample of 13 accelerators and used primarily semi-structured interviews to distil various accelerator-related constructs, such as mentoring services and alumni network.

In the classification stage, constructs are being organized into meaningful categories in the sense that higher level patterns are formed and objects of interest can be differentiated based on these higher-level categories (Christensen & Carlile, 2009). Again, in Pauwel et al.'s study, five higher-level categories of dimensions of accelerator design elements were formed while several different lower-level constructs existed as options under each category. For example, they distilled a higher-level category called selection process, which had three possible lower-level constructs under it: online open call, use of external for screening, and team as primary selection criterion.

As another example, Figure 2.4 illustrated three options for delivering the same entrepreneurship competence educating function. The options listed were entrepreneurship course, mentoring program, and startup event. The educating function represents the higher-level category while the different means represent the unique characteristics a program can have alongside the higher-level dimension. In general, in OPM, the classification-instantiation, or generalization-specialization structural links, or the inclusion of an attribute with various states can be seen to represent the classification step as meant by Christensen and Carlile (2009). A detailed introduction to OPM will be given in the third chapter. See Figure 2.6 for an illustration of the classification step.

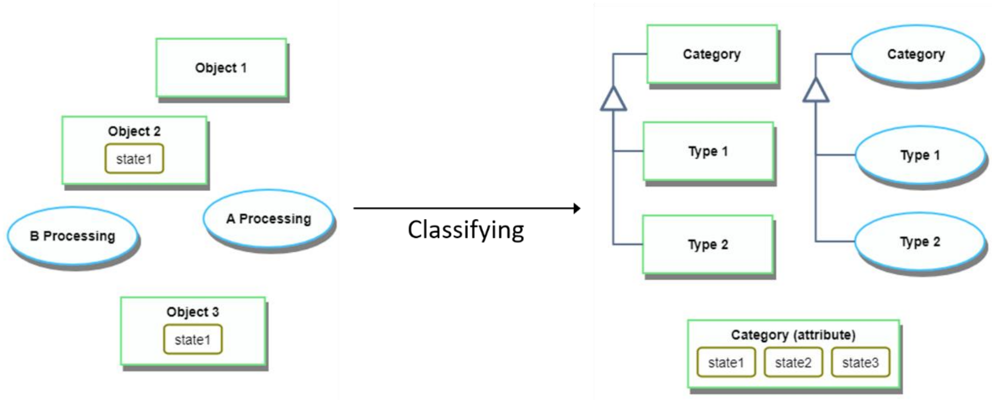

Figure 2.6: The classification step of the descriptive theory building stage.

As another example of classification, Cohen (2013) developed a classification scheme for separating incubators from angel investors and accelerators. In her scheme there are categories such as duration, business model, and selection process.

In the third theory-building step, that is, the *defining relationships* step:

> researchers explore the association between the category-defining attributes of the phenomena and the outcomes observed. They make explicit what differences in attributes and differences in the magnitude of those attributes correlate most strongly with the patterns in the outcomes of interest. (Christensen, 2006, p. 40)

In systems engineering terminology, *outcomes of interest* would correspond with the term *function*, *requirement*, or *purpose*. An example of this step is the study by Cohen et al. (2019), who looked at how various accelerator design parameters, such as cohort size, correlated with various outcomes like the maximum valuation of the alumni startups. Another example is Nabí et al. (2017), who reviewed various correlative studies that had explored the correlations between pedagogical styles and entrepreneurship education outcomes.

Figure 2.7 illustrates the relationship-defining step of the descriptive, or inductive, theory building process. In the model on the right side of the figure, Option 1 enables Process A, which can result in two outcome states: state 1 and state 2. The texts next to the arrows correspond with observed probabilities: Pr = 0.7 for Option 1 leading to state 1. As a result of correlative studies, researchers can build models based on which characteristics are linked to which outcomes (Christensen & Carlile, 2009).

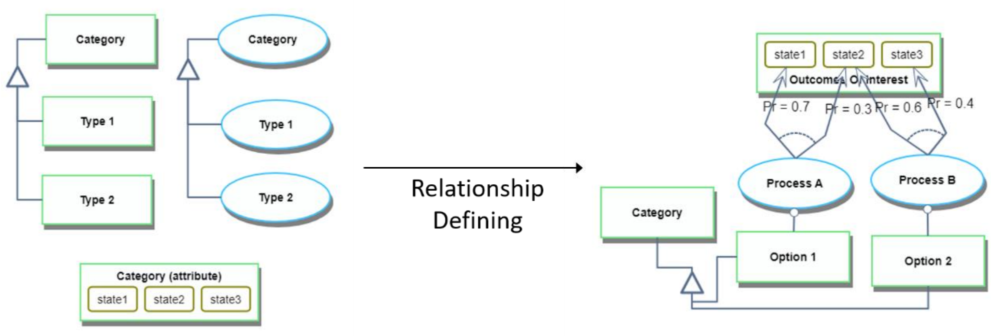

Figure 2.7: The relationship defining step of the descriptive theory building process.

In model testing and improving, in the fourth step of the descriptive theory building stage, as researchers move to model testing and improving, they also enter the deductive part of the descriptive theory building process. In this part, models built in the previous step are tested. If anomalies, that is, unexpected results, are found, the model can be improved by returning to the categorization step with new anomalous data from the model test. This leads to an improved theory that accounts for the anomaly (Christensen & Carlile, 2009).

As stated above, this overlaps with the general descriptions of the deductive process, such as those by Bell et al. (2019): 1. theory, 2. hypothesis, 3. data collection, 4. findings, 5. hypothesis confirmed or rejected, and 6. revision of theory. For example, the study by

Azoulay et al. (2019) challenged the common assumption, that is to say, the model, that youth correlates with business success especially in the high-growth startup world. Also, Cohen et al. (2019) discovered that an accelerator having working spaces or external mentorship did not have positive startup outcomes even though that was what researchers assumed based on the model that connected interactions in co-working spaces and positive outcomes.

In summary, the current state of university entrepreneurship and entrepreneurship program research is predominantly descriptive. If the field can take the leap to prescriptive theory, the findings will become practically applicable.

Prescriptive theory building

According to Christensen and Carlile (2009), the outcome of prescriptive theory building is such an advanced theory that it can guide practitioners towards making informed choices in order to reach the desired outcomes in their given circumstances. Accordingly, this theory building step has two important aspects: 1. statements of causality and 2. categorization of circumstances.

In this dissertation it is interpreted that formal systems engineering (SE) processes, such as those used by NASA, operate chiefly in the prescriptive theory building domain. A key element in SE is how engineers logically break a larger problem into a set of subproblems (NASA, 2017). Each of these subproblems involve their own phenomena, as in Arthur's definition that all technologies work only because they harness naturally occurring phenomena (Arthur, 2009).

Based on the literature review, the way entrepreneurship program research has approached the research problem could be likened to rocket engineers trying to develop a single theory of rockets of associative relationships with different outcomes. This would make no sense as building a rocket requires the use of findings from many fields, such as Newtonian principles governing acceleration and movement, rocket engines, aerodynamics, material behaviour in extreme temperatures, mechanical forces, life-support systems for astronauts, etc.

Prescriptive theory differs from descriptive theory in that it claims to explain causal relationships between observed phenomena and not just mere correlative relationships (Christensen, 2006). The temporal motivation theory (Steel & König, 2006), for example, could be seen as a prescriptive theory which instructs how the likelihood to act can be increased. The lowest level of NASA's technology readiness level classification scheme starts with the existence of a prescriptive theory. The exit criteria for TRL 1 reads: "Peer reviewed publication of research underlying the proposed concept/application" (NASA, n.a., p. 1).

Christensen and Carlile explain that prescriptive theory is improved in the same way as descriptive theory. If an anomaly is encountered, an opportunity to improve the theory emerges. Testing a causal theory in SE corresponds with the technology experiencing repeated rounds of experimentation of increasing realism and severity. If anomalies are encountered, engineers need to cycle back and improve their understanding (NASA, 2017). For more detailed descriptions of systems engineering practices and technology readiness level classification, read Chapter 3.

Christensen and Carlile describe the categorization of circumstances as:

> It is only when they encounter an anomaly that they can move to the categorization stage again. Rather than categorizing by the attributes of the phenomena, however, researchers identify the different situations or circumstances in which managers might find themselves. They do this by asking, when they encounter an anomaly, "What was it about the situation in which those managers found themselves, that caused the mechanism to yield a different result?" (Christensen and Carlile, 2009, p. 244)

A child might have an initial theory to lick everything that is cold and frosty for pleasure, but after the first time sticking one's tongue to a lamp post during winter, a new category emerges that excludes metal objects from the circumstances of when the theory works. In systems engineering, a similar approach could be called discovering the mechanisms of failure (Camarda et al., 2013).

2.3.3 Complex and multi-layered phenomena

In order to take the leap from descriptive theory to prescriptive theory, the question is why such a leap has not yet occurred. In this sub-section it is argued that because of the complex and multi-layered nature of the phenomena, a lack of proper methodology to be able to handle said complexity has prevented the field from moving forwards.

Balancing multiple functions in multi-stakeholder environment

A major theme brought forward by multiple reviewers and authors is that the universities are experiencing multiple, sometimes conflicting, demands from a diverse set of stakeholders. Rothaermel et al. (2007) wrote that policy changes both in the US and Europe have resulted in the rise of economic development as a third mission to complement the education and research missions. As mentioned earlier, based on their literature review, they report that "conflicting opinions over the university system's mission have been consistently identified… as a key barrier to university entrepreneurship" (Rothaermel et al., 2007, p. 708). Accordingly, Rothaermel et al. reported that the issue of the conflict between the three missions of universities has not been studied enough. Can a researcher be an entrepreneur at the same time? Or, is time and effort invested in business activities taken away from research?

Over ten years later, Miller et al. (2018) maintain that the tension between basic research and commercialization remains one of the main themes regarding university entrepreneurship. Intertwined with this is the issue of stakeholder relationships between faculty and other actors in the wider quadruple helix context. Likewise, taking the university-region-level perspective, Guerrero et al. call out for research to study "What is the most effective mix of Entrepreneurship and Innovation in an Entrepreneurial University to meet societal needs and for positive regional impact?" (Guerrero et al., 2016, p. 10). Grimaldi et al. (2011) point out that universities are constantly adapting to new regulations, policies, and new entities at the regional and national levels. The expectations are many and they are in a process of constant transformation.

Some authors would like to see more research on the role of academic spin-offs in improving welfare and sustainability (Miranda et al., 2018). According to them, studying the effects on the wellbeing of academics, the impact on their teaching and their income would be especially interesting. Miranda et al. "urge researchers to integrate the research of antecedents and outcomes and to explore the mediating role of academic entrepreneurship on different types of outcomes" (Miranda et al., 2018, p. 1021). Ollila and Middleton (2011), in their paper about venture creation, specifically approach the call for more research regarding integrated approaches where education and venture creation are combined.

Bruneel et al. (2012) suggest that their analysis of business incubators' balancing act of multiple components in their value proposition should be expanded to study so-called virtual BIs, which, unlike their first, second, and third generation predecessors, do not offer physical facilities but focus on the business support and networking functions. These virtual BIs seem to fit the definition of what are now known as accelerators, but Bruneel et al.'s request for future research would nevertheless be valuable as physical facilities can be seen to bring many indirect effects and mechanisms related to idea-flow between people (Pentland, 2014).

Regarding politics and incubators, Hacket and Dilts explain that as many incubators depend on public funding, they exist in a "politically charged environment" (Hacket & Dilts, 2004, p. 58), where they must be able to demonstrate their capability to deliver value. For future research, this needs to be taken into account. Overall, they emphasize the need to develop explicit theory of business incubation, along with explicit theory of what causes what in the incubation processes. Perkmann et al. (2013) call for more research on the relationship between the academic engagement with industry and commercialization or entrepreneurship. Even though both of these activities fit under the third mission umbrella, engagement is more research-oriented. Looking carefully at the dynamics between these two seemingly close yet distinct activities can reveal more of the bigger picture.

Another two very concrete questions by Miller et al. (2018b) are: "What type of intermediaries at core UTT junctures are needed to increase quadruple helix stakeholder engagement?" and "How can TTOs support and enhance quadruple helix stakeholder collaboration for UTT?" (Millet et al., 2018b, p. 18). Both of the questions implicitly suggest the need for a more design-based view in the sense that it is not enough to study only what exists but that there is a need for design principles that would guide the development of new and better structures.

Grimaldi et al. (2011) note that there is great variety in universities' strategies toward knowledge transfer, which is a result of universities being embedded in a populous and diverse ecosystem of internal and external actors at various scales from individuals to the ecosystem-level. Offering a unique perspective departing from other similar reviews, Grimaldi et al. emphasize that universities should not be seen as homogenous clones embedded in similar contexts. Instead, actions taken should be informed by the context of the university and the stage of development. They explain that "applying the same set of rules to Stanford University and a small teaching-oriented state university might handicap both and lead to outcomes opposite of those desired by policy-makers" (Grimaldi et al., 2011, p. 1048). Ollila and Middleton also ask for more research that would look at the integration of entrepreneurship education and university entrepreneurship from a multi-stakeholder perspective because: "the way in which the integration is viewed is highly dependent upon the position from which the perspective is taken" (Ollila & Middleton, 2011, p. 175).

Methodology to capture complex multi-level phenomena

As the phenomenon itself is multi-faceted, increasing amounts of authors have started to call out for methods and models that would better capture how multiple stakeholders interact at various scales and levels. Based on their review of literature, Rothaermel et al. (2007) state that the research on entrepreneurial university up until that point had been focused on subsystems and components, such as the existence of intermediaries, incentive systems, and culture and university ownership, of the whole system. They emphasize the way forward should be in multi-level, multi-stakeholder analysis acknowledging the complex nature of interactions. This is echoed by Grimaldi et al. (2011), with more emphasis on the contextual factors.

Likewise, Miller et al. mention that research on "the increasingly complex network of quadruple helix stakeholder interactions is in its infancy" (Miller et al., 2018b, p. 19). To guide future research with the goal of tackling this complexity, they suggest that research themes such as university technology transfer (UTT) performance measures and entities, as well as UTT and organizational structure, would be the steps forward. For example, as a concrete research area, Miller et al. suggest the issue of how UTT processes and the sub-processes interact with stakeholders.

Even though not strictly about university entrepreneurship, Chesbrough and Bogers (2014) explicate and replicate the need for analysis on multiple levels when studying the phenomenon of open innovation. Because open innovation research analyses the phenomenon of external R&D results' commercialization from companies' perspective, the request of Chesbrough and Bogers is relevant to this dissertation as well. Based on their analysis of the 20 most highly cited papers about open innovation, firm/organization and network levels are the most studied while other levels, such as individual/group, industry/sector, and national institutions and innovation systems, remain understudied.

Schmitz et al. (2017) also point out that future studies should be holistic, including both the social and economic aspects. Pauwels et al. call for more research “to examine the influences of policy, industry, density and economic conditions” (Pauwels et al., 2016, p. 11). Miranda et al. would like to gain a better understanding of the role of supranational, national, and regional factors. They recommend that “the use of multilevel methodologies will enable researchers to better analyze academic entrepreneurship activities in a comprehensive manner” (Miranda et al., 2018, p. 1021). Guerrero et al. (2016) would like to know which activities of entrepreneurial universities are directly linked to regional/national development, and thus in effect asking for more research on how the various levels of the phenomenon are linked.

In summary of this sub-section, other authors have recognized and pointed out that it is the complexity and multi-level nature of the phenomena that is the hurdle. Accordingly, a call has been made to use methodologies that can actually handle the complexities of the phenomena. Taken together, the discussions and findings presented in Chapter 2 lead us to define the first research question of this dissertation as follows:

1. What conceptual framework and methodology can help university entrepreneurship research to transform from descriptive to prescriptive?

2.3.4 Criteria for a new framework and methodology

Using the description of theory building, and especially the description of prescriptive theory by Christensen and Carlile (2009), and the conclusions of past reviewers regarding the challenging complex and multi-stakeholder of the university entrepreneurship phenomena, a set of criteria can be defined that make answering research question 1 precise and accurate. These criteria with short summary descriptions are presented in Table 2.1. In the paragraphs following the table, each criterion is discussed in more detail. This final section of the second chapter also brings together and summarizes the insights presented in section 2.3, “Problems with existing literature”.

Table 2.1: Criteria for a new framework and methodology.

Criteria	Description
1. Cause and effect	Causal relationships of interest can be modelled.
2. Complexity	Complexity of the university entrepreneurship phenomena can be managed.
3. Multiple scales	Multi-scale nature of the university entrepreneurship phenomena can be managed.
4. Multiple stakeholders	Inclusion of multiple stakeholders' perspectives can be incorporated into the models.
5. Knowledge retention	Findings from past research can be retained in the new framework.
6. Universality	The framework is ontologically applicable to as many fields as possible.
7. Theory developing	Manages the three theory-developing operations: observing, classifying, and relationship-defining.
8. Practicality	Framework facilitates both design and reverse engineering.

The first criterion, cause and effect, refers to the main property of a prescriptive theory as defined by Carlile and Christensen. A prescriptive theory is able to specify causality, that is, cause and effect relationships, in the area of interest and related to the outcomes of interest. Thus, a new framework and methodology needs to be able to model causal relationships in a clear way.

The second criterion, complexity, is based on the findings described in the previous section which stated that research on university entrepreneurship has struggled to cope with the complexity of the phenomena. In complexity science, complexity is defined as a property of the system's behaviour. Specifically, complexity describes the number of states a system of interest can be in (Bar-Yam, 1997). This means that the framework and methodology need to be able to allow the modelling of phenomena with multiple possible states and behaviours.

The third criterion, multiple scales, is also an outcome of the past reviews, which have concluded that one of the challenges of the field has been the fact that the scale can range from actions of individuals to long-term development of the economy. Thus, a better framework and methodology must be able to effectively model scale-related relationships, such as smaller units being part of larger systems.

The fourth criterion, multiple stakeholders, means that as socio-economic phenomena, university entrepreneurship and entrepreneurship programs include multiple actors with varying needs and goals, and sometimes conflicting behaviours. The framework and methodology need to be able to handle this diversity of perspectives and offer insight into synergistic design.

The fifth criterion, knowledge retention, and the sixth criterion, universality, mean that the new framework and methodology must be able to retain and use findings from past studies regardless of their field. As the literature review completed in this chapter has demonstrated, much is already known and this should not be wasted but instead built upon. On the other hand, as the review and the description of the broader background of this dissertation demonstrated, university entrepreneurship and entrepreneurship programs are related to many fields, including economy, management science, psychology, sociology, and education. This means that the framework and methodology need to be universal enough to bring in findings from sometimes distant fields.

The seventh criterion, theory-developing, refers to the three theory-developing steps or operations (Christensen & Carlile, 2009): observing, classifying, and relationship-defining. The framework and methodology need to be able to handle these three operations in order to be useful for researchers as a prescriptive theory-building tool.

The last criterion, practicality, refers again to the definition of prescriptive theory. A prescriptive theory needs to be able to be used by practitioners. This means that the framework and methodology need to be able to present research findings in a practically applicable manner. This can include both the study and improvement of existing entrepreneurship programs and also the design and creation of completely new programs.

In the next chapter, we use these criteria to show that an object-process methodology incorporating insights from systems engineering and complexity science is a framework and methodology that satisfies all eight criteria and is thus able to answer research question 1. This methodological choice then leads to the realization of the centrality of stakeholders in the design and study of entrepreneurship programs, which again leads to the specification of research questions 2, 3, 4, and 5 of this study.

3 Conceptual framework

In this chapter, it is argued that a systems perspective, and specifically object-process methodology incorporating insights from systems engineering (SE) and complexity science, is the answer to research question 1. This answer is validated by comparing details of the framework to the eight criteria defined at the end of the previous chapter.

The chapter concludes by defining the remaining four research questions as direct derivatives of the chosen conceptual framework and methodology. In the first section of this chapter, past uses of the systems perspective in the study of university entrepreneurship and entrepreneurship programs are reviewed.

3.1 Past uses of systems perspective

As mentioned earlier in Chapter 2, there is an interesting parallel with the history of the entrepreneurial university and the development of systems engineering practices. In his review of the development of the entrepreneurial university, Audretsch (2012) reported how the successful involvement of certain technical universities in the development of major advanced weapon systems was one of the first events that emphasized universities' role as a source of innovations and as economic actors. In a curious way, systems engineering has its origins in similar major advanced projects of the same era (Walden et al., 2015).

It is as if the research diverged from there so that humanities, including economics, management science, and sociology, took more interest in the university entrepreneurship phenomena towards the end of the century, while engineering sciences never stopped developing practices and theories that would guide designers and engineers in their complex projects. This dissertation could be seen as an effort to bring the tools of systems engineering to the study of university entrepreneurship and entrepreneurship programs. Thus, it is important to find out whether and how systems approaches have been utilized earlier in the field.

There have been only a few significant past studies that have approached the phenomenon of entrepreneurship programs from a perspective that resembles the perspective of systems engineering or complexity science. Hacket and Dilts (2004), in their review of incubator research, describe how early research adopted the view of incubation as a system and then moved to study the components of the system. However, Hacket and Dilts report that beyond the detailed analysis of the selection mechanisms, there has been little effort to really understand what causes what.

An important aspect of Hacket and Dilts' review is that it clearly adopts a view that there are various actors, such as the incubator, the incubatee, and the community, in the incubator landscape, and that each of these actors via their interactions bring a certain type of value to the other two. Hacket and Dilts categorize specific value-delivering mechanisms under each relationship type, for example, incubator to incubatee. This is important as the study of how the components of a complex system interact is a key step in understanding its overall behaviour (Siegenfield & Bar-Yam, 2020).

In their review and study of accelerators, Pauwels et al. (2016) used a so-called activity system perspective by Amit and Zott (2012), which was originally developed to model business models of all kinds. The approach recognizes two sets of design parameters called design elements and design themes. According to Pauwels et al. the first set describes what happens in the company and how things are organized, while the second set describes the system's *dominant value creation drivers*, such as novelty and efficiency. The big drawback of their approach was that they did not build on the vast existing literature and knowhow in the engineering fields. For example, the fundamental ontological distinction of object and process, that is, form and function, is not clear in this approach. Also, even though the activity system perspective recognizes the existence of multiple levels, the perspective emphasizes the big picture only. This is not sufficient enough as in complex systems the high-level, big picture behaviours can rise from the interactions of the component elements (Bar-Yam, 2002).

In the study by Pauwels et al., the resulting model of business accelerators manages to describe many different features but fails to clearly separate the functions from the methods utilized. This would give a designer the freedom to select new methods as the purpose of these methods would have been defined in advance. For example, a design element called the Program package "…consists of all services the accelerator offers to its portfolio ventures" (Pauwels et al., 2016, p. 5). The types of services (or constructs) Pauwels et al. list are mentoring services, curriculum/training program, counselling services, demo days/investor days, location services, and investment opportunities. When form is separated from function, or means from purpose, it becomes obvious that mentoring services, training program, counselling services, and even demo days can all be seen to serve the function of improving the entrepreneurial competences of the accelerator's participants. At the same time, the function of acquiring funding and resources could be handled by demo days/investor days, investment opportunities, and also mentoring services because, as Pauwels et al. write, "mentors help ventures to … connect with customers and investors" (Pauwels et al., 2016, p. 5). Would such a function-based categorization be a step forward?

Cohen et al. (2019), in their paper "The Design of Startup Accelerators", by using the word "design", give the reader the initial impression that the authors have adopted a design or even a systems perspective. What Cohen et al. do is that they clearly separate the so-called design parameters and then study what different parameter value combinations, that is, accelerator types, exist and how these design parameters are linked to certain outcomes. Ideally, anyone planning to create a new accelerator would look at these parameters and design their version of an accelerator along these dimensions. However, the study was largely based on an existing quantitative data set that had been gathered for years by other entities (Cohen et al., 2019). Thus, the data set is more of a reflection of the thinking of original data collectors.

As Cohen et al. (2019) willingly admit, the study does not demonstrate or even aspire to demonstrate causality, which would be key for an accelerator "engineer" to understand. They write: "We are careful to note that the documented associations are simply that; given the lack of exogenous variation in feature sets, causal statements cannot be made from our current dataset" (Cohen et al., 2019, p. 28). However, it seems that Cohen et al. have one of the key system engineering concepts, that is, separation of form and function, at least implicitly understood. This is evident when they speculate that if future research demonstrates that it is the education activities of accelerators that are the most valuable elements, there might be other more cost-efficient ways to deliver education. Also, when they discuss that there might be other more efficient ways for the screening and certification process, it seems that form and function are being thought of as separate entities.

Regarding entrepreneurship education, the seven-component framework of entrepreneurship education programs (EEP) by Maritz and Brown (2013) also hints at a systems view in the sense that it separates objectives and outcomes from content and pedagogical approaches. It also offers the assessment, that is, the measures or outcomes, as a key component of the conceptual framework. This again is very close with systems engineering concepts. See Figure 2.4, where the "Pedagogical approach" and the indirect "Impact generating" process correspond with the functions of the entrepreneurship education system.

To summarize, some past authors have used methods that have some resemblance to systems engineering. However, as systems engineering and complexity science are much more developed practices, it is time to learn about those practices in detail. In the following section, the definition of a system is looked at from various perspectives in the systems engineering and complexity science literature.

3.2 System definition

Systems engineers study systems, but what exactly are systems? According to INCOSE, systems are "an integrated set of elements, subsystems, or assemblies that accomplish a defined objective. These elements include products, processes, people, information, techniques, facilities, services and other support elements" (Walden et al., 2015, p. 5).

NASA provides two definitions: "The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose." (NASA, 2017, p. 192), and "The end product (which performs operational functions) and enabling products (which provide life-cycle support services to the operational end products) that make up a system" (NASA, 2017, p. 192). Entrepreneurship programs clearly fit the definitions of a system by both INCOSE and NASA.

In *Dynamics of complex systems*, Bar-Yam (1997) characterizes (complex) systems as having the following attributes: elements, interactions between elements, formation and operation, diversity/variability, environment, and activities and their objectives. This definition is more general in the sense that it includes natural or non-purposeful systems. Bar-Yam goes on to illustrate the mathematics of systems' behaviour. Instead of continuous time, discrete time is better-suited for system behaviour as it enables computer simulations (Bar-Yam, 1997). A mathematical function called an iterative map captures the dynamics. Bar-Yam writes: "An iterative map f is a function that evolves the state of a system s in discrete time $s(t) = f(s(t-\theta t))$, where s(t) describes the state of the system at time t" (Bar-Yam, 1997, p. 19). For example, a system of interest could be the stock market, and state *s* corresponds to the value of stocks at a given moment in time. Function *f* is the unknown mathematical relationship between the value of stocks at the previous moment in time and the current value.

Cyberneticist and system scientist Francis Heylighen's definition is as general as it gets. Heylighen et al. (2015) and Heylighen (2011) can be interpreted to mean that system S is a process or transformation from state a to state b. This cand be expressed as S: a → b or mathematically as S(a) = b. The first expression corresponds with how chemical organization theory denotes chemical reactions (Heylighen et al., 2015). Heylighen has advocated its use as a more general language for expressing all types of processes and systems. As an example, by defining *S = ageing*, *a = young*, *b = old*, the result is *ageing*: *young* → *old*. If a third letter, c, is added to both sides of the expression, it becomes S: c + a → c + b. This can be interpreted to mean that the state c or system c catalyses or enables process S to occur. S could be interpreted as a system or as an agent (Heylighen, 2011). If *S = baking*, *c = baker*, *a = ingredients*, and *c = bread*, the result is *baking: baker + ingredients* → *baker + bread*.

In object-process methodology, a system is defined as a *function providing object* (Dori, 2016). This is the definition that will be used throughout this dissertation. Using this definition, an entrepreneurship program, in order to be classified as a system, would need to consist of two elements, a function, that is, a value-delivering process or transformation, and an object that enables that function.

The key to a systems viewpoint is that form and function can be viewed separately (Dori, 2016; de Weck, 2015d; Heylighen, 2011). Compared to technical objects, such as cars, entrepreneurship programs are a bit more difficult to intuitively understand as objects as they are a looser collection of parts, such as program participants, mentors, and idea development tools. The many functions of a single entrepreneurship program could be handled by physically completely separate systems in a distributed manner. Thus, attention should not lie with the physical structure of a system but instead with the functions and the transformations that are desired. Idea refinement, business creation, and entrepreneurship skill improvement are clear examples of functions.

The relationship between system and its components is defined in OPM as "a subsystem, also known as a component, or a module, is a part of the system, which, in itself, does not provide the function that system provides” (Dori, 2016, p. 85). These OPM-based definitions will be elaborated in the following section.

3.3 Object-process methodology

In this section, Object-Process Methodology (OPM) is introduced. OPM is a conceptual systems modelling language, and in 2015 it became an ISO 19450 standard (Dori, 2016). According to de Weck (2015) and Dori (2019), OPM has been used to architect and study numerous systems of varying complexity, which is a sign of universality (sixth criterion) and knowledge retention (fifth criterion). This includes cell biology (Dori & Choder, 2007), Mars mission planning (Do, 2016), and business process improvement (Casebolt et al., 2020). The author of this dissertation has also previously utilized OPM to model an entrepreneurship program (Immonen, 2019a).

A formal modelling language allows a systems engineer to communicate with other stakeholders in such a way that miscommunication is avoided (de Weck, 2015; Dori, 2016). A unique feature of OPM is that it utilizes a dual-channel approach. In OPM every modelled system has a graphical representation and a corresponding natural-language textual representation. Both visual and textual representations are re-producible from one to another. For the purposes of this dissertation, this is very valuable as it allows the conversion of information that exists in multiple forms, such as documents, webpages, and observations, and which concerns different entrepreneurship programs into a form that allows easier comparison and analysis (fifth criterion, knowledge retention).

It is also possible to use OPM diagrams as part of the data gathering process from the stakeholders (Dori, 2016). In this case, instead of doing traditional interviews, the researcher could, together with a stakeholder, such as an entrepreneurship program manager, create a model that corresponds to the structure and behaviour of the program. The second important benefit of the OPM approach is its simplicity. Instead of using multiple different types of diagrams, like UML, which uses 13 different types (Peleg & Dori, 2000) and SysML, which uses nine different types (Dori, 2002), OPM uses only one type of diagram (Dori, 2016). The resulting benefit is improved flexibility and internal consistency of models (Dori, 2016). These factors are in support of the eighth criterion, practicality.

The reason why OPM is able to do with only one type of diagram is that it is based on a very simple yet all-encompassing ontology. According to Heylighen (2011) and Bell et al. (2019), ontology is that part of a world-view which defines the fundamental building-blocks of existence. In OPM the world is defined to consist only of objects and processes and relationships between these two. Building on this simple foundation, the semantics, that is, the meaning of different symbols in the language, and syntax, or, the rules that tell you how to generate new sentences, remain manageable (Dori, 2016). As mentioned in the introduction, OPM satisfies the minimal ontology principle, which is in support of OPM satisfying the universality criterion.

In the next few sub-sections, the basic elements of OPM are introduced and examples from entrepreneurship program literature and entrepreneurship in general are provided and converted to corresponding OPM representations.

3.3.1 Objects and processes

In OPM, Basic Things, that is, *objects* and *processes,* are the fundamental building blocks of existence and accordingly the key ontological elements in the modelling language (Dori, 2016).

Objects

Objects are those elements of existence that we can observe directly (Dori, 2016). A car is an object, a human is an object, the air inside a room is an object. Objects can have *attributes* (which are objects themselves) with measurable *states*. The air inside a room has an attribute called temperature. The attributes modelled or to be explained are up to the modeller and depend on the purpose for which the model is used. For a smoke alarm, the temperature is not an important attribute, but rather the amount of smoke particles in the air. A person could be defined to have different attributes such as weight, height, level of happiness, or the combined value of her possessions. The graphical symbol for an object is a rectangle (see Figure 3.1). The *value* of an attribute is expressed as a rectangle with rounded corners inside the rectangle symbolizing the attribute. (Dori, 2016)

In OPM, objects (and processes) can be classified based on their essence. There are two types of essence, *physical* and *informatical*. In graphical representation, physical objects and processes have a grey shadow under them. An informatical object is an object for which physicality is not relevant and only the information content matters (Dori, 2016). A business idea is good example of an informatical object. The essence of a process is determined by the essence of the objects it transforms. Attributes are always informatical, as attributes correspond to measurements and, as such, are information.

Systemic and *environmental* is a second way to categorize objects (and processes). Systemic objects and processes are part of the system of interest or study. Environmental objects and processes happen or exists outside the system but can interact with the system. Environmental objects and processes are distinguished from systemic ones by a dashed line (Dori, 2016).

Processes

Processes are the other fundamental aspect of existence. Processes cannot be observed directly. Instead, they are seen through how they transform objects (Dori, 2016). Ageing is a process that can be observed in the slow decline of human health and fitness. Heating is a process that can be observed because of the temperature of an object of interest rises. Paying is a process where the amount of money in the buyer’s wallet decreases while the amount of money in the cash register increases. In OPM the graphical symbol for a process is an ellipse (see Figure 3.1). Process titles are always written with an -ing ending, for example, paying, heating, ageing (Dori, 2016). In the following, specific types of processes are introduced in more detail. These processes describe so-called procedural transforming relationships between processes and objects.

Creating is a process which yields an object. Where there existed no object before, now exists an object (Dori, 2016). For example, flour is created by the process of grinding. A business plan document is created by a process called business plan writing. The symbol of creating a process in OPM is an arrow starting from the process and ending in an object.

Consuming is the second main type of a process. Consuming happens when a process consumes an object so that it does not exist afterwards (Dori, 2016). Melting is a process that consumes a snowman. Eating is a process that consumes food. Testing is a process that consumes prototypes if those prototypes are destroyed as a result of testing. The symbol for consuming is an arrow starting from the object and ending in the process ellipse (Dori, 2016). Many processes are a combination of both consuming and creating. In bread-making the ingredients are consumed and a loaf of bread is created.

State changing, or *transforming*, is the third type of process. In transforming the object is not consumed or created. Instead, the value of at least one of its attributes is changed (Dori, 2016). Heating does not create any new air in the room; it changes the temperature attribute of air from cool to warm. The written OPM sentence reads: “heating changes the temperature of room from cool to warm”. Graphically transforming is expressed with two arrows, with the first arrow starting from the value of the attribute before the process and ending in the process ellipse and with the second arrow starting from the process ellipse and ending in the resulting attribute value (see Figure 3.1). An entrepreneurship program with a selection process changes the *selection status* attribute of an applicant team from *applicant* to *selected*.

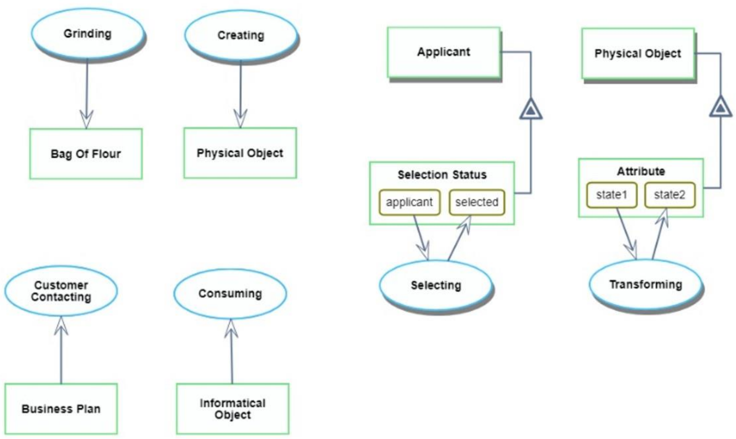

Figure 3.1: Objects (rectangles), processes (ellipses), states (rounded rectangles), and relationships (line-connectors). Based on Dori (2016).

As mentioned earlier, in OPM a system is defined as a function-providing object. The function is a process. And as mentioned above, a process is always defined by the way it transforms objects by creating, consuming, or changing their state. The object upon which the process operates is called the *operand* (de Weck, 2015d; Dori, 2106). In Figure 3.1, the bag of flour, the business plan, and the applicant are the operands. As an additional explanation for Figure 3.1, the consuming process titled "Customer Contacting" in the lower left-corner of the figure refers to the statement "no business plan survives first contact with a customer" by Steve Blank (2010, p. 1).

3.3.2 Procedural relationships

In OPM, procedural elements are elements that enable or are important for transformations to occur. *Agent* is a specific kind of an object which enables a process to happen. Agent *handles* Processing. An agent is always a human cognitive object able to initiate the process (Dori, 2016). For example, "salesman" is an agent in a relationship with the "sales calling" process. The graphical symbol for this relationship is an arrow with a solid circle as the end point (see Figure 3.2).

Figure 3.2: Agent handles Processing. Instrument enables Processing. Based on Dori (2016).

Instruments are objects that are required for the process to happen. Instruments are not transformed by the process but are there to *enable* it. The difference between instrument and agent is that instruments cannot initiate a process. In this sense the process needs more than an instrument in order to take place, it “waits” until an agent initiates the process or an initiating event occurs (see below) (Dori, 2016). For example, a “phone” is an instrument that is required by the “sales calling” process. The graphical symbol for this relationship is an arrow with an empty circle as the end point (see Figure 3.2). The enabling link can also be used to describe a situation where a certain state of the system, that is, a value of an attribute, is required for a process to happen. For example, freezing requires the temperature of water to be less than zero.

Condition links are special enabling links that describe a relationship between an object or value of an attribute and a process. A condition link means that an object (or an attribute’s value) is required for a process to happen, and if it does not exist, the whole process is skipped (Dori, 2016). For example, an investor might require for a startup team to have the revenue to be larger than zero before investing. Condition is symbolized with the letter c next to a link between object and process (see Figure 3.3).

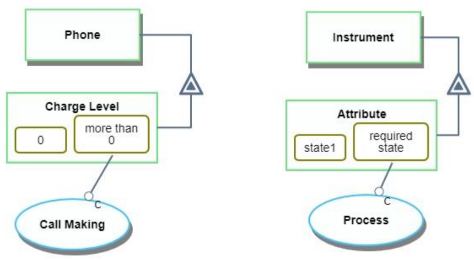

Figure 3.3: The condition link's symbol is the letter c. Based on Dori (2016).

An *event* can trigger a process without the existence of an agent. The process might require other conditions to be satisfied or other instruments to exist, but these need to wait for the triggering event regardless of their existence (Dori, 2016). For example, a person on a market square can be in two states: 1. “has not seen the ice cream stand” OR 2. “has seen the ice cream stand”. This second state could be an event that triggers the process “ice cream buying”. The event relationship is symbolized by the letter e next to the link connecting an object and a process (see Figure 3.4).

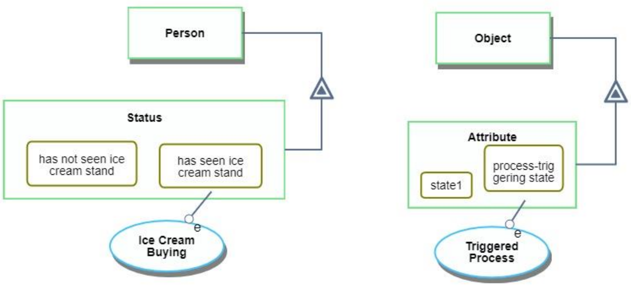

Figure 3.4: Events trigger processes. The symbol is the letter e. Based on Dori (2016).

The triggering event that causes a process to occur can also be seen as the “cause” in “cause and effect”, while the resulting transformation is the “effect” (Dori, 2016).

3.3.3 Structural relationships

Structural relationships describe relationships between objects or between processes. Never between objects and processes. An exhibition-characterization link describes a relationship between an object and its attribute: “*an object (exhibitor) exhibits attribute”* (Dori, 2016). For example, a “business idea” can exhibit the attribute “level of uncertainty”.

Figure 3.5 shows the *aggregation-participation*, *generalization-specialization*, and *classification-instantiation* relationships. The aggregation-participation link connects a whole to its parts. *An object (whole) consists of parts*. “A team consists of manager, programmer and graphics designer”. Similarly, the process of cooking can consist of sub-processes called “ingredient preparing”, “ingredient combining”, and “heating”. The generalization-specialization link symbolizes a relationship between general and specialization. For example, a “game development team” (*specialization*) is a “team” (*general*). The fourth and last type of structural relationship is the classification-instantiation relationship. “Team Blue Game” (*instance*) is instance of a “game development team” (*class*). (Dori, 2016)

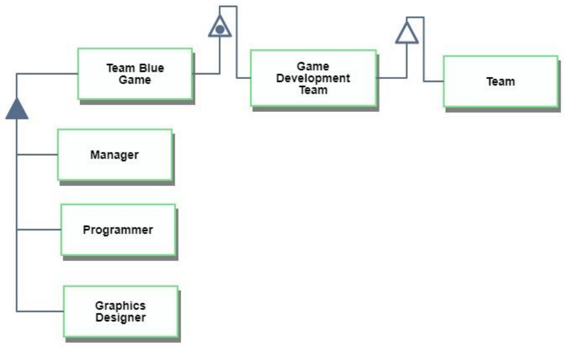

Figure 3.5: Structural relationship links. Based on Dori (2016).

3.3.4 Comparison to other frameworks

Now that the key symbols and concepts of OPM have been introduced, a more direct examination of how OPM relates to the other definitions of systems that were discussed in section 3.2 can be performed. Table 3.1 lists all the definitions mentioned. Next, each of these definitions will be taken and an OPM version of that definition is created to facilitate comparison between frameworks. This is direct evidence of the universality and knowledge retention ability of OPM.

Table 3.1: Different system definitions from literature.

Definition by	Definition of System
Object Process Methodology, OPM (Dori, 2016, p. 83)	"system is a function providing object"
NASA Systems engineering handbook (NASA, 2017, p. 192)	"(1) The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose. (2) The end product (which performs operational functions) and enabling products (which provide life-cycle support services to the operational end products) that make up a system."
INCOSE (Walden et al., 2015, p. 5)	"an integrated set of elements, subsystems, or assemblies that accomplish a defined objective. These elements include products, processes, people, information, techniques, facilities, services and other support elements."
Francis Heylighen (Heylighen, 2011)	P: s + a → s + b, where process P is enabled by the system s and it transforms the operand's state from a to b.
Yaneer Bar-Yam (*Dynamics of complex systems*, 1997)	(1) S(a) = b, where a and b are the states of the system and function S is the state-changing function of the system. (2) s(t) = f(s(t-θt)) where s(t) and s(t-θt) correspond to the system's states at times t – θt and t.

OPM's system definition

As mentioned in the beginning of this chapter, in OPM a system is defined as a function-providing object (Dori, 2016). Function equals the main process of the system. The object that is affected by this process is called the operand (Dori, 2016; de Weck, 2015d). The left side of Figure 3.6 captures these terms in a simple diagram. The figure also illustrates a key feature — the clear separation of form and function. The "System" object represents the form-side of a system while the process ellipse that transforms the Operand represents the function-side of the system.

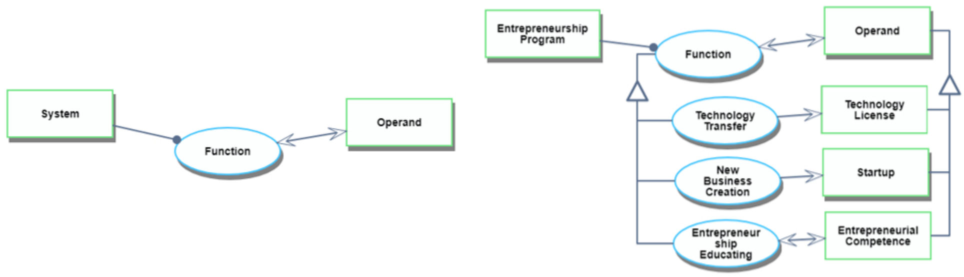

Figure 3.6: An entrepreneurship program is a system with many possible functions.

The right side of Figure 3.6 defines the entrepreneurship program as a system. The structural link with the white triangle means that technology transfer, new business creation, and entrepreneurship educating are specialized functions of an entrepreneurship program. Each process has their corresponding operand: "technology transfer" yields "technology license" (based on Figure 2.2), "new business creation" yields "startup" (based on Figure 2.3), and "entrepreneurship educating" affects "entrepreneurial competence" (based on Figure 2.4).

Next, let's look at how NASA and INCOSE's definitions translate to OPM diagrams.

NASA and INCOSE's definitions

The left side of Figure 3.7 visualizes NASA's first definition of a system. The difference to the OPM-based visualization in Figure 3.6 is that NASA's definition lists types of sub-systems and related sub-processes. The Need object corresponds with the operand object. NASA's second definition (NASA, 2017), when visualized on the right side of Figure 3.7, clearly shows how the system is split into two components, the end product and the enabling products. The function of the latter is to keep the former operational.

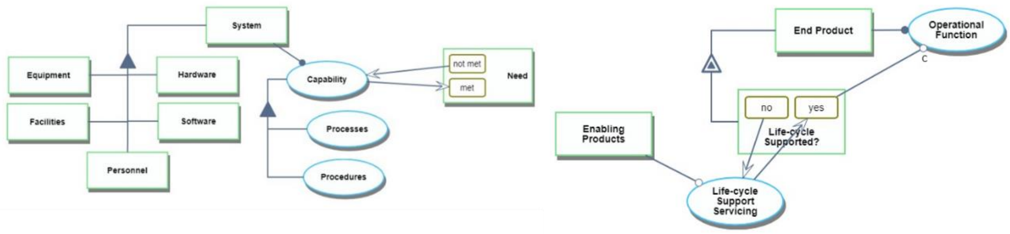

Figure 3.7: NASA's two-system definition. Based on NASA (2017).

NASA's second definition interpreted in an entrepreneurship program context could be seen as the way the program or the entrepreneur acquires and maintains its resources but also as the initial design and implementation steps of the program itself. Figure 3.8 represents INCOSE's (Walden et al., 2015) definition of a system, which looks similar to NASA's first definition. The object "objective" corresponds with the object "operand".

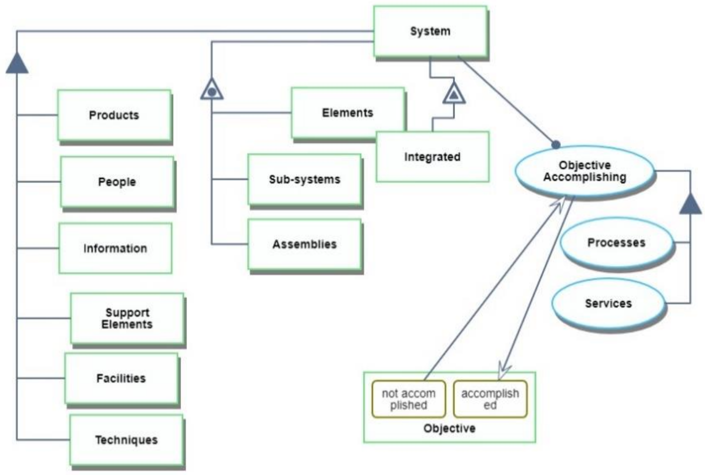

Figure 3.8: INCOSE's definition of a system. Based on Walden et al. (2015).

As an example of a similar level of detail as in NASA's and INCOSE's definitions in the entrepreneurship program context, a diagram of a business accelerator located in Helsinki (see Figure 3.9) was created. The diagram is based on publicly available information on their website.

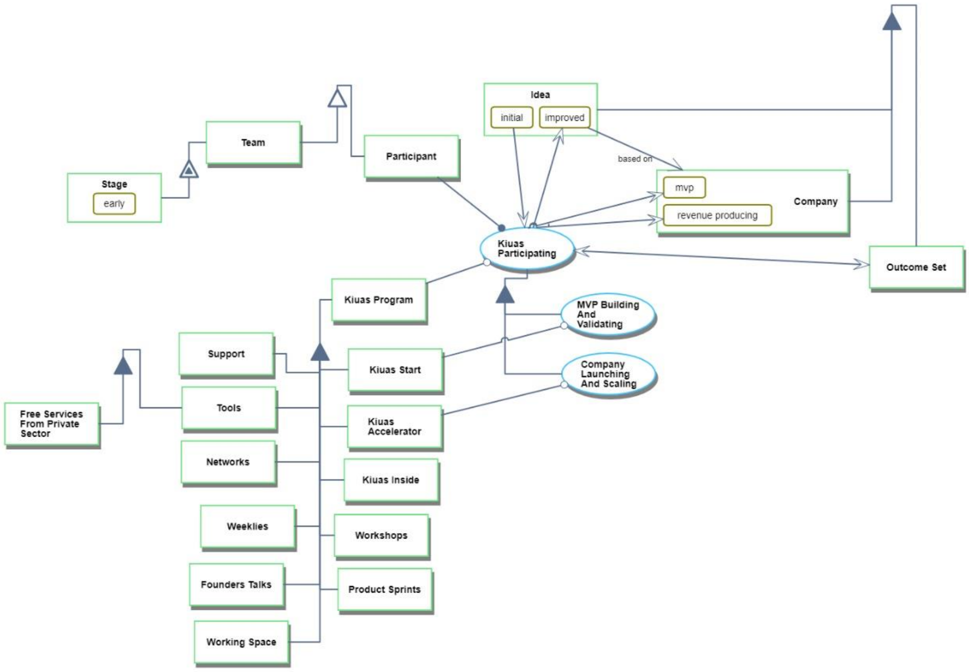

Figure 3.9: The Kiuas accelerator.

From Figure 3.9 it can be seen that the system, that is, the Kiuas Program, has multiple elements, such as software tools, facilities, and events. The operand, or the outcome set, has two main parts: initial business ideas will be improved and startups will be created either in a mvp state or a revenue producing state. As an important distinction, the participant was modelled as the agent of the main process and the Kiuas accelerator as an enabling system.

Representing Heylighen and Bar-Yam

Heylighen and Bar-Yam's definitions of systems differ from those of NASA and INCOSE. In the former definitions, the function-providing objects and the operands are seen as the same system. At this high level of analysis, it is the system itself that enables the transformation of its own states. In this sense, the systems defined by Heylighen and Bar-Yam are more general definitions as they also include non-designed or non-purposed systems.

Using Heylighen's COT-inspired formalism, a system is defined as P: s + a → s + b, wherein P corresponds to the process or function in OPM while s is the enabling system. a and b correspond to the state of the operand, and if a is a null state, the equation reads as P: s → s + b, which would correspond with the creating process in OPM. Likewise, P: s + a → s would correspond with consumption (see Figure 3.10).

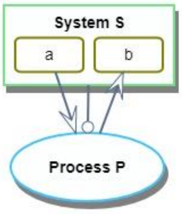

Figure 3.10: An OPM-representation of Heylighen's system definition. Based on Heylighen (2011).

Next, Bar-Yam’s (1997) mathematical formalism comes either in the form (1) S(a) = b, where a and b are system states, or (2) s(t) = f(s(t-θt)), where s(t) and s(t-θt) correspond to system states. In Figure 3.11, these have been converted to OPM diagrams. For the first equation, we will get process S transforming unnamed System S’s unnamed attribute from value a to value b. For the second equation, we get process F transforming System S’s state from value s(t) to value s(t-θt). According to Bar-Yam, s can be a variable of arbitrary dimensions. For OPM this can be interpreted to mean that the attribute of the operand transformed could be described as a group with an arbitrary number of single dimensional attributes.

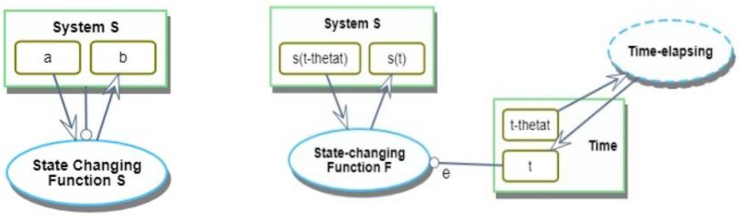

Figure 3.11: Representations of a system's state changing functions. Based on Bar-Yam (1997).

An important aspect of Heylighen and Bar-Yam’s definitions is that without any other model details, they can be interpreted as the state changing functions being triggered when the correct initial states happen. The transformation from state a to state b happens when the system enters state a.

Summary of this section

In summary of section 3.3, entrepreneurship programs were defined as systems, and the OPM-based definition of system as a function-providing object was adopted. It was also shown that many other common system definitions do not contradict the OPM-definition. The key to all of these definitions is the separation of form and function, or the means and the purpose. Entrepreneurship programs can have multiple functions (see Figure 3.6) and multiple methods of achieving the same function (see Figure 3.12).

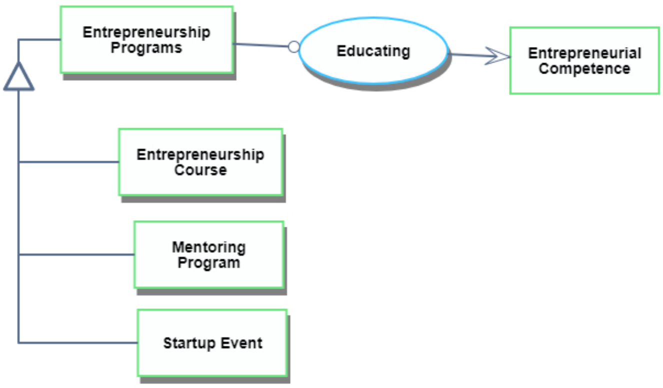

Figure 3.12: Multiple types of entrepreneurship programs can enable the same function.

By demonstrating that other system definitions can be represented in OPM, evidence of its universality (sixth criterion) and knowledge retention capability (fifth criterion) was provided. In the next section, the OPM-based conceptual framework is complemented with some of the key findings related to complexity and scale.

3.4 Complexity and scale

In the following few pages, five key concepts related to complexity and scale are discussed.

State of a system

At any given time, the objects in existence and the values of the objects' attributes define the state of a system (Dori, 2016). A thermometer is a tool that provides information on the state of human physiology when the attribute of interest is body temperature. In a classroom setting, a teacher uses an exam to measure the level of understanding individual students have about the topic. For a learning system, this would be a key representation of the state of the system. For a university interested in graduation rates, the progress and state of studies of individual students would be key information for describing the state of the university as a degree-producing system.

In OPM, an attribute is an informatical object that can be linked to both objects and processes alike. The value of this attribute at the moment of interest describes the state of the object or process. According to Dori, a “state is a situation or position at which an object can exist, or a value an attribute can assume, for some period of time during its existence” (Dori, 2016, p. 274).

Complexity of the system’s behaviour

According to Bar-Yam (2002), a system’s behaviour is a description of how its states change as time passes. For example, a cyclist moving at fixed speed changes his location in a predictable manner, at least for short durations. Using OPM, the behaviour of a system is captured in the OPM element “process” and how it transforms the “objects” and the “values” of their “attributes”. Dori writes: “Behavior of a system is its dynamics — the way the system changes over time by transforming systemic (internal) and/or environmental (external) objects” (Dori, 2016, p. 89).

According to Bar-Yam, the complexity of a system’s behaviour is a measure of the number of possible states (Bar-Yam, 1997). In a new business, for example, the business can end up being modelled in three states: “failed”, “stagnated”, and “growing”. Or, taking the water molecules in a glass of water based on Bar-Yam (2002), at this level of accuracy, the complexity is more than astronomical. Each of the molecules has its own movement vector, and thus the combined collective of the water molecules inside the glass can be in ridiculously many states, resulting in very high complexity.

The number of states a classroom of students in terms of their understanding can be anything from “everybody has full understanding” to “everybody has zero understanding”. For example, if the course comprises of 100 facts or pieces of knowledge and each of the 20 students can understand any specific number of these facts, there would be roughly $100!^{20}$ possible states, that is, potential complexity. Given this, it is impossible for a teacher to optimize teaching for each individual student in a traditional classroom setting (Bar-Yam, 2004). In physics, complexity is called entropy (Bar-Yam, 2016), and it defines the number of possible states a physical system can have at a microscopic level. Thus, as exemplified above, the number of these states is proportional to the number of molecules involved.

Figure 3.13 represents a system with an initial state and five possible end states and, accordingly, five possible behaviours. The system shows all the possible ways to combine the three parts: Part A, Part B, and Part C. Behaviour 1 keeps everything as it is. Behaviours 2, 3, and 4 combine two parts and leave one part alone. Behaviour 5 combines all three parts into one combination. Thus, the complexity of this system would be five, which is the number of possible states the system can be in.

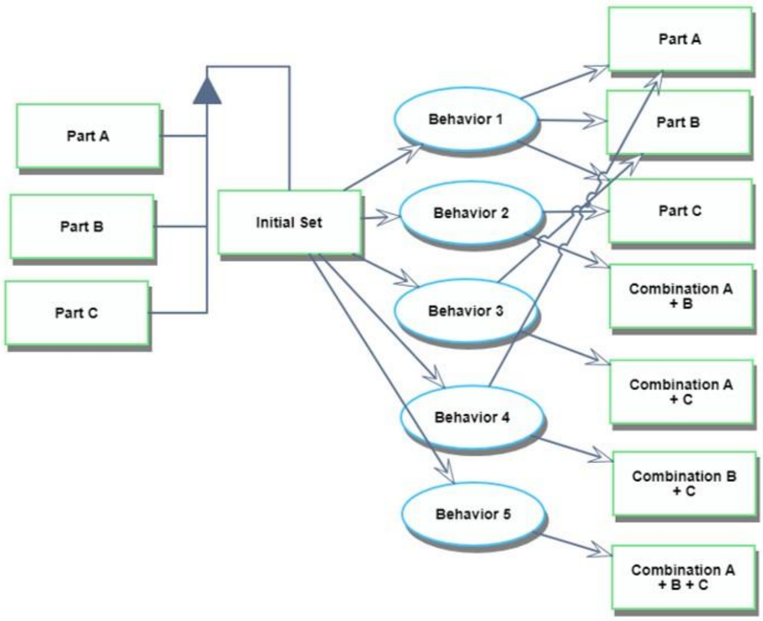

Figure 3.13: An example of a multi-behaviour model.

Implicit in the examples above is the other side of complex systems science. It is not enough to only focus on complexity, that is, the number of possible states, but also to look at what role scale plays in the understanding of the system. Thus, the concept of scale will be looked at next.

Definition of scale

Scale is defined as the number of physical components involved in the behaviour (Bar-Yam, 2002). For example, modelling of a school setting can start with one student and the scale can increase by looking at the behaviour of larger and larger groups. One student → one team of students → one class → one whole school. At the level of the school, the number of components could already be 500 students and teachers, and the interest of the modeller could lie in even larger scale behaviour, such as town- or nation-level, where the number of units could be 10,000 times higher. An economy studied at the level of a small town might consist of several hundred or thousand companies and tens of thousands of households.

According to Bar-Yam (2002), physical length is a good proxy for scale. When a longer distance or a larger area or volume is taken into account, the amount of components naturally tends to multiply. For example, taking the ecological dynamics of a forest and focusing on one square metre of forest. As the size of the square is first increased to 10 x 10 and then to one hectare, the number of plants and animals involved in the ecological dynamics of the forest system increases. This way the absolute lower boundary of scale is the Planck scale of distance (Ohanian & Markert, 2007) and the upper bound diameter of the universe.

In OPM, the process of zooming out reduces the number of components visible while increasing the scale of the analysis. At the level of SD, the whole value providing system is depicted with only two objects, system and operand. These two high-level objects contain all the objects involved in the process the system enables. On the other hand, zooming in increases the number of components visible in the model. This corresponds with reducing the scale of analysis, as shifting the analysis to smaller and smaller sub-systems causes the number of objects to decrease. A car's engine has fewer parts than the whole car, which includes both the engine parts as well as all the other parts.

Figure 3.14 illustrates a multiscale structure of a fictional startup ecosystem using the aggregation-participation relationship connector. At the lowest and most detailed scale, there are team members, who form startups, which are the second lowest scale. Multiple startups form a cohort, which are the second highest scale, and multiple cohorts form the startup ecosystem, which is the highest and roughest scale. The higher the scale is, the higher the number of units that comprise the system that is being analysed. A startup as a system consists of three team members. A cohort of three startups has 3 * 3 = 9 team members. And finally, the startup ecosystem consisting of three cohorts has 3 * 3 * 3 = 27 team members.

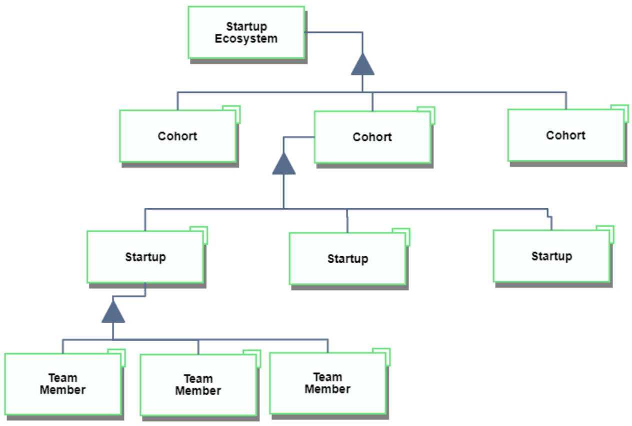

Figure 3.14: An example of the multiscale structure of a startup ecosystem.

Connectedness of complexity and scale

A key finding from complexity science is that complexity of behaviour is scale-dependent (Bar-Yam,1997). This means that when a system is studied at a different scale, it can be seen that only a certain level of complexity is required to model its behaviour effectively (Siegenfield & Bar-Yam, 2020). For example, when the movement of a car is analysed as a whole, only its current velocity and the strength of acceleration or deceleration it experiences, is relevant. At this level, there is no need to include specific components, such as the engine, seatbelts, or car radio, into the analysis, and their states can be excluded from the model of the car's behaviour at this level.

If the interactions of components are fully dependent on other components, then the complexity of behaviour at the level of the system, that is, at a higher scale, is equal to the lower scale. In the other extreme, if components are fully independent from each other, the complexity of behaviour at the lower level is very high but the emergent behaviour at a higher level is very low because the individual behaviours average out. However, for a system whose components' states are somewhat interdependent, complexity of the emergent high-level behaviour can be relatively complex, but not as complex as the behaviour observed at the lower scale. In general, there is a trade-off between complexity and scale so that complexity of behaviour decreases when modelling accuracy becomes rougher, that is, when the scale is increased. (Bar-Yam, 2002).

In OPM, an emergent feature of an object is classified as emergent, when "no one of the object's parts alone exhibit it" (Dori, 2016, p. 253). Next, the three mechanisms of theory-developing by Christensen and Carlile (2009) and how they can be interpreted using our framework are discussed.

3.5 Modelling and theory building with OPM

Christensen and Carlile (2009) recognized three mechanism for theory building: observing, classifying, and relationship-defining. Experiments and other rounds of observing can further improve a theory. In this section, how the framework satisfies the seventh criterion specifying research question one is discussed. In the following, each of these mechanisms are discussed from the perspective of OPM based on Dori (2016) and from the perspective of complex system modelling based on Bar-Yam (2016).

3.5.1 Observing and the process test

According to Bar-Yam (2016), the first two steps of modelling complex systems are: 1. recognize relevant components and 2. recognize relevant attributes and range of values. Regarding the first step, he writes: "identify the set of elements of a system to be described" (Bar-Yam, 2016, p. 20). In OPM this corresponds to identifying the objects in the phenomena to be modelled. In the second step, the idea is to define the *distinguishable states* (Bar-Yam, 2016) the relevant components have, that is, the attributes and their values (Dori, 2016). As an example, a person eating ice cream on a market square could be in such states as *has not bought*, *is buying*, *is eating ice cream*, and *has eaten ice cream*. As another example, in a very simple viral infection model, a component, that is, a person, can have only two states, *not infected* and *infected*.

For entrepreneurship programs (and for any system), the relevant states are dependent on the purpose of the program. If the purpose is to train students in entrepreneurship skills, the states could be related to whether the student has taken a specific entrepreneurship course or not. (Dori, 2016)

The Process Test

As mentioned earlier in this chapter, one of the key benefits of OPM is its universality and ability to model different phenomena in a unified way. As information for these models can come from text-based sources, including documents and interviews, a key criterion for successful modelling is to correctly build the model based on the semantics. Dori writes: "To apply OPM in a useful manner, one should be able to analyze sentences semantically. This primarily entails telling the difference between an object and a process" (Dori, 2016, p. 103).

This problem is solved by implementing the process test. The process test is defined as follows: "By default, a noun is an object. To be a process, the noun must meet each one of the following three process test criteria: (1) Object transformation, (2) time association, and (3) verb association" (Dori, 2016, p. 109). The three criteria are defined as follows: 1. "The object transformation criterion is satisfied if the noun in question transforms at least one of the objects in the involved object set" (Dori, 2016, p. 109), 2. "The time association criterion is satisfied if the noun in question can be thought of as happening through time" (Dori, 2016, p. 110), and 3. "The verb association criterion is satisfied if the noun in question can be derived from, or has a common root with a verb or has a synonym which is a verb" (Dori, 2016, p. 110).

The process test is implemented by default in all the modelling tasks in this dissertation. The process test is also a key element in facilitating knowledge retention (fifth criterion) as well as a feature that allows for a clear distinction of objects and processes in the observing stage of theory building (see Figure 2.5).

3.5.2 Classifying using structural relationships

The second step of theory building by Christensen and Carlile (2009) is classifying, which is about taking initial simple models based on the observing step and creating higher-level categories. In OPM category-development can be accomplished by utilizing the four fundamental structural relationships described earlier: the aggregation-participation relationship, the exhibition-characterization relationship, the generalization-specialization relationship, and classification-instantiation.

These structural relationship types allow the connection of different functions, operands, and attributes from one system diagram to the functions, operands, and attributes of other system diagrams. In OPM the key to this is to observe what objects, including attributes or processes, are shared in simpler models. This way, findings from different sources can be combined into a unified model. A similar approach has been used, for example, in the study of cell metabolism (Dori & Choder, 2007).

When it comes to the generalization-specialization relationship, the inheritance property of the relationship is particularly useful. Inheritance states that specialized versions of an object inherit all the parts, all the features, all tagged structural links, and all the procedural links of the general object (Dori, 2016). This logic can also be used in reverse to develop higher-level abstracted categories based on specific constructs. If a general object, which satisfies the definition of inheritance stated above, can be imagined in relation to the specialized objects, then it can be seen as valid.

It is important to note that the correct way to classify is not always evident from the models themselves but might require additional expertise. Figure 3.15 is an example of this, where on the left are two initial models based on an analysis of stakeholder expectations, and on the right, there is a more complete model, where the initial two processes, financial calculations completing and marketing planning, are modelled as parts of the same business planning process, while the financial calculations and marketing plan are parts of the whole business plan.

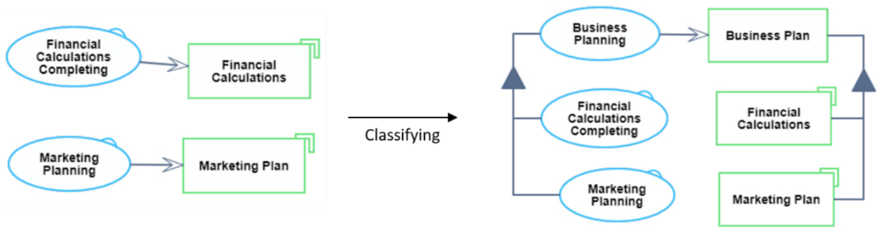

Figure 3.15: An example of classifying based on the aggregation-participation relationship.

Often, however, the proper classification move can be inferred from the models directly. This is the case in Figure 3.16, where on the left three different programs, “incubator”, “accelerator”, and “venture creating program”, all have the same main function, that is, “new business creating”. This allows the modeller to classify all of the three programs as a “new business creating system”. Because of inheritance, any attributes or features linked to the “new business creating system” would also be inherited by the three specialized systems.

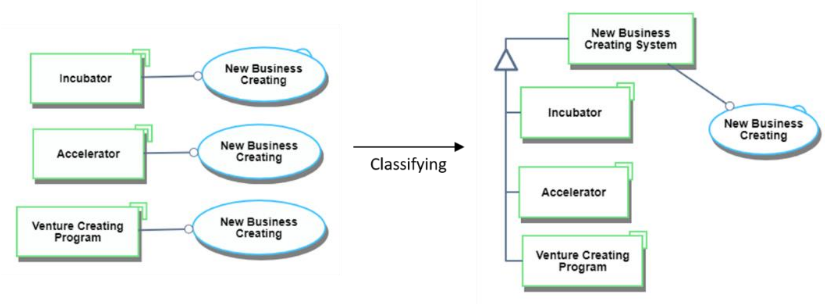

Figure 3.16: An example of classifying based on the generalization-specialization relationship.

Furthermore, higher-level category-development can be completed by using the folding property of OPM, that is, leaving only generalized versions or wholes visible in the model. See a more detailed description of folding and other complexity-scale management tools in 3.5.4.

3.5.3 Relationship-defining via behaviour-modelling

The third step in theory building is the relationship-defining step. As described by Christensen & Carlile, it can yield both correlative and causal models of the phenomena of interest. Based on Bar-Yam (2016), in the study of complex systems, the last three modelling steps of a complex system, after defining their components, attributes, and values of a system, are: 3. study how components interact, 4. analyse the states of the whole system emerging from the components' interactions, and 5. analyse how the external environment influences the system. These steps together capture the behaviour of the whole system, which corresponds to the relationship-defining step by Christensen and Carlile.

The third step in complex systems modelling by Bar-Yam (2016) is to identify interactions (dependencies) between the components of the system. The modeller needs to understand how the state of one component affects the states of the other components. A "viral infection" state of individuals is dependent on the state of the other people in close proximity. An infected person has a non-zero chance of infecting those in close contact with him. Perhaps in an open market square, the sight of a person eating ice cream can increase the likelihood of another person buying ice cream. In OPM, interactions are captured by processes, as the definition of a process describes how objects (or their states) are consumed, created, or transformed (Dori, 2016).

The fourth step, "Analyze the states of the whole system emerging from the components' interactions" (Bar-Yam, 2016, p. 20) means, according to Bar-Yam (2016), that the nature of the interactions between components dictates the states of the system on the higher levels. In OPM the emergence of high-level behaviours can be conceptually modelled by creating a pair containing a higher-level object and a process which captures the behaviour at this higher level (Dori, 2016). For a more detailed description of scale-management, see the next section. The OPM-based conceptual model of emergence can then be developed into a numerical model or, for example, using agent-based models, to observe emergence directly (Dori, 2016).

The fifth step of complex system modelling is to “Analyze how external environment influences the system” (Bar-Yam, 2016, p. 20). It is to characterize how external influences affect the dynamics of the system (Bar-Yam, 2016). For ice cream buying, outside temperature can play a huge role. When it is hot, many more people buy ice cream. When it is cold and rainy, nobody does. The popularity of a startup-establishing behaviour is influenced by the job market. When the unemployment rate is low, people start fewer new businesses. When it is high, more businesses are started out of necessity (Bosma et al., 2020). In OPM, the effect of the environment on the system of interest is conceptually modelled as a process and/or object with a dashed line, and which interacts with the systemic objects (Dori, 2016).

As the way the theory-building steps can be handled by using OPM has now been explicated, the focus of the next section is to inspect how OPM allows the modeller to manage complexity and scale.

3.5.4 Managing complexity and scale

In OPM, the modeller manages the complexity and the scale of the model by using four refinement-abstraction mechanisms (Dori, 2016): 1. unfolding-folding, 2. in-zooming-out-zooming, 3. state-expressing-state-suppressing, and 4. view creating. Of these the first two are presented here and used later in the dissertation. The folding (and unfolding) property in OPM, where details, that is, refinees, are hidden from the model so that only the higher-level element, that is, the refineable, is left (Dori, 2016). This completes the inductive process of creating higher-level categories, that is to say, theory, from specific observations or findings (Bell et al., 2019; Christensen & Carlile, 2009).

The concept of zooming in and out (or un-folding and folding) is another mechanism. In the standard OPM modelling process (Dori, 2016), after establishing the high-level system diagram (SD) (see the left side of Figure 3.17), the next step is to start adding details in order to better understand the exact nature of the dynamics.

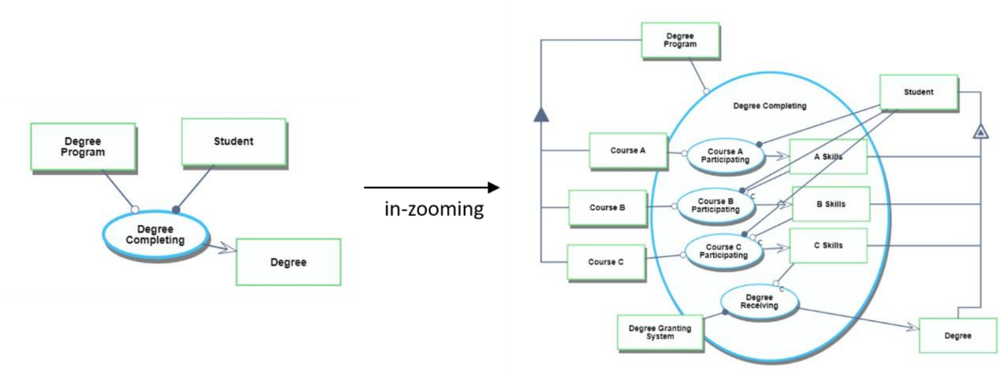

Figure 3.17: An example of the in-zooming mechanism in OPM.

Adding details happens via the process of in-zooming. Starting from the main process, it is possible to zoom into this process by decomposing it to a set of sub-processes. This creates a new diagram called SD1. In SD1 the interactions of the sub-processes with the operand or parts of the operand as well as the enabling system's parts are illustrated (see the right side of Figure 3.17). This process of in-zooming can be continued by zooming in to individual sub-processes, thus generating an increasing number of additional diagrams. Each time the model is magnified through zooming in, the total number of objects, attributes, and processes in the model increases. (Dori, 2016)

For example, zooming in to an imaginary entrepreneurship skill increasing system (see Figure 3.17), and by studying the system in detail, one might discover that the entrepreneurship course can be divided into a set of modules and the final exam. Each module would enable a sub-process responsible for a specific part of the entrepreneurship skill set. The final exam would enable a skill-level assessing process that would allow both student and teacher to verify the gained skill level. The organization of the modules, whether linear or delivered in a more parallel manner, would have to be captured in the dynamics at this SD1 level. This way, at a lower scale, more details (objects, processes, relationships) are revealed, thus increasing the complexity of the system behaviour modelled, which is a demonstration of the complexity-scale trade-off (Bar-Yam, 1997; Dori, 2016).

In the next section, the conceptual framework will be completed by the incorporation of insights from the work W. Brian Arthur on the nature of technology.

3.6 Entrepreneurship programs as purposed systems

In his 2009 book, *The Nature of Technology*, complexity science pioneer W. Brian Arthur defines all technologies as *means to fulfil a human purpose*. The purpose in this definition implies that technology is useful and beneficial. It solves somebody's problem. It also means that technology gets reproduced. It "earns" the resources needed for its production.

When Arthur's terminology is matched with OPM, it can be seen that "means" corresponds with "object", "fulfil" with "function", and "purpose" with the desired transformation or state of the "operand". See Figure 3.18 for an OPM-based representation of Arthur's definition.

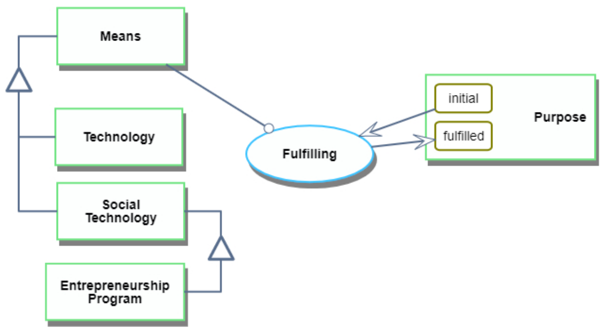

Figure 3.18: The definition of an entrepreneurship program as a purposed system using OPM. Based on Arthur (2009).

Arthur does not limit this definition only to physical technologies but acknowledges that also human institutions, social organisations, practices, etc., fit the definition of technology (Arthur, 2009). He uses the term *purposed systems* to distinguish these from physical technologies. Accordingly, entrepreneurship programs, the object of this study, are defined as purposed systems. Thus, in Arthurian terms, entrepreneurship programs are a means to fulfil a human purpose.

This is a natural leap when OPM is adopted and the term "purposed system" is replaced with the term "system". It is also noted here that in OPM and in systems engineering, systems can be both physical and social (Dori, 2016; NASA, 2017). Thus, an accelerator is a purposed system, that is, a means to fulfil a purpose. This purpose, as indicated by the literature in the previous chapter, is to create new fast-growing businesses but also to bring best investment opportunities to investors (Cohen et al., 2019; Hacket and Dilts, 2004).

Stakeholders define systems' purpose

An important insight is that in systems engineering, the purpose, or function, is derived from *stakeholders' expectations* (Lightsey, 2001; de Weck, 2015a; NASA, 2017), which then guide the design choices of engineers. According to NASA's systems engineering handbook, "A "stakeholder" is a group or individual that is affected by or has a stake in the product or project" (NASA, 2017, p. 191). de Weck (2015a, p. 35) defines stakeholder as “a group or individual who is affected by or is in some way accountable for the outcome of an undertaking”.

In object-process methodology, stakeholder is defined as follows: “A stakeholder is an individual, an organization, or a group of people that has an interest in, or might be affected by, a system.” (Dori, 2016, p. 87). All of these definitions share the central idea that whatever the system does, the result (or the cost of delivering the results) or some other outcome is relevant to the stakeholder.

3.7 Harnessable socio-economic phenomena

Arthur’s second, and perhaps deeper, insight is that at their core all technologies are based on some or several naturally occurring phenomena (Arthur, 2009). As a modification of Arthur’s original example, a thermometer inside a Finnish sauna harnesses the key phenomenon of heat expansion. Metals expand when they become warmer and contract when they cool down. Different metals do this at different rates. In this case, the thermometer technology harnesses this phenomenon by having two different metal strips attached together to make a spiral. When the temperature changes, the two metals expand at different rates, resulting in a twisting of the spiral. A needle attached to the spiral will move and can be used to read the temperature.

Figure 3.19 illustrates Arthur’s insight of all technologies harnessing naturally occurring phenomena. In the figure, two phenomena have been modelled as environmental processes (ellipses, dashed line, yellow colour) as those processes are naturally occurring. Hot air inside a sauna causes a heat-transferring process (phenomenon 1) to occur, which results in the temperature increase of the metal. This triggers the dimensional expansion of the metal (phenomenon 2). The dimensions of the metal, together with the temperature measurement scale, enable temperature reading to occur, which is the actual function of the thermometer.

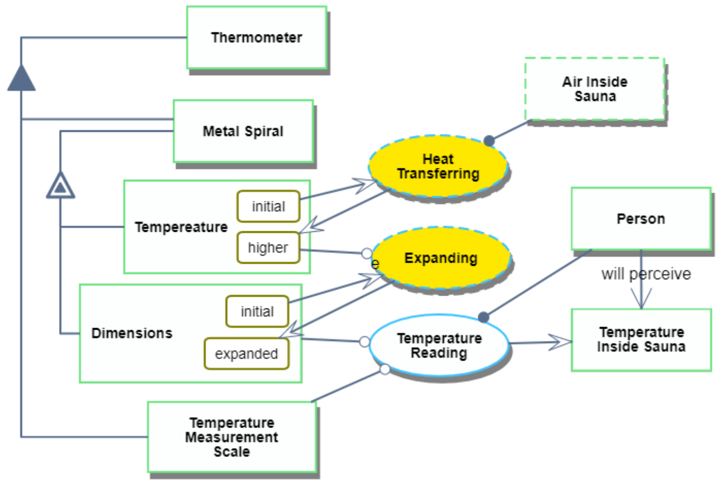

Figure 3.19: A representation of Arthur's insight that all technologies (such as a thermometer) being based on natural phenomena (yellow ellipses). Based on Arthur (2009).

Arthur's concept of *phenomena* overlaps with concepts from systems engineering. In systems engineering, a key step in the design process is to find suitable processes that can deliver the desired function (de Weck, 2015d). MIT professor de Weck provides an example where several processes, or phenomena, can be harnessed to deliver the function of reducing food spoilage rate. Examples of such processes are chilling, drying (bacteria will die or cannot multiply), or irradiating (bacteria will die when experiencing radiation) (de Weck, 2015d). There is another specific way Arthur's phenomena are part of NASA's SE process. NASA uses a so-called Technology Readiness Level (TRL) classification to assess a technology's readiness to be used in missions. In order to be classified as TRL 1, the lowest level above zero, engineers need to understand the basic principles, that is, the phenomena, behind the suggested solution of technology (NASA, 2017). EU has adopted a similar classification scheme for its Horizon program (Héder, 2017). This also connects phenomena to "cause" in "cause and effect", as phenomena explain why the technology or system works. As shown in Figure 3.19, in this dissertation the choice has been made to model Arthur's phenomena as environmental processes.

Social phenomena

Where it concerns purposed systems like entrepreneurship programs, the phenomena are not so obvious. In 2015 the International Council on Systems Engineering (INCOSE) published a white paper that provided guidance to systems engineers when dealing with complex systems such as social systems (Sheard et al., 2015). The primer includes several tips that align with the idea of harnessing social phenomena, of which four are presented in Table 3.2. There are limits to the extent of the design choices which can be made in complex systems (Bar-Yam, 2004).

Table 3.2: Guiding principles for complex systems engineering. Based on Sheard et al. (2015).

Principle	Description
Principle 1: "Think like a gardener, not a watchmaker"	"Consider the complexity of the environment and the solution, and think about evolving a living solution to the problem rather than constructing a system from scratch." (Sheard et al., 2015, p. 9)
Principle 4: "Use free order"	"In architecting and designing solutions, build in "order for free" using self-organization, presuming it has been modeled and can be limited to desired effects. This in particular applies when the system being designed must be resilient." (Sheard et al., 2015, p. 9)
Principle 5: "Identify and use patterns"	"Patterns are exhibited by complex systems, can be observed and understood, and are a key mechanism in the engineering of complex systems. Patterns are the primary means of dealing specifically with emergence and side effects—that is, the means of inducing desired emergence and side effects, and the means of avoiding undesired emergence and side effects." (Sheard et al., 2015, p. 9)
Principle 13: "Understand what motivates autonomous agents"	"Changing rewards will shape collective behavior. Implement incentives that will move the system toward a more desired state." (Sheard et al., 2015, p. 13)

Even when acknowledging the limits of design choices when dealing with complex systems, it can still be argued that these principles align with Arthur's thinking and that purposed systems work in so far as they harness relevant phenomena, which are likely to be socio-economical or psychological. When the purpose, that is, the function of the system, is known, potential phenomena can be located. Due to the opacity of these systems, the purpose might be revealed only iteratively.

Example of social phenomena and accelerators

The following paragraphs and Figure 3.20 are an attempt to demonstrate how a fictional top startup accelerator harnesses several social phenomena that drive accelerators' reputation as the producer of successful growth companies. In the model, two natural socio-economic phenomena, "picking the winners" and "economies of scale", lead to increases in the number of investors, number of applicants, and finally in the higher level of alumni startups' success.

First, the "picking the winners" phenomenon. When an accelerator has a lot of applicants, it can choose the best startups (Cohen et al., 2019). These startups are more likely than average to become successful regardless of what the accelerator does. Thus, the size of the applicant pool drives the fact whether or not the accelerator has successful alumni.

There is another phenomenon at play, called the “economies of scale” (Hacket & Dilts, 2004; Bruneel et al., 2012; Cohen et al., 2019). Cohen et al. argue that the cohort structure is one of the main benefits of accelerators. For investors the cohort structure lowers the cost of looking for and evaluating potential investment targets. This logic works the other way as well. For startups, when the number of investors connected to the accelerator is high, both the cost and difficulty of searching for external funding decreases, as the startups can potentially meet many investors during the same demo day, instead of contacting various investors separately.

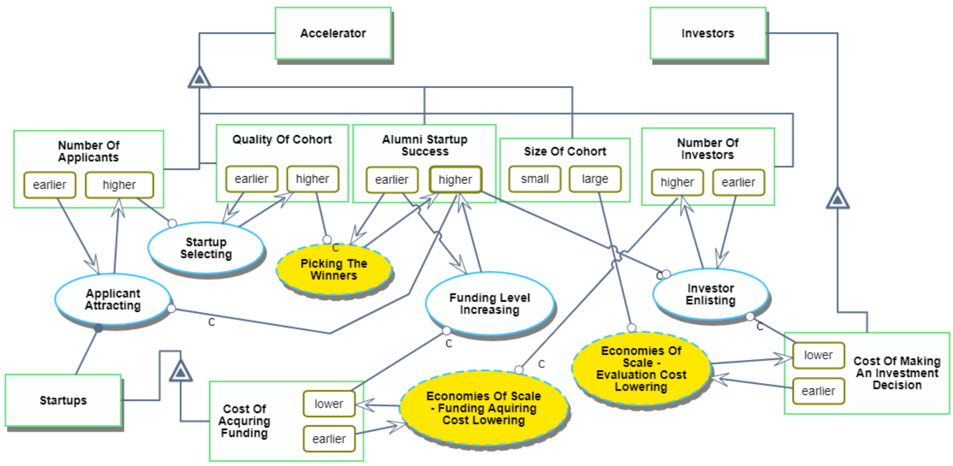

Figure 3.20: A model of accelerator success based on two natural phenomena, picking the winners and economies of scale.

In Figure 3.21, a generic OPM representation of Arthur’s insight that all technologies harness naturally occurring phenomena to fulfil their designed purpose has been created.

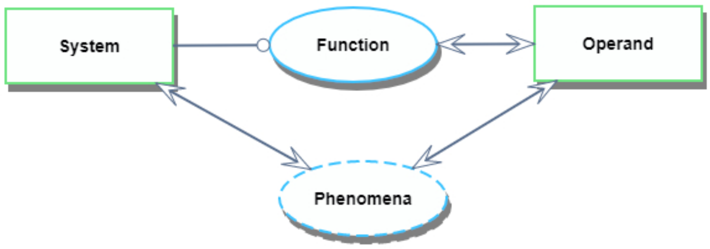

Figure 3.21: A generic OPM representation of Arthur's insight that all technologies harness phenomena.

Arthur’s findings, incorporated into the broad OPM-based conceptual framework, point to the centrality of stakeholders in the challenge of understanding university entrepreneurship. In the next section, research questions 2 to 5 are derived from this insight.

3.8 Centrality of stakeholders

As the phenomena in the case of entrepreneurship programs is socio-economic, the key actors, whose behaviours form the social phenomena, logically are based on the stakeholders of the system. Likewise, it is the stakeholders who define the purpose of a system. Both of these aspects point to the centrality of stakeholders in a prescriptive theory of university entrepreneurship and entrepreneurship programs. Thus, the second research question must be formulated as:

2. Are stakeholders’ expectations and the stakeholder-based socio-economic phenomena associated with the programs key to understanding the formation and survival of entrepreneurship programs?

As was argued in this chapter, entrepreneurship programs are means to a human purpose and that these purposed systems work only so far as they are able harness naturally occurring socio-economic phenomena. Logically, to answer the second research question in a universally meaningful way, three derivate research questions need to be answered first:

3. What are the expectations of entrepreneurship program stakeholders?
4. Is there any universal purpose or purposes all entrepreneurship programs share? If so, what would those be?
5. What phenomena can be harnessed to fulfil said purposes?

When these questions are answered in a specific context, which, in the case of this dissertation, is the Finnish higher education context, the answers can be compared to real patterns in the formation of entrepreneurship programs as well as survival in that context.

3.9 Comparing framework and methodology details with criteria

Table 3.3 summarizes the details of the conceptual framework and methodology used in this dissertation. The table shows specific details of how object-process methodology incorporating insights from systems engineering and complexity science satisfies the eight criteria that together define the first research question. Some details presented in the table, especially details regarding the fourth criterion, will be further elaborated in the next chapter, where the methodological details of the three conceptual studies (stakeholder analysis, functional analysis, and analysis of harnessable phenomena) based on OPM and systems engineering practice are presented.

Table 3.3: Description of how the framework and methodology satisfy the criteria.

Criteria	Framework details
1. Cause and effect	"Effect" in "cause and effect" correspond with purpose (Arthur, 2009) or function, that is, the desired transformation of the operand (Dori, 2016). "Cause" in "cause and effect" corresponds with naturally occurring phenomena that are harnessed by a purposed system (Arthur, 2009) or (environmental) processes that are enabled and triggered by a system (Dori, 2016). The desired "effect" is defined by the stakeholders of a system (Dori, 2016).
2. Complexity	Complexity is a measure of the possible states a system can be in (Bar-Yam, 1997). The states of a system are represented by objects and values of attributes in the model and behaviours by processes that transform objects and values of attributes (Dori, 2016). The modeller controls the complexity of the model by using four refinement-abstraction mechanisms: 1. unfolding-folding, 2. in-zooming-out-zooming, 3. state-expressing-state-suppressing, and 4. view creating (Dori, 2016).
3. Multiple scales	Scale is defined as the number of components involved in the behaviour, for which physical length is a proxy (Bar-Yam, 2002). In OPM, aggregation-participation relationships are used to model an object consisting of component-objects or a process consisting of sub-processes. The modeller can manipulate scale using the refinement-abstraction mechanisms (see above) (Dori, 2016).
4. Multiple stakeholders	Expectations and socio-economic phenomena related to multiple stakeholders can be incorporated into system models by adding new functions and environmental objects and processes which interact with the system. Designers can derive these functions via stakeholder analysis and functional analysis (Lightsey, 2001; NASA, 2017), as well as via analysis of harnessable socio-economic phenomena (Arthur, 2009).
5. Knowledge retention	OPM has been used successfully in diverse fields, including cell biology (Dori & Choder, 2007), Mars mission planning (Do, 2016), and business process improvement (Casebolt et al., 2020). Semantics (meaning) of past findings can be derived by converting findings to OPM models. Objects are distinguished from processes with the process test (Dori, 2016).
6. Universality	OPM is by definition a minimal universal ontology (Dori, 2016). Physical and informatical stateful objects and processes, which are the transformations objects experience, can be used model everything that is or can be (Dori, 2016).
7. Theory developing	The first step, creation of constructs from observation, that is, observing, happens when a modeller defines objects, attributes and values and processes as well as aggregation-participation relationships based on observations (Dori, 2016; Bar-Yam, 2016). The second step, creation of general categories from initial constructs, that is, classifying, is accomplished with the specialization-generalization and aggregation-participation relationships (Dori, 2016). The third step, relationship defining, happens by modelling the processes that lead to the outcomes of interest, including the process-enabling objects and triggering events (Dori, 2016). For example, how higher scale states emerge from lower scale behaviours (Bar-Yam, 2016).
8. Practicality	OPM is a model-based systems engineering methodology, which helps designers to develop new systems (Dori, 2016). Purpose or function define what the system should do (Dori, 2016), while harnessable phenomena allow designers to create a solution that fulfils its purpose (Arthur, 2009).

In summary, Chapter 3 answered the first research question by arguing that object-process methodology incorporating findings from systems engineering and complexity science is the methodology that handles the complex and multi-level nature of university entrepreneurship and entrepreneurship programs and satisfies the other six criteria set for such a framework and methodology. Adaptation of this framework then led to the realization of stakeholders' centrality in the prescriptive theory of university entrepreneurship. This realization can guide entrepreneurship program designers further. This realization also led to the formulation of research questions 2 to 5. In the next chapter, details answering research questions 2, 3, 4, and 5 are provided.

4 Conceptual and empirical study research designs

In this chapter, the research design and methodological details answering research questions 2 to 5 are provided. Questions 3 to 5 are answered by conducting three conceptual studies, one for each question. Question 2 is then answered by conducting two empirical studies and comparing the results of those studies to the findings of the conceptual studies.

Research question 3 is answered using a method called stakeholder analysis, question 4 using a method called functional analysis, and question 5 using a method called analysis of harnessable phenomena. The rationale of this pairing is explained in the first half of Chapter 4. The results of implementing these three methods are presented in Chapter 5. In the second part of this chapter, the focus is on research question 2 and in the methodological details of answering it. The results of the two empirical studies will be presented in Chapter 6.

All of the five studies use some parts of the OPM and complexity science -based techniques introduced in the previous chapter. This chapter begins by providing a compact overview of systems engineering as the specific methods have their origins in systems engineering. This is followed by sections describing the details of stakeholder analysis, functional analysis, and analysis of harnessable phenomena.

4.1 Systems engineering overview

In this section, an overview of systems engineering using NASA's approach as an approximate map will be presented. The field specializing in the design, development, and management of systems is called systems engineering (de Weck, 2015a; NASA, 2017). Systems engineers start with a problem or challenge and, through specific stages, move to design, build, and operate a system that solves the problem or challenge (Walden et al., 2015). This framework is useful not just in designing new systems but also in reverse engineering of existing systems (Dori, 2016; de Weck, 2015d), such as entrepreneurship programs.

Of the many methods in systems engineering, the focus in this dissertation will be on using the practices of stakeholder analysis, functional analysis, and analysis of harnessable phenomena, which belong to the early stages of systems engineering.

History of system engineering

According to de Weck (2015a), the origins of the informal practices of systems engineering are in the large-scale construction projects of antiquity. According to INCOSE's systems engineering handbook (Walden et al., 2015), the origins of more formal systems engineering practices are in the British air defence system analysis in 1937 and Bell Labs' involvement in the US NIKE missile project development in 1939–

1945. From 1951 onwards, the Massachusetts Institute of Technology (MIT) has been an important developer of systems engineering practices (Walden et al., 2015).

Another key player has been NASA, which started using formal systems engineering practices during the Apollo Program (de Weck, 2015a) and since 1995 has published the NASA systems engineering handbook. According to de Weck (2015a), by 2015 there existed four important systems engineering standards and handbooks: 1. *NASA Systems Engineering Handbook,* 2. *INCOSE Systems Engineering Handbook,* 3. *ISO/IEC 15288:2008€, IEEE Std 15288-2008*, and 4. *ECSS-E-10A*, which is the European Systems Engineering Standard. For illustrative purposes, NASA's approach will be briefly discussed in more detail.

NASA's approach to systems engineering

According to the *NASA Systems Engineering Handbook* (NASA, 2017), developing and completing any new mission at NASA follows the NASA program/project life-cycle. The purpose of the life-cycle is to make such large-scale projects more manageable. NASA's life-cycle achieves this by dividing the project into phases. This way the managers can follow and guide project implementation based on schedule and budgetary limitations. Large-scale decisions of "go" or "no-go" are made in the boundary spaces between life-cycle phases. These points are called Key Decision Points (NASA, 2017).

All in all, the seven phases from Pre-Phase A to Phase F cover everything from concept studies to closeout, that is, decommissioning/disposal (NASA, 2017). The work conducted in this dissertation will mostly overlap only with pre-phase A, that is, the early conceptual stage of the project/process life-cycle. The focus is on studying entrepreneurship programs at the conceptual level as no prototype programs are created. In the next section, the details of the first method, stakeholder analysis, are provided.

4.2 Stakeholder analysis

The purpose of stakeholder analysis in this dissertation is to answer the third research question: "*What are the expectations of entrepreneurship program stakeholders?*" It is the first of the three conceptual studies implemented. The benefits of completing a thorough stakeholder expectations process are, according to de Weck (2015a, p. 41): 1. the resulting system meets customer expectations, 2. the system "…can be tested, operated and maintained", and 3. "stakeholder commitments are obtained and realized". NASA (2017) emphasizes that by documenting everything, the process and decisions can be assessed and evaluated in the future. One of the key strengths of object-process methodology is how it improves communication between systems designers and stakeholders (Dori, 2016).

NASA's stakeholder expectations definition process assumes that the actual stakeholders are available for repeated communication. However, the focus in this dissertation is not to design any specific entrepreneurship program but to focus on general features all entrepreneurship programs share. Also, as entrepreneurship programs are social purposed system and the underlying phenomena is social, the stakeholder analysis will also act as an initial tool for studying said phenomena.

Stakeholder types

A formal definition of a stakeholder in OPM was presented in the previous chapter. Stakeholders can be classified into external and internal stakeholders and also to customers and other interested parties (NASA, 2017; de Weck, 2015a). Other interested parties, according to de Weck (2015a, p. 35), “provide broad overarching constraints within which the customers’ needs must be achieved, or who have influence on success of the system”.

Subcontractors could be classified as such non-customer stakeholders (de Weck, 2015a). Dori calls them suppliers (2016). Dori (2016) highlights four different stakeholder types: beneficiary, customer, user, and supplier. It is critical to understand that these roles are functional and they can be split between several people or be combined into a single individual (Dori, 2016). According to Dori (2016, p. 87), a beneficiary is the one “who extracts value and benefits from the system”, a customer provides the resources for setting up and operating the system, user “operates the system or directly interacts with it”, and the supplier “oversees the development, support, and maintenance of the system or product”.

4.2.1 Stakeholder analysis process steps

In this dissertation, a literature-based stakeholder analysis is conducted in three major steps. Each step is broken down to its own, smaller steps (see Table 4.1).

Table 4.1: Stakeholder analysis steps.

Stakeholder analysis step	Description
Step 1: Establish a list of stakeholders	
Review of stakeholder categories and types	1. Online search with keywords, 2. initial review of papers, and 3. review of papers
Compiling of a categorized list of stakeholder types	Based on the review and using the stakeholder definition and generic stakeholder types as a guide.
Step 2: Elicit universal stakeholder expectations	
Reviewing findings about expected value	Same steps as when establishing the list of stakeholders. Additional papers taken from the initial literature review in chapter 2.
Reviewing findings about circumstances of stakeholders	Based on the same pool of papers as expected value and additional source via organic discovery.
Relationship with other stakeholders	Same as previous step.
Additional modelling with OPM	Selected stakeholder types and related findings converted into OPM models.
Step 3: Update with contextual information	
Recognize key stakeholders	Selecting key stakeholders given the Finnish higher education context.
Find contextual information	Short literature review with focus on context relevant statistics and reports.

In the following sub-sections, each step is explained in detail. The review was conducted in the spirit of qualitative inductive research, because as Bell et al. (2019, p. 20) state, in induction “theory is to be the outcome of the study”. Using the descriptions of the theory building process steps by Christensen and Carlile (2009), this review can be placed in the classification phase of theory building where a researcher produces meaningful categories that can be used to distinguish objects of interest from one another.

The resulting findings will be limited by the scope of the review and due to the erosion of situational factors. de Weck (2015a) writes that many formal approaches assume that stakeholder expectations remain stable over time, but this is not often the case. For example, in the Finnish system, the public university funding model seems to be updated every few years (Minedu, n.a.). Thus, the facts and insight that are reported in this dissertation are bound to become at least partially invalid as time passes.

4.2.2 Establish a list of stakeholders

In order to establish a list of stakeholders, a compact review of stakeholder types mentioned in the literature was carried out. Papers for this step were selected and reviewed using the following process: 1. online search using Google Scholar, 2. initial review of papers, and 3. detailed review of papers. The online search using Google Scholar was carried out using keywords "*stakeholders*" and "*entrepreneurship program type*", wherein the "*entrepreneurship program type*" is a placeholder for one of the program types used in the analysis of existing research findings: "*academic engagement*", "*technology transfer office*", "*incubator*", "*accelerator*", and "*entrepreneurship education*".

The initial analysis of existing research findings was based on the number of citations the paper had, the title of the paper, the abstract of the paper, and the availability of the full paper. When the title of the paper and the abstract indicated that the study included some type of stakeholder categorization scheme and/or discussion about different stakeholder types, it was selected for the detailed review. Some sources that the author of this dissertation had already familiarized himself with during the initial literature review of entrepreneurship program and university entrepreneurship literature were also selected. Because of scheduling limitations, only the most relevant papers were reviewed.

In the detailed analysis of existing research findings, the selected papers were examined using the definition of stakeholder presented above and the descriptions of stakeholder types in systems engineering literature (see earlier). This is in line with Bell et al. (2019), who emphasize that the key to review is specifying the research question clearly. Herein the stakeholder definition and past generic types represent the "clearness". After that a resulting list of stakeholder types was compiled and organized under meaningful categories with an emphasis on universal functional categories similar to Dori (2016).

4.2.3 Elicit universal stakeholder expectations

With the list of stakeholder types defined, the next section details how to study stakeholder expectations, and the following three-step process to capture stakeholder expectations for each recognized stakeholder type was used: 1. define the expected value of each stakeholder type, 2. record information about stakeholder-related circumstances, and 3. note mentions of stakeholder-to-stakeholder interaction patterns.

For each step, the same minimal version of the paper selection and review process and criteria as the ones used to compile the list of stakeholders was used.

Expected value (Motivations, needs, goal, objectives)

The value a customer expects to gain from a product or service is commonly defined as the desired transformation in the operand relative to cost (de Weck, 2015a). One of the main purposes of stakeholder analysis is to capture the thing that brings value to the stakeholder. This corresponds with the desired transformation of the operand (Dori, 2016).

Famed business professor Clayton Christensen and his co-authors wrote extensively on the importance of segmenting one's customer-base based on the so-called job-to-be-done and not based on the demographic details of the customers, such as age, race, or sex (Christensen et al., 2005; Christensen et al., 2016). A job-to-be-done is in essence a description of a customer need and the relevant circumstances that affect the satisfaction of that need. Using our OPM framework, a job-be-done describes the operands and how they should be transformed as well as the specific limitations the customer has, such as the availability of time and skill.

For this analysis of existing research findings, as suggested by Bell et al. (2019), a preliminary reading was done, and the author's experiences from the extensive literature review that had already been performed guided the author to focus on the keywords "*motivations*" and "*value*". For example, it had been discovered there is ample research regarding motivations academics have regarding entrepreneurship and university-engagement (D'este & Perkmann, 2011; Carsrud & Brännback, 2011). Additionally, the terms "*revenue*" and "*income*" as markers for economic value expectations were included. With these keywords the three-step review process for each stakeholder type was conducted and relevant information was recorded.

Circumstances (availability of time, resources, etc.)

What is very important to realize is that the ability to receive value is always context-dependent. One has to consider several parameters that affect the usability of the solution in development (Christenssen et al., 2016; de Weck, 2015a). For example, an entrepreneurship program offering business counselling services to university alumni has to take into account that the alumni are probably employed during office hours and can only work on their personal business project during the evening or very early in the morning. Likewise, at the level of a city, the skills of the unemployed and the current structure of the local economy are very important contextual pieces of information which should affect the design of any solution hoping to reduce unemployment. Contextuality means that often there are no universal one-size-fits-all solutions to complex problems (Sheard et al., 2015).

In order to be more specific about the type of contextual information of interest, the Fogg behaviour model was used (Fogg, 2009; Fogg, 2019). In Stanford psychologist Fogg's conceptual behaviour model, behaviour B happens when the three factors — motivation = M, ability = A, and P = prompt or trigger — come together. Fogg illustrates the relationship between these different elements using the formula B = MAP. The conceptual key issue is that motivation M, that is, the expected value, can be very high, but low ability A will prevent the behaviour from happening. It is interesting to note that this thinking can be reversed. If the required ability for a given task is low, and thus the relative ability is high, the motivation to engage in an action, that is, an expected value, does not need to be high for the action to take place. Fogg has utilized this insight in his Tiny Habits method of behaviour change, which is based on the idea that new habits can be ingrained by starting with something small and easy (Fogg, 2019).

A low amount of required ability is also a key characteristic of disruptive innovation. According to Christensen (Christensen & Raynor, 2003), disruptive innovation makes something difficult and expensive easy and affordable. Even though performance might suffer, the product is still preferable to solutions that are too complicated or difficult. In total, Fogg's model (Fogg, 2019) recognizes six components of ability (time, money, physical effort, mental effort, and routine), but for this study a choice was made to focus solely on the time component. If something requires a lot of time, people are less likely to do it or commit to it. Thus, emphasis is put on any stakeholder-related information that is related to the scarcity of time.

In order to capture stakeholder-related circumstantial and contextual information, the following steps were taken: 1. re-reviewing papers the author had already reviewed and 2. a complementary review of additional papers. The re-reviewing step was based on the now considerable pool of literature that had been gathered. If the authors of the papers cited some related author, this lead was followed and how these related authors had covered stakeholder-related circumstantial information was reviewed. However, as the emphasis was on the expected value component, less effort was made on the time-consuming process of finding circumstantial information. Naturally, when a designer works on a specific entrepreneurship program, acquiring context-specific information is highly recommended.

Relationship with other stakeholders

A key insight from the previous chapter was that for an entrepreneurship program, the environment and the context that the system needs to operate in and fulfil its purpose is to great extent composed of its stakeholders. The stakeholders and their behaviours form the socio-economic phenomena the program must harness in order to fulfil its mission. Thus, a very important and highly relevant point for this dissertation is the existence of the various relationships between stakeholders. de Weck writes:

> Most stakeholder models only focus on a single focal organization and Ignore the indirect relationships amongst other stakeholders. This Can lead to project failures if not recognized. Stakeholder Value Network (SVN) models attempt to capture these 2nd order effects and value loops. (de Weck, 2015a, p. 42)

Even though formal quantitative SVN analysis will not be performed in this dissertation, simple Object-Process Methodology-based interaction models will be created later in the function analysis and analysis of harnessable phenomena studies, following the modelling instructions from Chapter 3. Thus, in order to prepare for an analysis of value, delivering mechanisms that are based on social phenomena, a decision was made to gather information about stakeholder interactions already during the stakeholder analysis stage.

The protocol that was followed was the same as with capturing circumstantial and context specific information. First, existing references were re-reviewed and then, if any of those existing references pointed to new studies, those new studies were added.

Modelling using OPM

As a final step, several stakeholder types were chosen along with related specific findings from other authors to be converted into OPM models. The purpose of doing this modelling at this stage was to gain a clearer understanding of the expectations of said stakeholder types. The obvious benefit of OPM having a clear distinction between form and function would also be visible in these models. This would then make the following modelling steps easier.

The modelling was based on the semantic analysis of the source literature. A key element of this analysis was the distinction of objects and processes. To do this the so-called process test was utilized repeatedly. The details of the process test were given earlier in Chapter 3. All in all, 14 models covering several stakeholder types were produced.

4.2.4 Update with contextual information

As the final step, stakeholder analysis information regarding the Finnish higher education context needs to be gathered as the datasets to be later used in the two empirical studies are related to entrepreneurship programs in the Finnish higher education context.

For example, a student in a publicly funded university in a small town in North-Eastern Finland experiences different environmental conditions than a student in a private university in New York City. In the words of de Boer and Jongbloed (2015, p. 5): "'Context matters', and given the uniqueness of each higher education system, experiences from elsewhere always must be interpreted with care." As Christensen and Carlile wrote (2009), a proper circumstance-based theory allows practitioners to factor in their unique circumstances and base their actions on these conditions. Thus, stakeholders and their expectations should reflect the local unique circumstances as much as possible.

Key stakeholders in the Finnish context

As this study focuses on entrepreneurship programs in a higher education context, the university is one of the key stakeholders. Next, given the new findings regarding the relationship between age and business success (Azouley et al., 2020) and the student entrepreneurship hype, a decision was made to include the student as another key stakeholder type. There is a need to understand how programs targeting students or people who are not students should be designed differently. Because entrepreneurship programs were argued to broadly have either an education focus or a new business creation focus, or both, another important stakeholder dimension becomes whether or not a person is an entrepreneur or not. Being an entrepreneur implies that the person or group has an existing business or business idea under development.

Given the global variety of university funding models and as the datasets in the case studies are from Finland, the focus needs to be on the Finnish model. From here the Finnish government is defined as the fourth context-specific stakeholder to which special attention is paid.

Find contextual information

For each key stakeholder type in the Finnish higher education context, an additional round of literature review was performed, now focusing on reports and official statistics, which provided the author with information of the expectations of these stakeholders in the Finnish higher education context. The information covered the same aspects of stakeholder expectations as the universal stakeholder expectations review in the previous step: expected value, circumstances, and relationships with other stakeholders.

4.3 Functional analysis

In order to answer research question 4, "*Is there any universal purpose or purposes all entrepreneurship programs share? If so, what would those be?*", a method called functional analysis was implemented. As discussed in Chapter 3, the term "function" has the same meaning as "purpose". The steps of functional analysis are summarized in Table 4.2.

Table 4.2: A summary of the steps of functional analysis.

Functional analysis step	Description
Step 1: Identifying functional requirements	
Identifying for each stakeholder what changes or gets transformed and is valued	Creation of simple stakeholder-specific OPM models based on stakeholder expectations, produced as a result of stakeholder analysis.
Classification of specific stakeholder functions into meaningful categories	Based on simple stakeholder-specific models and four structural relationship types in OPM, objects and processes are categorized into general categories.
Developing formal function definitions by reducing model details	Using the detailed models from the previous step, formal definitions are developed by removing specialized and partial objects and processes from the models.
Modelling of main functions' relationships	Based on the simplified formal definitions created in the previous step, relationships between the three main functions are modelled by focusing on objects that are shared.
Step 2: Functional decomposition	
Functional decomposition based on fundamental definitions	Using fundamental definitions of the conceptual framework, sub-functions are created deductively.
Producing specialized sub-functions for each main function type	Specialized main-function specific sub-function models are created to evaluate consistency with main function definitions.
Modelling of sub-functions' relationships	Based on main-function specific sub-function models created in the previous step, relationships between the three sub-functions are modelled by focusing on objects that are shared. Two fictitious examples are generated.

In systems engineering, stakeholders' expectations are converted to specific requirements before engineers move on to developed solutions that match those requirements. Steps 1 and 2 from Table 4.2 are typically separate activities in systems engineering, with the former belonging to the requirements analysis (Lightsey, 2001), or technical requirements definition (NASA, 2017) stage, and the latter to the logical decomposition (NASA, 2017), or the functional analysis (Lightsey, 2001) stage in systems engineering processes. However, as the purpose of this study was not to build and implement an entrepreneurship program, it was reasonable to focus on functional requirements only instead of the wide range of other technical requirements.

Function of functional analysis

Since the framework is based on OPM and systems engineering, it is also grounded on the separation of form and function. Especially with human systems, the ability to use many approaches to do the same thing exists within anything, and the seeming differences in these approaches might make it appear as though it is a completely different phenomenon. When the focus is only on the tool, its purpose might not be clear. A simple knife can do the job of many specialist tools such as an axe, a hand plane, a chisel, or a drill. A business incubator can have many roles (Hacket & Dilts, 2005; Bruneel et al., 2012; Pauwels et al., 2016), but because it is called an incubator or an accelerator, other dissimilar approaches that do the same thing are ignored.

When a tool and its function are separate, a powerful creative shift can happen (de Weck, 2015d). For example, the snow shovel is a common tool during the winter in the North. The function of the snow shovel is not snow shovelling. It is removing snow from the driveway, or put even more simply, keeping the driveway snowless. Using the function of the snow shovel as a basis, the snow shovel can be categorized as a snow-removal tool. With the right category in use, there are many other ways to remove snow as well, such as blowers, salt, tractors, and heating the pavement. This is why the need to inquire what the proper functional categories, that is, the purposes, of entrepreneurship programs are exists. As Christensen and Carlile (2009) write, getting the categories right is critical in order for a theory to have any exploratory power.

Functional requirements

Requirements are statements that tell designers or engineers what they should develop. According to de Weck (2015b, p. 4), “Requirements describe the necessary functions and features of the system we are to conceive, design, implement and operate”. In NASA’s process, requirements are a way to verify that engineers have truly understood what the stakeholder expectations are (NASA, 2017). As Arthur (2009) writes, invention happens when the problem is specified well. Requirements are a way to be very specific about the problem. On the basis of literature reporting that past research had trouble handling the multi-stakeholder nature of entrepreneurship programs, it can be concluded that the one of the issues past designers have struggled with is the vagueness of what exactly those programs should do.

There are many types of requirements (de Weck, 2015b; NASA, 2017; Lightsey, 2001). Functional requirements “define what functions need to be done to accomplish the mission objectives” (de Weck, 2015b, p. 19). This connects back to the definition of a system as a function-providing object (Dori, 2016). According to NASA, “Functional requirements define what functions need to be performed to accomplish the objectives. Performance requirements define how well the system needs to perform the functions” (NASA, 2017, p. 56). The definition of functional requirements by Lightsey reads: “The necessary task, action or activity that must be accomplished. Functional (what has to be done) requirements identified in requirements analysis will be used as the top-level functions for functional analysis” (Lightsey, 2001, p. 36).

Thus, at the highest level of analysis, the functional requirements define the purpose of a system, that is, its main functions. Next, the details of the first step in the functional analysis conducted in this dissertation become the focus.

4.3.1 Identifying functional requirements via cross case analysis

In order to identify entrepreneurship programs' main functions, four steps were worked through: 1. identifying for each stakeholder what changes or gets transformed and is valued, 2. classification of specific stakeholder functions into meaningful categories, 3. developing formal function definitions by reducing model details, and 4. dynamic modelling of main functions' relationship.

As the first step, "identifying for each stakeholder what changes or gets transformed and is valued", the information in the stakeholder expectation tables was converted into simple system diagrams in order to clearly understand what is the operand, possible attribute of the operand, and the desired transformation in each case. Several OPM diagrams were created already during the stakeholder expectations analysis stage and even earlier in the literature review stage, and these diagrams were collected whenever appropriate. The modelling followed the guidelines presented in Chapter 3, especially by implementing the process test so that objects and processes could be reliably distinguished.

As the second step of identifying general main functional requirements, "classification of specific stakeholder functions into meaningful categories", the large set of simple system diagrams was taken and grouped into meaningful categories following the instructions of classifying using OPM in Chapter 3. This resulted in a smaller number of diagrams showing how generalization emerged from several specializations and wholes emerged from several parts.

As a result of the previous step, three generic high-level system diagrams emerged. As for the third step, "developing formal function definitions by reducing model details", each of the three resulting general functions were then defined formally by creating models without the specialized or partial objects or processes. This corresponds with the complexity-reducing and scale-raising "folding" mechanism as described in Chapter 3, where only the general or whole objects and processes are left.

As the fourth step, "modelling of main functions' relationships", the relationship between the three high-level system diagrams was studied in order to have a preliminary understanding of the dynamics between these three main functions of an entrepreneurship program. Again, for this modelling step, object-process methodology was utilized, resulting in several diagrams that capture the relationship between the three functions. The key to this modelling step was to analyse which objects are shared by the separate models. If an object is shared, it indicates interaction between the systems. When needed, modelling decisions were justified by referring to proper literature. For example, if person A makes coffee and person B drinks coffee, we can interpret that A and B interact via coffee.

Now that the functional requirements are properly identified and modelled, it is time to move to the next major step in functional analysis — functional decomposition.

4.3.2 Functional decomposition

The functional decomposition steps implemented as part of functional analysis modelling were: 1. functional decomposition based on fundamental definitions, 2. producing specialized sub-functions for each main function type, and 3. sub-functions' relationship modelling.

Functional decomposition definition

According to NASA:

> The key first step in the logical decomposition process is establishing the system architecture model… System architecture activities drive the partitioning of system elements and requirements to lower level functions and requirements to the point that design work can be accomplished. (NASA, 2017, p. 62–63)

And according to Lightsey in functional analysis, "functions are analyzed by decomposing higher-level functions identified through requirements analysis into lower-level functions" (Lightsey, 2001, p. 32). The functional decomposition process can be seen also as a process of decision-making because decomposition to lower levels requires architectural decisions at a higher level (Do, 2016). For example, the decision to shop online yields a different set of sub-processes compared to visiting a physical store, even though both of these architectures deliver the same main function.

In OPM, functional decomposition corresponds with the refinement of a model, that is, moving to a lower scale and adding details. Refinement mechanisms such as unfolding and in-zooming were described in Chapter 3.

Functional decomposition based on fundamental definitions

Due to the scope of this study, it was not possible to implement a thorough multi-level inductive functional decomposition process. Instead, a methodological choice was made to use fundamental definitions, forming the core of the overall methodology deductively to derive more refined, that is, decomposed, models. These core definitions include the basic OPM definitions and the basic system definition presented using OPM in section 3.3. This step can be likened to deductive research wherein theory (main model) yields new hypotheses (new models) (Bell et al., 2019).

To do this, all the main functions that were defined in the previous step, "Identifying functional requirements via cross case analysis", were taken and the question of which sub-functions are necessitated by the fundamental concepts of object-process methodology and systems engineering based methodology was asked. As a result, this yielded three sub-functions.

Producing specialized sub-functions for each main function type

After yielding the sub-function structure deductively from fundamental conceptual assumptions, the sub-functions were evaluated in the light of each main function. The purpose of this step was to evaluate the relevance of each sub-function for the given main function. This can be likened to one more deductive step of producing hypotheses out of theory (Bell et al., 2019) but also to a form of conceptual hypothesis testing where the new models are compared to other models that are based on empirical findings.

To do this, the main functions' formal definition models were taken and the generic sub-function model was used to generate a main function-specific specialized sub-function model. After, the internal validity, that is, the consistency, of the specialized models with the generic main function models and the implications of the resulting models were discussed.

Sub-functions' relationship modelling

As the final step, all the sub-function specific models were used to create a combined model wherein the interactions and the dynamics between the sub-functions or sub-systems become clear. This modelling step was based on the same logic as the step where the relationships of the main functions were modelled. The key to this step was to focus on objects shared by each sub-function model and then produce an interaction model where all functions interact via shared objects.

In addition, two decomposed business operating examples were created using the identified sub-functions. The purpose of these fictitious yet realistic examples was to demonstrate the validity of the decomposed model as a way to decompose real-life cases.

4.4 Analysis of harnessable social phenomena

The final systems engineering based method utilized and the third conceptual study was a combination of a literature review and complex systems analysis to answer the fifth research question, "*What phenomena can be harnessed to fulfil said purposes?*"

As was mentioned earlier, entrepreneurship programs are purposed systems or means to fulfil a human purpose. Based on Arthur (2009) and others, it has been argued that entrepreneurship programs need to harness relevant social phenomena in order to deliver the value that is expected of them. Stakeholder analysis and functional analysis focused on understanding what that purpose is or should be. In this third step, the goal was to gain better understanding of the related social phenomena. Because social phenomena are often complex (Bar-Yam, 1997), there is a need to utilize complexity science principles in their study. The specific steps implemented were: 1. analysis of scale, 2. categorization of literature-based phenomena according to scale and function, and 3. modelling of Finnish higher education incentive dynamics.

Table 4.3 summarizes the details of each of these specific steps.

Table 4.3: Summary of the analysis of harnessable phenomena steps.

Analysis of harnessable phenomena step	Description
Step 1: Analysis of scale	
Identification of shared objects across scales.	Based on stakeholder-specific simple OPM models. Creation of multiscale model representing relationships between scales.
Classification of specific stakeholder functions into meaningful categories at different scales	Based on stakeholder-specific simple OPM models and four structural relationship types in OPM, objects and processes are categorized into general categories for new recognized higher-scale objects.
Step 2: Categorization of literature-based phenomena according to scale and function	
Re-reviewing papers	Identification of function and scale from already reviewed papers.
Complementary review of additional papers	Identification of phenomena from additional papers: 1. online search of papers using Google Scholar, 2. initial review of papers, and 3. detailed review of papers
Organization of findings into two dimensions: scale and function	Organization of found phenomena into tables that categorize the phenomena based on scale and related function.
Step 3: Modelling of Finnish higher education incentive dynamics	
Recognize relevant components	Based on stakeholder-specific simple OPM models and stakeholder expectations containing information about the Finnish context.
Recognize relevant attributes and range of values	Based on stakeholder-specific simple OPM models and stakeholder expectations containing information about the Finnish context.
Study how components interact	Creation of a combined model based on shared objects in separate models.
Analyse the states of the whole system emerging from the components' interactions	Creation of higher-level objects and processes that capture the conceptual meaning of emerging behaviours.
Analyse how the external environment influences the system	Inclusion of the environment's influence in the model as environmental objects and processes.

To better understand the core concepts related to this modelling step, a brief review of the concepts of complexity and scale follows.

4.4.1 Analysis of scale

As implied by the basic concepts of complexity science presented above, in order to be able to recognize proper harnessable phenomena at the right level of complexity, the scale of the system needs to be taken into account. Thus, in the "analysis of scale" part of the understanding harnessable phenomena method, two modelling steps were completed: 1.

identification of shared objects across scales and 2. classification of specific stakeholder functions into meaningful categories at different scales.

Regarding the first step, “identification of shared objects across scales”, Bar-Yam writes:

> Any system can be decomposed into components and an important way of constructing a model is developing an understanding of how the behavior of the components in aggregate comprise the behavior of the whole if their dependencies are properly accounted for. (Bar-Yam, 2016, p. 20)

Thus, this step was about identifying what the relevant systems and scales of analysis are in relation to the purpose of the system. To do this, the stakeholder-specific OPM models from stakeholder analysis and functional analysis were used, and the scale of key operands associated to stakeholder’s expectations was identified as implied by the simple stakeholder-specific models. Then, the simple models that capture the relationships between different scales, such as in Figure 3.14, were created. This modelling step was based chiefly on the aggregation-participation structural relationship in OPM (Dori, 2016).

Finally, in the second step, “classification of specific stakeholder functions into meaningful categories at the different scales”, the stakeholder-specific OPM models produced earlier were used to explore whether or not analogous functions (operating, developing, and meta-developing) are relevant also at higher scales beyond the scale of a single business. This was done by implementing the same process as in the “classification of specific stakeholder functions into meaningful categories” step that was performed as part of the functional analysis. The difference was that this time the process was implemented for a different scale of objects (economy) and processes.

4.4.2 Categorization of literature-based phenomena

In the next step of analysing the complex phenomena that could be harnessed in entrepreneurship programs, the scales identified in the previous step and the functions and sub-functions identified in the functional analysis were used, and a focused literature review of potential phenomena was performed. This is in line with common systems engineering practices and, for example, with NASA’s technology readiness level classification scheme, where at TRL 1 the phenomena need to be understood at the level of peer-reviewed articles (NASA, 2017; NASA, n.a.). The steps implemented were: 1. re-reviewing papers already reviewed and 2. a complementary review of additional papers (a. online search using Google Scholar, b. initial review of papers, and c. detailed review of papers).

As a considerable amount of literature had been covered by now, it was possible to use the information gained from these papers and record phenomena connected to the relevant functions at the scales of interest. When in need of additional information, a review of additional papers was performed through an online search with Google Scholar using the recognized scales and functions as keywords. Then, an initial review of papers was performed using titles and abstracts as information and the selected few papers for a more detailed review. After this, the third step, "organization of findings into two dimensions: scale and function", was performed.

Finally, it was possible to produce a table of phenomena that were categorized based on scale and function. This categorization scheme can guide future researchers and designers in their future studies.

4.4.3 Modelling Finnish higher education incentive dynamics

As the final step of the analysis of harnessable phenomena, a decision was made to focus on the analysis of the multi-stakeholder and -scale phenomena of funding and study outcomes in the Finnish higher education context. As had been defined during the functional analysis stage, developing and meta-developing systems depend on the surpluses generated by the business operating systems. Without access to surpluses, business developing and meta-developing systems would not be able to operate. Thus, it was possible to narrow the focus of this final step to the resource acquisition and maintaining functions of entrepreneurship programs in the Finnish higher education context.

In order to model and understand the related dynamics, the following five steps based on Bar-Yam (2016) and OPM modelling principles, both described in section 3.5, were implemented: 1. recognize relevant components, 2. recognize relevant attributes and range of values, 3. study how components interact, 4. analyse the states of the whole system emerging from the components' interactions, and 5. analyse how the external environment influences the system. When needed, additional information or research findings were ascertained from the literature.

In the "recognize relevant components" step, simple models were created using the already existing stakeholder-specific models and stakeholder expectations information related to the Finnish context. As a result, a list of relevant objects was compiled. In the "recognize relevant attributes and range of values" step, the already existing simple models and the stakeholder expectations from literature were again utilized to define the *distinguishable states* (Bar-Yam, 2016), that is, the attributes and values, in OPM.

In the "study how components interact" step, as described in Chapter 3, the key to interaction analysis using OPM and several separate models is to observe what objects, including attributes, are shared by simpler models and how processes transform these objects. Thus the findings from different sources can be combined into a unified model (Dori & Choder, 2007). The processes in the model capture the relationships between components. In this case, there were several simpler models related to student, university, and government stakeholders as well as other stakeholder-specific information produced during the stakeholder analysis that could be used for this step.

As described in section 3.5, the key to the “analyse the states of the whole system emerging from the components’ interactions” step was utilizing the complexity and scale management mechanisms of OPM. A whole could be attributed with emergent attributes resulting from the collective behaviour of lower-level components. Simple models and stakeholder-specific information from stakeholder analysis were again used.

Finally, for the “analyse how external environment influences the system” step, several environmental processes and objects were included into the model if the already acquired stakeholder information and models implied it. When the information was not sufficient, additional information was ascertained from the literature.

By completing all these steps, a single model of the Finnish higher education financial incentive phenomena was created.

4.5 Mixed methods case study

Two sets of studies were completed in order to directly answer the second research question: “*Are stakeholders’ expectations and the stakeholder-based socio-economic phenomena associated with the programs key to understanding the formation and survival of entrepreneurship programs?”* The first of these studies is focused on observing the features of existing entrepreneurship programs in Finland that are, in most cases, connected to Finnish universities, thus answering the “formation” part of the second research question. In this section, the methodological details of the first case study are presented. The methodological choices are presented in Table 4.4.

Table 4.4: Summary of methodological choices of the case study.

Methodological component	Description
Overall research strategy / design	Cross-sectional multiple case study combining qualitative and quantitative methods.
Initial case selection / sample formation	(nearly) complete sample of programs associated with Finnish universities based on university-specific online search. Sampling dates winter 2019–2020.
Qualitative data collection	Recording of program information available on programs' public websites.
Qualitative data analysis	Creation of program-specific OPM models from an initial sample of 30 programs. Inductive creation of 21 general feature categories (objects or processes) from an initial 173 OPM objects and processes using the OPM generalization-specialization structural relationship definition.
Case and sample expansion	Initial sample complemented with programs included in an unpublished third-party report of Finnish incubators and accelerators. Sampling dates were in Summer 2020.
Quantitative data collection	Content analysis of the completed sample of 45 program websites using the 21 variables (objects or processes) developed as a result of the qualitative data analysis. Each program assigned values for each of the 21 dichotomous (0 or 1) variables.
Quantitative data analysis	Assigning specific (participant stakeholder related) variables as independent variables and observing connections to other assigned dependent variables. Next, quantitative patterns were compared to the conceptual findings.

4.5.1 Overall research strategy and design

Overall, this the first empirical study which could be categorized as multiple case study combining qualitative and quantitative methods. Given the limits of the available resources, an experimental study was out of the question.

4.5.2 Initial case selection and sample formation

The goal of the case selection and overall sample formation was to have a sample that covers entrepreneurship programs in Finnish, especially in the Finnish higher education context, as comprehensively as possible. The sample was formed in a two-step process and the purpose of the first sample or case selection process was to have programs for the qualitative analysis. In the second sample expansion step, the sample was expanded for the quantitative analysis part of the study. The description of that second step will be described later.

For the online search, the initial sample of 30 programs for the multiple case study was formed by studying each Finnish university one by one and searching for entrepreneurship programs with the keywords “entrepreneurship”, “incubator”, “accelerator” and “innovation”. The list of 38 universities was taken from the Ministry of Education and Culture websites (Minedu, n.a.). Searches were conducted in English using universities’ websites search engines and Google search engine along with the name of the university. The hits (i.e. pages) that were discovered this way were further searched for possible program names and hyperlinks to dedicated program websites. If a program title was discovered, this title was fed back into university websites and Google search engine.

Regarding the inclusion criteria, programs that had their own homepages either as separate domains or as part of the larger university webpages, and that clearly had an independent identity as a program, were included in the sample. This way, programs that were only included in the curriculum as descriptions of courses were excluded from the sample. All programs associated with each university were accepted.

4.5.3 Qualitative data collection

The qualitative data was based on publicly available information on programs’ preferably English websites. English was emphasized as a way to ensure easier replicability for international reviewers. A copy of each website was saved to the author’s computer and a list of these programs was published as a separate blog post (Immonen, 2019b). If the website included downloadable documents, these documents were also saved. When possible, only the English language versions of websites were saved. The data recording dates to winter end of November 2019 to early January 2020.

For the validity of data, based on Bruneel et al. and Pauwels et al., it was assumed that the publicly available information on websites reflects, at least to some extent, the interests of at least two stakeholders’ groups: the participants and the sponsors. As a website is an information source for potential applicants, it is assumed that the information content reflects features that are considered valuable for participants.

Based on the Lindy effect (Taleb, 2012), statistically older non-physical objects are more robust, that is have survived more stressors or challenges to their existence. Thus, the oldest features of the programs could be trusted as most representative of stable patterns within the system and its environment. This is also reflecting Hayek’s argument that the institutions have evolved to reflect patterns in social fabric and culture (Butler, 2010). However, as it was not possible to assess the age of the programs or the age of individual program components, the sample is bound to contain noise and programs to have components that have not experienced selective pressures.

4.5.4 Qualitative data analysis

Qualitative data analysis was based on the same two step OPM-based modelling process used in the process of functional analysis. This could be seen as a form of qualitative content analysis (Bell et al., 2019).

In the first step of the qualitative data analysis, “Creation of program specific OPM models”, publicly available website and other digital document content was used to create representative OPM models of each program. As previously described, the key to model-creation in OPM is the focus on the semantics of the text (and visuals) (Dori, 2016). In order to separate objects and processes, the process test was used to categorize nouns properly as either objects or processes. The details of the process test are provided in chapter 3, in the section OPM is introduced. Figure 3.9 is an example of the models that were created as a result of this step.

In the next step of qualitative data analysis, “Classification of OPM elements into higher level categories”, the initial 30 OPM models, comprising of 173 OPM objects and processes, were used to inductively develop higher-level generalized versions of the objects and processes. This resulted in 21 general object and process elements. This classification process was based on the instructions provided in section 3.5.2. Specifically, the generalization-specialization structural relationship and the inheritance property of this relationship, stating that the all the characteristics and relationships attributed to the general object or process, can be also attributed to the specializations, were used. A descriptive title for each generalization was subsequently invented.

Initially this classification process resulted in 24 generalizations. However, general objects (or processes) that had only a couple of programs in them were left out at this stage. For example, just two programs had an explicit location-related condition (attribute of the participant) for participation, such as requiring their participants to come from a certain geographical area. Thus, this attribute was left out.

4.5.5 Case and sample expansion

In the next stage, the sample was expanded based on an unpublished report regarding Finnish incubators and accelerator programs. The report was compiled by Oulu University of Applied Sciences during 2017–2018 on the order of Ministry of Economic Affairs and Employment of Finland (Jylhälehto, 2018). Even though the report was never made public, the author of this study was granted access to it by the coordinator and the ministry official. The report identified and analyzed 54 pre-incubators, incubators, and so-called growth accelerators in Finland. This included 13 pre-incubators, 20 incubators, 11 accelerators, and 6 growth accelerators. Identification was based on the Finnish Business Acceleration Network registry and earlier studies. The report utilized surveys and phone-based interviews to collect data about metrics services, pricing, sources of funding, and other factors regarding the programs. The motivation for the expansion was to have a larger sample for the quantitative part of the study.

Next, the initial sample of 30 entrepreneurship programs was compared to the 54 pre-incubators, incubators, accelerators, and growth accelerators listed in the report. There were 8 programs that were the same in both samples. Out of the remaining programs, 15 novel ones were identified. The rest had either stopped being in operation (14), which was verified with online search, or publicly available descriptions of their operations were not available. As a result, the total sample size was expanded to 45, likely covering most of the existing incubator- or mini-company type of entrepreneurship programs in Finnish higher education, but also several programs that have no direct connection to any Finnish university. Importantly, of the 15 added programs, only 3 were managed by a university, indicating that the initial sample formation process was quite robust as only 3 programs were missed.

4.5.6 Quantitative data collection

Quantitative data collection was done by implementing a content analysis of the 45 programs' websites using the 21 general objected-process generalizations as dichotomous variables. In other words, for each program, for each variable a value of either 1 or 0 was assigned in order to signify the presence of that object or process in the information on the website. Bell et al. state that "content analysis is firmly rooted in the quantitative research strategy, in that the aim is to produce quantitative accounts of the raw material in terms of the categories specified by the rules" (Bell et al., 2019, p. 280).

In this case, the rules were specified by the 21 general object and process categories generated in the qualitative part of the study. For the 30 programs, the initially recorded were used, and for the added 15 programs, the website information during June 2020 was used.

4.5.7 Quantitative data analysis

The resulting data set consisting of 45 programs characterized by 21 variables was analysed for patterns between variables. Due to the explorative nature of this study (no prior hypotheses were defined) and the small sample size, a minimalist approach was adopted. As the very initial step, a frequency table containing each variable was created with numbers and percentages of programs characterized as having the feature corresponding with variable.

In order to better answer the research question, a few key variables were selected as independent variables. The variables selected were "student-targeting", "business-targeting", and "selection process". The first two variables show whether the program is explicitly targeting students or businesses (entrepreneurs, startups, startup teams) on their website, thus being a clear indication of a specific type of a stakeholder. The third variable specifies whether an explicit selection process is mentioned, which is related more to the conceptual findings regarding targeting and selection sub-function.

In the next step, Microsoft Excel was used to observe how other variables co-varied with the independent variables. The results of this step are presented in chapter 6 in the form of contingency tables in which the columns of the table separated the two dichotomous values of the independent variables. The connection was expressed as a number and percentage of programs with the corresponding feature (dependent variable) existing together with and without the feature corresponding the independent variable. To analyse the strength of the relationship, a simple ratio between number of programs belonging to either category was used. For example, the ratio of student-targeting and non-student targeting programs offering credits was 12 to 1. Statistical significance is limited by the small sample sizes.

4.6 Quantitative longitudinal study

The idea and opportunity for the second empirical study came as a result of discovering a report published by the Ministry of Education and Culture in 2015/6. The report, titled "Good practices of entrepreneurship support in institutions of higher education" (Viljamaa, 2016), contained so-called good practices self-reported by all Finnish universities.

By using the report data as an initial sample, it would be possible to find out which of the practices were still operational 4-5 years later and those which had not survived. This would allow the second part of the research question: "*Are stakeholders' expectations and the stakeholder-based socio-economic phenomena associated with the programs, key to understanding the formation and survival of entrepreneurship programs?*" to be answered (i.e. program survival). The methodological choices of the second longitudinal study are summarized in Table 4.5.

Table 4.5: Summary of methodological choices in the longitudinal study.

Methodological component	Description
Overall research strategy / design	Longitudinal cohort study based on the use of quantitative methods.
Initial case selection / sample formation and case selection criteria	Based on a report published in 2016, selecting maximum of 4 "good practices of entrepreneurship support" from all 38 Finnish universities, resulting sample size of 117. First two practices from two different practice types per university, no project-funding based, no high-level principles or strategies.
Model-based variable definition	Defining 5 dichotomous variables based on conceptual findings and availability of information in the report.
Initial and follow-up quantitative data collection	Content analysis leading to the characterization of each good practice based on the five variables. Practice survival status is defined using three types of searches: Google, Facebook, and university website. Date July 2020.
Survival status defining criteria and case exclusion	A practice was characterized as non-surviving if any of the following criteria was met: no content about the practice available online, latest content dated to 2018 or earlier, cancellation of the practice explicitly mentioned. Unclear cases and cases were the initial program had changed dramatically were excluded. Total seven cases excluded.
Quantitative data analysis	Comparison of characteristics between good practices that survived and those that did not. Quantitative patterns were compared to the conceptual findings.

4.6.1 Overall research strategy and design

Compared to the first empirical case study, the overall design of this study is based on longitudinal quantitative analysis. According to Bell et al. (2019), there are two main types of longitudinal studies in business and management research: panel and cohort. This study belongs to the latter category, where a specific cohort of good practices was selected and then practice survival was observed 4 to 5 years later. The properties of each good practice (i.e. entrepreneurship program) at t_1 was observed from a publicly available report. The status of each practice at t_2 was defined based on an online web search.

As discussed by Bell et al., longitudinal studies are better suited for making conclusions about cause and effect. As the characterization of each good practice was based on the conceptual findings regarding the stakeholder expectations and the importance of the higher-education incentive model in the context of Finnish higher education context, the design allowed the researcher to observe whether conceptual findings match the observed patterns in the data and assess the validity of the conceptual findings.

4.6.2 Initial case selection and criteria, and sample formation

Initial case selection and sample formation was based on a report "Good practices of entrepreneurship support in institutions of higher education" (Viljamaa, 2016), published by the Finland's Ministry of Education and Culture. The report was based on self-reported free-format answers of a survey done in 2015 by all 38 Finnish universities. Of these, 14 are so-called academic or research-oriented universities and 24 are universities of applied sciences (see section 5.1.5 for a description of each university type). The summaries of good practices of each university were sent to the corresponding university's executives in early 2016 for verification and a chance to supplement additional practices. (Viljamaa, 2016)

In the report, universities had reported good practices under three categories: 1. Supporting entrepreneurship in education, 2. Supporting entrepreneurship in research and RDI activities, 3. Supporting entrepreneurship in interactions with society. Based on the first assessment of the report, practices in categories 1. and 3. were selected for further analysis. Practices in category 2. were excluded as it mostly consisted of mentions of research groups and separate R&D projects with external R&D funding.

The sample was further narrowed down by taking the first two practices under both categories for each university listed in their practice summaries. This would mean a maximum of four practices per university (two practices per category per university). As not all universities had reported two practices in both categories, a total of 117 practices were collected. Some universities had reported more than two practices per category, but only the first two were selected.

To qualify as a practice, there had to be a distinctive title such as an entrepreneurship course title, business idea competition, or a business counselling service. Broad generalist descriptions of how entrepreneurship is promoted in the university were omitted from the sample as well as mentions of R&D projects, which have a limited lifespan by definition. All in all, the sample presents a relatively comprehensive and diverse overview of various entrepreneurship practices in Finnish universities.

4.6.3 Model-based variable definition

The next step was to define a set of variables that could be used to characterize each variable using the data in the report. In the report, practice descriptions are relatively short, ranging from practice title only to two paragraph long descriptions. This limited the number and types of variables that could be used as it was important that each practice could be characterized with using variables.

The conceptual findings highlighted the importance of the financial incentive model in the Finnish higher education context. Specifically, if a practice produces study credits, it enables funding for both universities and students in the form of financial support.

Everything else being equal, a program under university management that would produce credits would then be more likely to survive than a practice that does not produce credits.

Based on the availability of information in the report and the conceptual findings, the following six dichotomous (either 0 or 1) variables were defined and selected to be included in the study: a. whether the practice produced study credits (i.e. is it a course, or a degree program), b. whether the practice is managed by a university (academic research university or university of applied sciences), c. whether the practice is managed by an academic research university, d. whether the practice is managed by a university of applied sciences, e. whether the practice is managed by a non-university organization such as a company or an association, f. status of the practice (survived, not survived).

4.6.4 Initial and follow-up quantitative data collection

Initial quantitative data collection was done by implementing a round of content analysis using the report by Viljamaa (2016) such that each practice in the sample was characterized based on the six variables dichotomously (as either 1 or 0) at time t_1.

As this data collection step was limited to only data available in the report, some miss-characterizations may have occurred as it is possible that a practice was managed by an external organization even though it was not mentioned in the report. Likewise, a practice could have been miss-characterized as externally managed even though it was managed by a university, as the characterization was based on an external organization was mentioned in the report.

The next key step in data collection process was to check whether the practice still existed in July 2020 (i.e. at time t_2, or about 4 to 5 years later). Importantly, other variables were assumed to have remained the same and only change of interest was the survival-status of each practice.

The survival of the practice was assessed based on information retrieved via an online search using a general Google online search, a search inside the university website using the websites internal search tool, and a search in Facebook. Search keywords were based on the good practice titles and practice descriptions

4.6.5 Survival status defining criteria and case exclusion

The status of each practice was deemed as not survived at time t_2 if the newest timestamps of content (on website, or in social media) were from 2018 or earlier, or the practice was no longer listed on official university website without timestamps. Additionally, if it was explicitly mentioned that the practice had ended, the status was set as not-survived. Those that survived were coded as 1 and those that did not as 0.

It is likely that this method has false positives, but also false negatives, as some practices may still ongoing even though their publicity online is limited, and vice versa, some practices might have ended even though mentions of them remained on public websites.

In order to avoid mischaracterizations, some cases were excluded from the sample based on the difficulty in defining their survival status. In some cases, the practice had a modified name but the content had remained the same, or the name of the practice had remained the same but the public content at time t_2 indicated a radically different practice from the one reported at time t_1. For example, in one case, a practice of an entrepreneurial co-working environment with student entrepreneurship services was reduced to a seminar room carrying the title of the initial good practice. This way, seven practices were excluded from the sample.

4.6.6 Quantitative data analysis

The final step in this longitudinal study was to observe patterns in the data. This was done by comparing: 1. characteristics between good practices that survived and those that did not, and 2. characteristics of practices that were managed by various organization types.

The method utilized was to sort the dataset in an Excel spreadsheet based on the key variables, observe their frequencies and report the data in the form of contingency tables. Because of the limited sample size, any concrete statistical conclusions cannot be made. The results can be seen as suggestive.

"Comparing practices that survived and those that did not" was about whether a practice had survived 4 years later and was a key variable in the dataset. Comparing the differences in the frequency of other variables in these groups would help assessing the validity of the conceptual findings. Importantly, it was expected to observe whether the practice or program offered credits would be associated with program survival. This would validate the idea that in a Finnish university setting, a key way to handle resource acquiring and maintaining sub-function is to align the program with the Finnish funding model and student financial aid system.

Another set of key variables was the type of organization that manages the practice. The expectation was that the difference in the management would be reflected in other aspects of the programs. Specifically, it was important to see what role offering credits had on practice survival depending on organization type, and also how organization type affected survival and the probability of offering credits in general.

Finally, the results were assessed by comparing them to the conceptual findings and any new insights which were offered.

5 Conceptual findings

In this chapter, the conceptual findings that resulted from the implementation of stakeholder analysis, functional analysis, and analysis of useable phenomena are presented. This way, findings presented in this chapter are also answers to research questions 3 to 5. Section 5.1 presents the results of the stakeholder analysis and answers the third research question. Section 5.2 presents the results of functional analysis and answers the fourth research question. Finally, section 5.3 presents the results of analysis of harnessable phenomena and answers the fifth research question.

5.1 Stakeholder expectations

In this section, the results of stakeholder analysis are presented.

5.1.1 List of stakeholders

As a result of the review, stakeholder types were organized into three categories: sponsor, participant, and partner. Each of the stakeholder categories is defined via their conceptual role in the entrepreneurship program process (see Figure 5.1).Figure 5.1: Stakeholder categories.

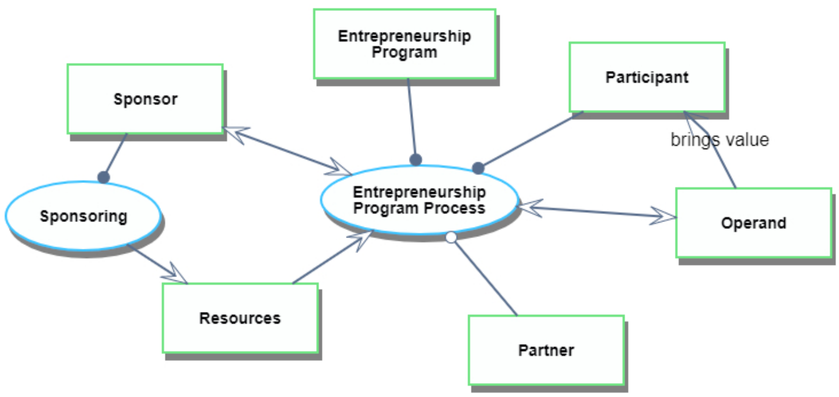

Figure 5.1: Stakeholder categories.

The main role of stakeholders in the sponsor category is to provide the resources that are consumed by the entrepreneurship program process. This is very similar to the customer stakeholder-type by Dori (2016) or NASA (2017). Participants overlap with the beneficiary and user types by Dori (2016) and thus, their expectations are key in defining the main function of the program. The partner category overlaps most with the supplier stakeholder-type by Dori (2016). Each of the three stakeholder categories have 5 to 7 stakeholder types which are presented in Table 5.1.Table 5.1: Sponsor categories and sponsor types.

Table 5.1: Sponsor categories and sponsor types.

Sponsor	Universities
	Government
	Corporations
	Investors
	Science Parks
Participant	Students
	Academics
	Entrepreneurs
	Startups
	Businesses
Partner	Incubators and accelerators
	Mentors
	Experts
	Managers and experts
	TTOs
	Educators
	User

Many of these stakeholders also could be placed in another category. The category it is in reflects the author's estimations of its main type.

5.1.2 Expectations of sponsor stakeholders

In this section, the expectations of each stakeholder type are presented as a result of the analysis of existing research findings. The expectations of each stakeholder type are discussed under its corresponding stakeholder category: sponsor, participant, or partner. At the beginning of each new category, more details regarding the overall category are provided. Additionally, in the introduction of each category, the stakeholder expectations are summarized in corresponding tables (see Table 5.2, Table 5.3, and Table 5.4)

In the literature, especially in the relatively new accelerator literature, sponsors are stakeholders who provide the funds needed for the accelerator to operate, such as salaries for the entrepreneurship program operators. More abstractly, they simply provide the resources needed by the entrepreneurship program. Several different types of sponsors mentioned in the literature are discussed below: universities, governments, corporations, investors, and science parks. The literature-based review of expectations of these sponsor types are summarized in Table 5.2.

Stakeholder types placed under the sponsor category reflect those existing in the literature. According to Cohen et al., program sponsors are "external institutions that provide financial or in-kind support, including office space, professional services, mentors and endorsement, to accelerator programs" (Cohen et al., 2019, p. 15).

Sponsor types of accelerators recognized by Cohen et al. are corporations, investors, universities, governments, entrepreneurs, and not-for-profit foundations. Previously, Allen and McCluskey (1990) used the term "incubator type" as an essentially the same concept as Cohen et al.'s sponsor. Allen and McCluskey's types were for-profit property developers, non-profit development corporations, academic incubators, and for-profit seed capital. Hacket and Dilts, in 2004, recognized four main forms of financial sponsorship of incubators: publicly sponsored, nonprofit sponsored, university sponsored, and privately sponsored.

Table 5.2: Expectations of stakeholder types in sponsor category.

Stakeholder type (category)	Description	References
Universities (sponsor)	**Expected value:** economic development, education, research, commercialization of research via new firm formation, increased faculty-industry collaboration, good will with community, support for entrepreneurial activity on campus, development of students' entrepreneurship skills, students can build business after graduation, funding via alumni donations. **Circumstances & relationships:** competition between other universities for funding and for students (who pay tuition fees), rankings influence student choices, timespan for alumni donations is long, R&D with regional industry generates spillovers.	Rothaermel et al. (2007), Allen and McCluskey (1990), Auranen and Nieminen (2010), Universities UK (2016), Cattaneo et al. (2017), Horstschräer (2011), Cohen et al. (2019), Hausman (2012).
Government (sponsor)	**Expected value:** economic growth, employment growth, worker salary increases, growth of tax base, increase of regional entrepreneurial potential (via cultural transformation), diversification of economy, utilization of vacant facilities, bring new entrepreneurs to area, retain skilled entrepreneurs, "friction" removal in development of high-quality firms. **Circumstances & relationships:** New technology can be converted to new business in other regions, startup success leads to growth of tax base.	Audretsch (2014), Hausman (2012), Grimaldi (2011), Allen and McCluskey (1990), Cohen et al. (2019).
Corporations (sponsor)	**Expected value:** real estate appreciation, sell services to participants, gain information about development and trends, learn about technologies and markets, new product or service to existing value chain, aid in investment decisions, earn financial premium via investments. **Circumstance & Relationships:** corporations are not successful in takeovers of portfolio companies, corporations R&D costs are lowered, startups and corporations can become co-owners.	Allen and McCluskey (1990), Kanbach and Stubner (2016), Cohen et al. (2019), Benseon and Ziedonis (2019).
Investors (sponsor)	**Expected value:** Profit from investments, discovery of scalable startups, improvement of discovered startups, lowering the cost of discovery and improvement, (university VCs: provision of funding for spin-offs, creation of academic spin-offs, reputation enhancement, support of economic development). **Circumstance & Relationships:** Most startups in portfolio fail which is compensated by big but rare payoffs, founders of startups backed up by investors earn less wealth, regions with higher patenting activity or skilled workforce are preferable.	Cochrane (2005), Cohen et al. (2019) Florin (2005) Good et al. (2019).
Science Parks (sponsor)	**Expected value:** real estate appreciation, increase collaboration between industry and academia, development of technology-based firms, **Circumstance & Relationships**: local industry tends to collaborate beyond local region, companies (startups) are located in science parks, established companies are preferable because they can pay rent.	Allen and McCluskey (1990), Minguillo et al. (2015). Phan (2005), Good et al. (2019), Bruneel et al. (2012).

Universities

In 2007, Rothaermel et al. wrote that that policy changes in both the US and Europe have resulted in the rise of economic development as a third mission to complement the existing education and research missions. As mentioned earlier, based on their literature review, they report that "conflicting opinions over the university system's mission have been consistently identified… as a key barrier to university entrepreneurship" (Rothaermel et al., 2007, p. 708.

According to Allen and McCluskey (1990), incubators funded by academic institutions had two main objectives: to increase faculty-industry collaboration, and the commercialization of university research. Cohen et al. report that "diffusion of new ideas into the economy through firm formation" (Cohen et al., 2019, p. 18) and entrepreneurship education are the two main desired outcomes. They continue to say that "university accelerators are therefore becoming an increasingly important element both in a university's support for the pathways from lab-based ideas out into the economy and in its support for entrepreneurial activity on campus more generally" (Cohen et al., 2019, p. 18).

Additional objectives mentioned by Allen and McCluskey were the creation of good will between institution and community and the strengthening of service and instructional mission. When university funding is looked at, there is variation between countries, and some countries also have more competitive funding systems than others (Auranen & Nieminen, 2010). In the UK, funding rests on undergraduate tuition fees and research grants from the government (Universities UK, 2016). Universities UK continues:

> Almost all universities that receive public funding are charities, and raise income from a wide range of sources. This publication illustrates the diversity of these sources. Any surplus income is reinvested back in to improving teaching and research, and innovating with business to support local and national growth. Without surpluses, universities would be unable to deliver the scale of investment required to meet student demands, remain internationally competitive and continue to be financially sustainable. (Universities UK, 2016, p. 2)

Cohen et al. (2019) report a different funding model-related detail connected to accelerators: MIT's Delta V accelerator's goal is that students can identify opportunities and build new business after graduation. Student capacity building, not firm-level outcomes. MIT's hope is to gain funding via alumni donations. This is long-term horizon. Cohen et al. (2019) say that universities (with alumni donations) can wait a long time for investments in (student) human capital to bring benefits.

Cattaneo et al. (2017) showed that universities are in competition for students using data from Italy. Regarding university competition for high-quality students, Horstschräer found that university rankings influence student choices and that ranking "provides more relevant information in the quality dimensions mentoring, infrastructure and students' satisfaction than with respect to research" (Horstschräer, *2*011, p. 1)

Government

The role of entrepreneurial university and the economy was discussed in some detail in the literature review. In general, economic growth is assumed to be a key objective of any modern government, and new university-generated knowledge and a university-educated workforce are what governments are looking for from universities with the emphasis on the former increasing (Audretsch, 2014). To expand the review of government as a stakeholder, additional interesting points from the literature are raised here.

According to Hausman (2012), regional employment growth and worker salaries are linked to amount of university spillovers in the related industry. The interpretation here is that if a university does R&D about regional industries, there will be spillovers. Grimaldi et al. (2011) raise the issue that new knowledge or technology at the basis of a new business and jobs might be researched and developed in a different region, or even country, while the jobs and new businesses end up being created elsewhere.

Allen and McCluskey (1990) recognized several objectives that, at least partly, government-sponsored non-profit development corporation might have. Of these, the job creation and the statement of the region having entrepreneurial potential were primary, while diversification of economic base, growth of tax base, and utilization of vacant facilities were some of the so-called secondary objectives.

In their paper regarding accelerators, Cohen et al. (2019) also discuss government motivations and goals. Cohen et al. mention two main goals for government-led accelerators that differ from earlier research: 1. bring new entrepreneurs into area, 2. retain skilled entrepreneurs. In addition, job creation and cultural transformation, and that local governments have “goal of facilitating the development of more high-quality firms in their region by solving some of the frictions that inhibit the creation and growth of such firms” (Cohen et al., 2019, p. 20).

In Cohen et al.’s data, the existence of government sponsor for an accelerator was negatively correlated with the amount equity taken from the participating startups. This could be interpreted to mean that government sponsors are not looking to maximize their profits, but instead are looking for other benefits such as job creation. There are mixed signals however, as government-sponsored accelerators are more likely to be located in areas with better employment (Cohen et al., 2019).

Cohen et al. also found out that government-sponsored accelerators are somewhat more likely to be located in areas with less than average patenting activity. This hints that the main motive is the diversification of the economy, not necessarily job creation. Though, it could also mean that in a region with less patenting activity, no private investor-backed accelerators exist, which motivates governments to remedy the situation (Cohen et al., 2019).

Corporations

The older types of incubator sponsors were real-estate companies with simple objectives of real estate appreciation and to sell proprietary services to tenants (Allen and McCluskey, 1991). This type of behavior can be likened to modern day science parks (see below). Kanbach and Stubner (2016) recognized four types of corporate sponsored accelerator types: 1. listening post, 2. value chain investor, 3. test laboratory, and 4. unicorn hunter.

Each type differs from the others based on their objectives, program focus, organization etc. Kanbach and Stubner write that for the first type, motivations are those of learning about the market and trends. Cohen et al. also write that corporations want to "cement their competitive advantage via learning" (Cohen et al., 2019, p. 17). Cohen et al. also recognize that accelerators are a source of learning for corporations. Corporation are looking for new knowledge by observing startups as they "experiment in both markets (problems) and technologies (solutions)" (Cohen et al., 2019, p. 17).

For Kanbach and Stubner's second corporate accelerator type, the expected value is in expanding the parent company value chain with new products. For the third, the motivation is to facilitate the testing of internal and external ideas. For the fourth, the objective is simply to receive returns from very successful investments. Figure 5.2 illustrates the different types of corporate accelerators as OPM models based on Kanbach and Stubner (2016).

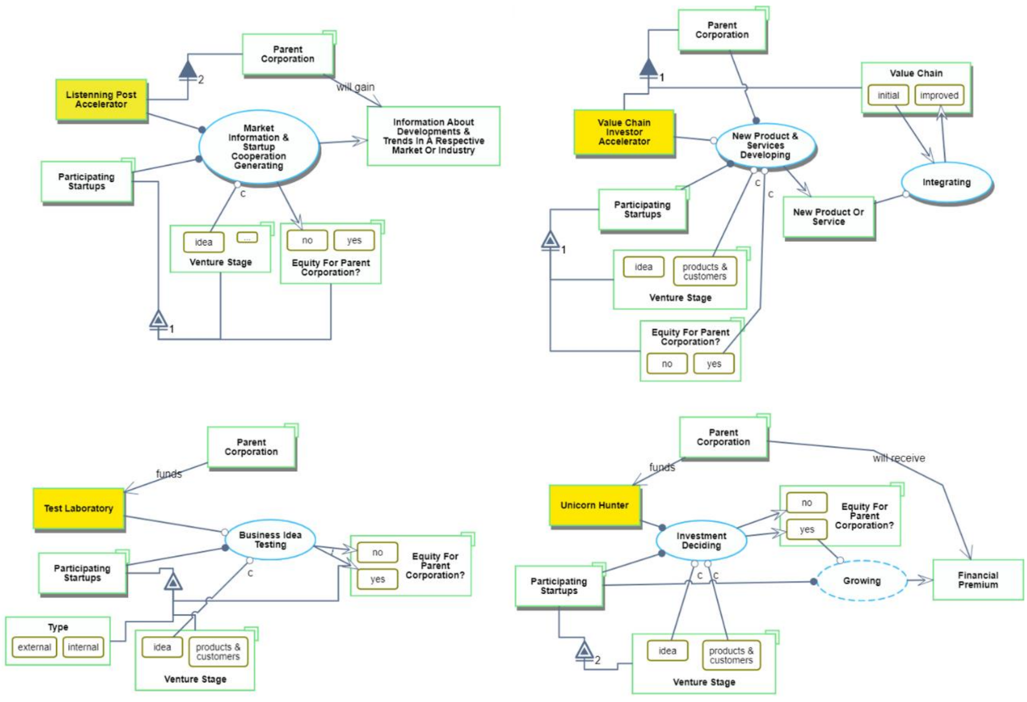

Figure 5.2: Corporate accelerator types based on Kanbach and Stubner (2016).

In their study of corporate venture capital, which corresponds with the fourth type of corporate accelerator, Benson and Ziedonis state that "surprisingly, our analysis reveals that takeovers of portfolio companies destroy significant value for shareholders of acquisitive CVC investors, even though these same investors are “good acquirers” of other entrepreneurial firms” (Benson & Ziedonis, 2010, p. 1). Additionally that corporations might have “internal capabilities or new products”, for which further development or utilization might be too expensive compared to their current strategy. In this case accelerator can select for startups that are “strategic match for their partner company’s interests” (Benson & Ziedonis, 2010). This lowers development costs for the corporation (Cohen et al., 2019). Interestingly, startups participating in an accelerator are, in a way, trying to do the same as the corporate sponsoring an accelerator. For corporations, the accelerator is a form of doing innovation and new business creation in open innovation manner.

Investors

Investors such as venture capital (VC) firms are looking to make a profit from their investments. In 2005, Cochrane discovered that the mean return on VC investments was 57 % but at the same time the volatility was extremely high. This means that VC (and other early-stage high-risk) investors have typically very diversified investment portfolios with many failures and a small chance for an extremely big payoff (Cochrane, 2005).

Cohen et al. (2019) found out that investor sponsored accelerators are more likely to be located in geographical areas with higher patenting activity. This points to the fact that investors are looking for scalable startups. Technology is typically a key component in scalability. Thus, according to Cohen et al. (2019), in order to keep investor-type sponsors happy, such as venture capital funds or angel groups, accelerators must attract high-quality startups and/or improve their quality and/or reduce the cost of this attraction and/or quality improvement process. High regional patenting activity can be interpreted to signal the existence of skilled workforce (Cohen et al., 2019).

Entrepreneur and investor interests are not always aligned. Florin’s results showed a conflict between venture capital and founders’ interests:

> Founders resorting to VC funding before taking their company public generated significantly less wealth for themselves and were less likely to remain as CEOs of their ventures after the IPO. Results suggest that founders motivated primarily by wealth creation and those motivated by remaining in control of their ventures should, in both instances, minimize VC backing when taking their ventures public. (Florin, 2005, p. 1)

University Venture Funds invest in academic spin-offs with the goal of commercializing university R&D results (Good et al., 2019). Good et al. (2019) recognize five purposes mentioned in the literature, which include the provision of financing to startups and then generating revenues and profits from these investments. Additionally, through these activities, improving the university's reputation and supporting economic development locally and regionally.

Science Parks

In 2005, Phan et al. wrote that:

> There is no systematic framework to understand science parks and incubators, that there is a failure to understand their dynamic nature as well as that of the companies located on them, that there is a lack of clarity regarding the performance of science parks and incubators which is associated with problems in identifying the nature of performance. (Phan et al., 2005, p.1)

Science Parks were developed to facilitate interactions and collaboration between industry and academia by offering facilities and office space for companies and academia (Minguillo et al. 2015). Minguillo et al. found that in the UK, Science Parks were more likely to succeed in this task when compared to other types of intermediary organizations such as technology parks and incubators. However, they also discovered that companies located within science parks "tend to collaborate with partners beyond their local region rather than the local HEI" (Minguillo et al., 2015, p. 1).

According to Good et al. (2019), the purpose of Science Parks is to help develop technology-based firms. They do this, for example, by providing office space and access to other resources such as business support services (Good et al., 2019). Early incubators operated based on the logic of real estate-development primarily (Allen & McCluskey, 1990). This was also confirmed by Bruneel et al. (2012) who discovered that so-called first-generation incubators tended to favor companies that were more established and could pay rent.

5.1.3 Expectations of participant stakeholders

The next major category or pattern we see in the literature is that of the participant. In line with OPM framework, a participant can be seen as the main beneficiary of the entrepreneurship program. Five types of participant stakeholders are recognized: students, academics, entrepreneurs, startups, and businesses.

Hacket and Dilts write about the importance of the participant category:

> Regardless of the incubator stakeholders' desire – and political need – to demonstrate ancillary effects of job creation and economic development, the universal goal of incubates is (or should be) to survive and develop as a corporate financial entity that delivers value to the owner(s)/shareholders. (Hacket & Dilts, 2005, p. 60)

Allen and McCluskey (1991) and Hacket and Dilts (2005) call incubator participants incubatees, while Bruneel et al. (2012) call them tenants. For accelerator participants, Cohen et al. (2019) uses the term portfolio firms, or simply, startups. What is striking is that the analysis of existing research findings here does not differentiate between participant types much compared to sponsor category. In Table 5.3, the expectations of stakeholder types in the participant category are summarized.

Table 5.3: Expectations of stakeholder types in the participant category.

Stakeholder type (category)	Description	References
Students (participant)	**Expected value:** satisfy interest in entrepreneurship, become an entrepreneur, increase in motivation to become an entrepreneur, startup survival, (motivation to be in university) will to grow up and social curiosity, improve position in job market via specific skills and diplomas **Circumstances and relationships:** 20-year-olds without families of their own, adult learners already in working life with families have limited time and no need for social activities.	Farhangmehr et al. (2016), Cohen et al. (2019), Jack and Anderson (1998), Nabi et al. (2107), Weise and Christensen (2014).
Academics (participant)	**Expected value:** Continue doing research as an academic, improve skills, get funded, wish to leave academia, source of income, learn about or gain feedback from industry, become part of a network, gain access to resources. **Circumstances and relationships:** professional environment where in publishing is linked to funding, more experienced academic have more engagement.	Perkmann et al. (2013), D'este and Perkmann (2011).
Entrepreneur (participant)	**Expected value:** create new business, recognition and exploitation of opportunities, idea development, organize experts' specialized knowledge into business, internal drive to be entrepreneurial, economic gain/wealth, social/community/world benefits/difference, continuation of family tradition, the will to have a certain lifestyle, self-expression/pleasure in the craft, desire for independence, access to finance, motivation to earn a living. **Circumstances and relationships:** does not feel restricted, can operate outside "the usual tracks" in the economy, status of community, access to finance and risk-accepting culture promote entrepreneurial risk-taking, job-scarcity affects motivation.	Swedberg (2009), Schumpeter (1911), Alvarez and Busenitz (2001), Carsrud and Brännback (2011), Shane et al. (2003), Cumming et al. (2014), Bosma et al. (2020).
Startup (participant)	**Expected value:** searching for profitable and scalable business, speeding up the process, getting funded **Circumstances and relationships:** funding-level and burn-rate define runaway, desire to give up equity influences decision to join investor backed accelerators.	Ries (2011), Blank and Dorf (2012), Cohen et al. (2019).
Businesses (participant)	**Expected value:** office space, service, increase employee skills, improve business, gain new innovations, have university produce more employable students, gain tacit or explicit knowledge, access to discovery, new products and services, gain competitive advantage, gain ownership of new ventures, economic gains. **Circumstances and relationships:** in competition with other companies, employs graduates, clear strategic context and university's team's appreciation of company improve likelihood of economically successful collaboration.	Bruneel et al. (2012), Galan-Muros and Davey (2019), Pertuzé et al. (2010).

Students

Cohen et al. (2019) mention an “increasing student interest in entrepreneurship”, which they claim has resulted in activities that support student entrepreneurship activity. In their 2016 study, Farhangmehr et al. used mixed methods to study the effects of entrepreneurship education on entrepreneurial motivation. They write that “the study reveals that entrepreneurship competencies are a predictor of entrepreneurship motivation but that knowledge base is not. Additionally, entrepreneurship education does not improve the motivation of university students to become entrepreneurs” (Farhangmehr et al., 2016, p. 1).

As previously discussed in the literature review of university entrepreneurship, Nabi et al. (2017) used the impact indicators by Jack and Anderson (1998) to study the relationship between various pedagogical approaches and different outcomes by reviewing past studies on this topic. These outcomes ranged from short-term, such as interest and awareness about entrepreneurship, to long-term outcomes, such as startup survival and broader contributions to society and economy. All in all, the results of Nabi et al. show that there is some relationship between entrepreneurship education and short-term subjective outcomes, though the researcher’s original aim behind the study seems to define what type of pattern of impact gets demonstrated.

Adopting the jobs-to-be-done framework, Weise and Christensen (2014) argue convincingly that universities are serving two types of major customer segments in the student market. The first is the traditional segment consisting of young people going to college or university after high-school and for whom going to college is part of the process of growing up with all the social activities. Secondly, graduation and the resulting degree has been seen as sure ticket to good jobs, though this has been starting to erode (Weise & Christensen, 2014). The second segment are people already in the workforce, perhaps with families, who need to get very specific skills and/or diplomas that improve their position in the job market. They do not care about the social activities of 20-year-old students and are there to get the learning and the degree (Weise & Christensen, 2014).

Academics

Perkmann et al.’s (2013) review of past research on academics engagement with the industry revealed an interesting detail which points to an underlying motivational structure. As mentioned earlier in the review of past research, the level of academic engagement seems to not be correlated with the level of organizational support for these activities. On the other hand, organizational support is correlated with commercialization and academic entrepreneurship. If this relationship is directional in the sense that more support will result in more commercialization, it could be interpreted to mean that normal engagement activities with industry, such as consulting and contract research, are not beyond the typical skill sets of academics as they are close to the practices of teaching and normal research projects. Skills and tasks involved with commercialization, on the other hand, are more removed from the daily activities of academics. These activities, after all, have helped the academic survive (i.e. get funded) in their professional environment.

One could also interpret the differences in the relationship between organizational support and either academic engagement or commercialization to point to differences in how these two activities are in harmony with the career-level goals of academics. While engagement with the industry can be seen to satisfy the researcher's career expectations, commercialization and entrepreneurship is a deviation to a completely different kind of a career. An increase in the desirability of such a deviation might require "artificial" external and organizational support. This latter conclusion would seem to be supported by Perkmann et al. (2013) who reported that academia seniority is correlated with more engagement, but not with commercialization. People with entrepreneurial desires might opt out of academia and we are left with people who value research career more highly.

In their 2011 study, D'este and Perkmann constructed four motivations: commercialization, learning, access to in-kind resources, and access to funding. The list below is based on D'este and Perkmann (2011) and links specific motivational items with motivation constructs. The commercialization motivation items were seen as much less important compared to some of the learning and the two funding motivations. 1. Commercialization (source of personal income, seeking IPRs), 2. learning (information on industry problems, feedback from industry, information on industry research, applicability of research, becoming part of a network), 3. access to in-kind resources (access to materials, access to research expertise, access to equipment), 4. access to funding (research income from industry, research income from governments).

Entrepreneurs

The entrepreneur is the agent of economic change and new business creation. According to Swedberg (2009, p. 8), the famed economist Joseph Schumpeter called an entrepreneurial person a Man of Action in his 1911 book "the theory of economic development", stating "The Man of Action acts in the same decisive manner inside as well as outside the usual tracks in the economy. He does not feel the restrictions that block the actions of the other economic actors" (1911, p. 132).

Alvarez and Busenitz, representing the resource-based theory (RBT) of economy, define entrepreneurship as "the recognition and exploitation of opportunities that result in the creation of a firm that seeks to obtain entrepreneurial rents" (Alvarez & Busenitz, 2001, p. 756). They write that "the entrepreneur who recognizes the value and the opportunity of the expert's knowledge. While the entrepreneur may have specialized knowledge, it is the tacit generalized knowledge of how to organize specialized knowledge that is the entrepreneur's critical intangible resource" (Alvarez & Busenitz, 2001, p. 760).

According Carsrud and Brännback (2011), entrepreneurial motivations had not been studied considerably over two decades. They say that research on this topic started initially by borrowing heavily on other social disciplines, but trait theories, for example, failed to find entrepreneur-traits. In their review, Carsrud and Brännback recognize two main approaches to motivation theories: drive theories and incentive theories. The first one has psychological origins, seeing a person animated because of a need to release tension generated by internal pressures. The second type looks at motivation through the lens of economic theory and sees it as something generated via the "pull" of external economic goals.

Temporal Motivation Theory by Steel and König (2006) is one of the emerging theories that combines several former psychological and economic motivational theories. They write that "TMT indicates that motivation can be understood by the effects of expectancy and value, weakened by delay, with differences for rewards and losses" (Steel & König, 2006, p. 897). From our point of view, the key unknown in terms of entrepreneurship as a choice here is the question of value. What is the value a person is hoping to receive when starting on the entrepreneurial path?

From Carsud and Brännback (2011), we can get some indication of the type of value entrepreneurs gain by listing the four major categories of entrepreneurial motivation: economically motivated entrepreneur, socially motivated entrepreneur, lifestyle entrepreneur, and artist or craftsmen. According to this classification, only the economically motivated entrepreneur is interested in maximizing economic gains. For all others, economic gains only motivate them to some extent, other outcomes need to be factored in.

Shane et al. (2003), in their paper on entrepreneurial motivation, develop a model where the initial state includes the entrepreneurial motivations and cognitive factors of the entrepreneur, and the entrepreneurial opportunities and environmental conditions at present. This initial state then affects three steps of the entrepreneurial process: opportunity recognition, idea development, and execution. Cognitive factors are a group of items such as skills, knowledge, and abilities, while entrepreneurial motivation includes general desire for independence, and task specific motivations. Using this perspective, an entrepreneur could be defined as someone who is engaged in any of these three processes.

The environmental factors in Shane et al.'s model are, according to Shane et al., the macroeconomic conditions such as availability of capital or the state of the overall economy influencing individual's decisions. Figure 5.3 illustrates the entrepreneurship motivation model of Shane et al. (2003).

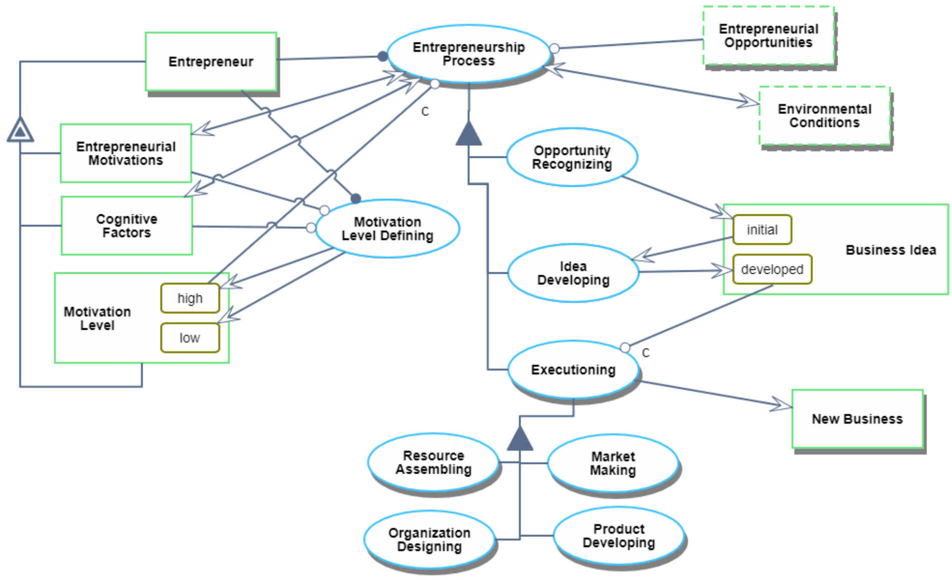

Figure 5.3: Model of entrepreneurial motivation and process based on Shane et al. (2003)

Cumming et al. (2014) found, using World Bank, OECD, and Compendia data, that access to finance which lowers or eliminates the downside costs are important for entrepreneurial risk-taking alongside risk-accepting culture. With these elements in place, entrepreneurship has “significantly positive impact on GDP/capita, exports/GDP, and patents per population, and a negative impact on unemployment” (Cumming et al., 2014, p. 1).

When we adopt the view that entrepreneurship is a tool for higher level goals, we see it as a choice. Global Entrepreneurship Monitor (Bosma et al., 2020) distinguished four different types of higher-level motivations: 1. motivation to make a difference in the world, 2. motivation to build great wealth or very high income, 3. motivation to continue a family tradition, and 4. motivation to earn a living because jobs are scarce.

Startups

A startup is a temporary organization in the process of searching for a profitable and scalable business model (Ries, 2011; Blank & Dorf, 2012). Funding and burn-rate define how long a startup has to find the right business model (Ries, 2011). For our purposes, the startup could be seen as the larger scale (i.e. more individual) version of the entrepreneur.

Of course, a startup is also a registered business or legal entity which brings certain constraints and opportunities, for example outside finance. As previously discussed, Cohen et al. (2019), in their analysis of American accelerators, illustrated how especially investor-sponsored accelerators take equity in response to providing funding for the startups selected to join the accelerator.

Businesses

As discussed previously, first generation incubators preferred to work with more established businesses as the revenue model for these incubators is based, at least partly, on the rents incubator tenants pay for the access to office space and other services (Bruneel et al., 2012).

Galan-Muros and Davey (2019) put together a conceptual model of university-business cooperation (UBC). Their model consists of eight main elements including activities, outcomes, supporting mechanisms, circumstances, and context. Under university-business cooperation activities, Galan-Muros and Davey list three activities that belong to the education domain: 1. joint curriculum design and delivery, 2. lifelong learning, such as continuing education provided by university to people working in a business, and 3. student mobility (e.g. internships). See Figure 5.4 for an OPM representation of the main UBC domains and the three activity types of the education domain.

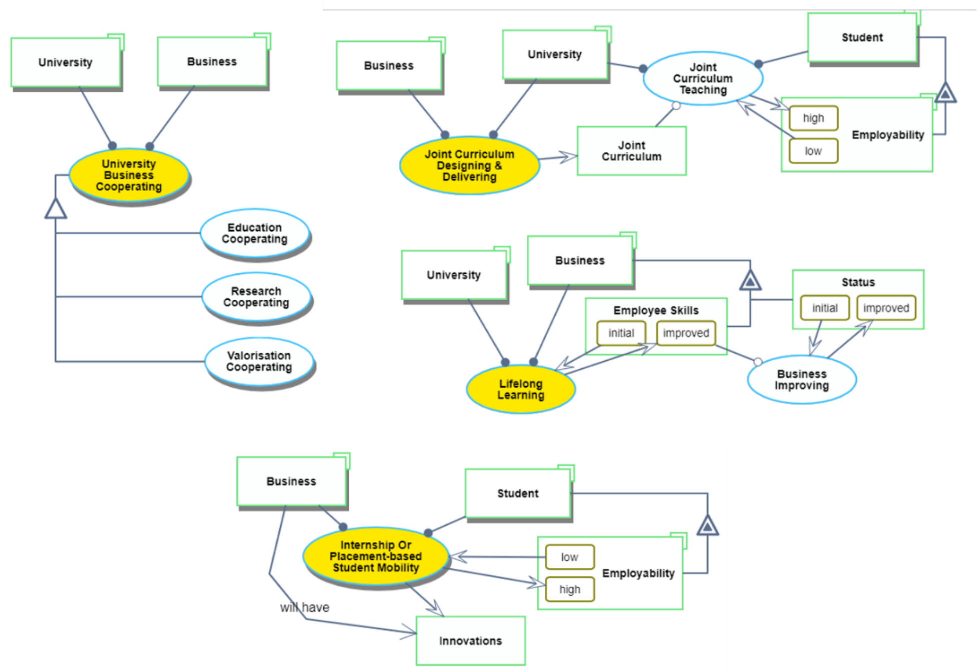

Figure 5.4: University-business cooperation domains and education activity types based on Galan-Muros and Davey (2019).

There are then two additional activities which belong to research domain (Galan-Muros & Davey, 2019): 4. professional mobility such as being a professor of practice or taking a sabbatical to work in a company, and 5. collaborative R&D. See Figure 5.5 for OPM representations of the two research domain activities.

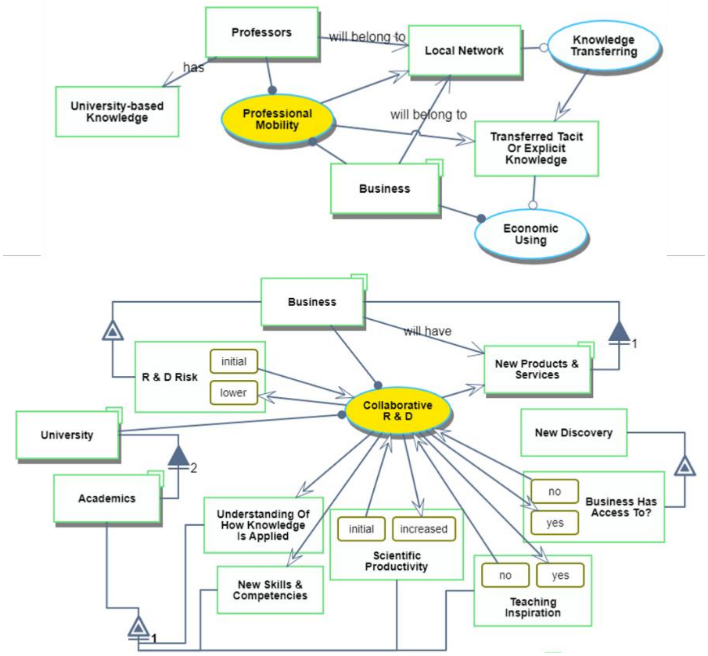

Figure 5.5: University-business cooperation activity types in the research domain based on Galan-Muros and Davey (2019).

Finally, two more activities belonging to the valorization domain (Galan-Muros & Davey, 2019): 6. commercialization of R&D results, which for businesses mean new products and growth, and 7. entrepreneurship, which is the process of new venture creation with or without existing businesses. See Figure 5.6 for OPM representations of the two activities belonging to the valorization domain.

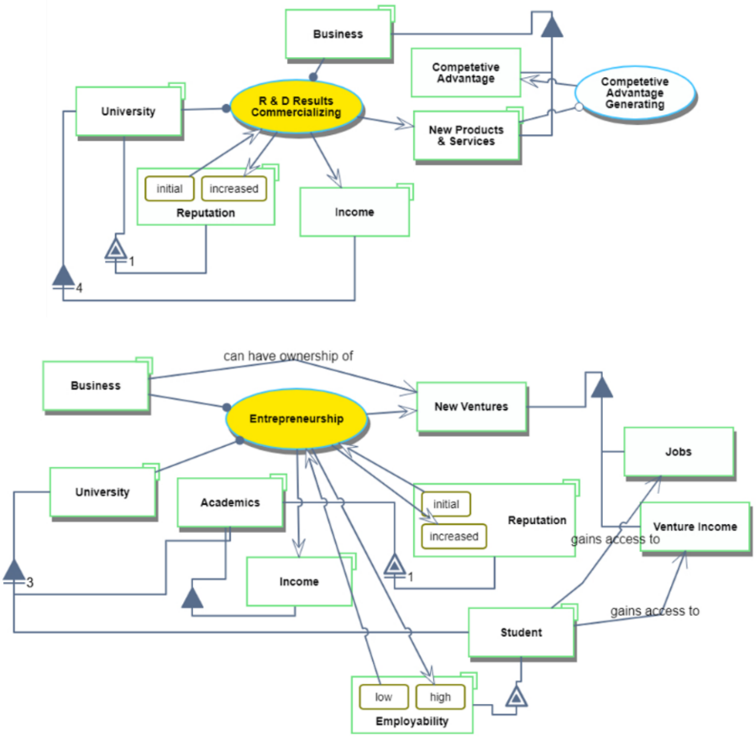

Figure 5.6: University-business cooperation activity types in the valorization domain based on Galan-Muros and Davey (2019).

Pertuzé et al. (2010) looked in detail at how industry-university R&D collaboration works, and especially in how to bridge the gap between outcomes (e.g. new ideas and inventions) and impacts (i.e. those outcomes produce economically important results). Pertuzé et al. discovered seven best practices that, according to them, help companies to bridge the outcome-impact gap. In their data of 106 university-industry collaboration projects, about 50 % of them produced so-called major outcomes, but only 20 % of the projects produced major impacts.

These practices from Pertuzé et al. are thus briefly discussed. First, the project's strategic context should already be defined at the time of selection. This means, for example, identifying internal users of the outcomes. Another point to be highlighted is the practice of university teams involved in the collaboration understanding and appreciating the company's context and goals. These and other practices, of which many revolve around improved communication, according to Pertuzé et al., help companies make sure they bridge the gap from outcomes to impacts, which, in the final evaluation, are what companies really care about and are depending on.

5.1.4 Expectations of partner stakeholders

In this section, a set of stakeholders in the literature are covered that either contribute to the entrepreneurship program or represent a step before or after in the entrepreneurship ecosystem. The former case was illustrated in Figure 5.1. The users of a possible innovation are also included in this category.

Based on the literature, one shared aspect of many of the "partner" stakeholder expectations was that mentors and experts participate in the entrepreneurship programs' process in order to learn of new knowledge. According to Eckermann et al. (2020), at the program level, this can translate to a process or capability of absorptive capacity, that is a process for the program to update its knowledge. Figure 5.7 represents an OPM interpretation of the absorptive capacity model in the accelerator context based on the illustration by Eckerman et al., which was based on Todorova and Durisin (2007).

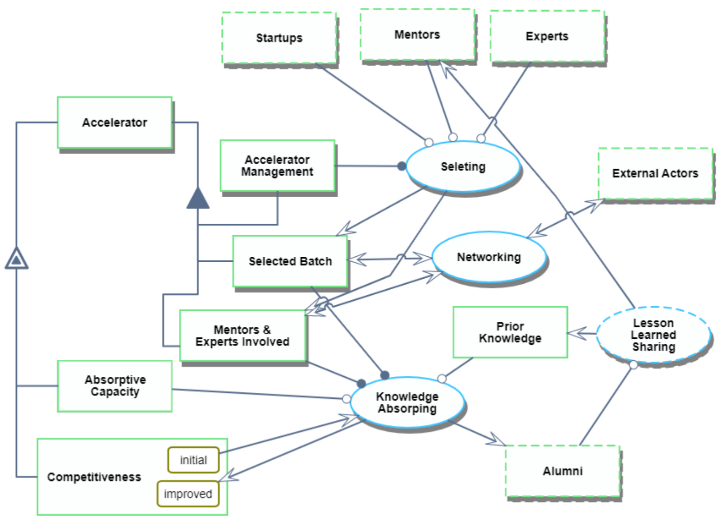

Figure 5.7: Accelerators and absorptive capacity based on Eckerman et al. (2020) and Donovan and Durisin (2007).

As the illustration shows, the model is lacking in some respects, including the main function of the accelerator. In Table 5.4, the expectations of stakeholder types belonging to the partner category are summarized.

Table 5.4: Expectations of stakeholder types in the partner category.

Stakeholder type (category)	Description	References
Incubators and accelerators (partner)	**Expected value:** pre-incubated startups, purpose to develop local economy and support formation of technology-based companies. **Circumstances and relationships:** focus and constraints defined by revenue model.	Deutschmann (2007), Good et al. (2019), Cohen et al. (2019), Bruneel et al. (2012).
Mentors (partner)	**Expected value:** altruistic desire to offer psychological and career support, to be a role-model, gain information and knowledge via protégé, increase diversity by supporting minorities. **Circumstances and relationships:** protégé competence preferable, more psychological support for new startups, reward system in corporation that rewards mentoring efforts, opportunities interaction predict likelihood, closeness to retirement is negative predictor.	St-Jean (2011), Mullen and Noe (1999), Waters et al. (2002), Aryee et al. (1996), Bear and Hwang (2015), Morales et al. (2017).
Experts (partners)	**Expected value:** economic compensation, tacit knowledge from tests and experiments, future customer acquisition.	Nimmolrat et al. (2011).
Managers and operators (partner)	**Expected value:** profits from equity taken, goal of developing local and regional economy.	Cohen et al. (2019).
TTOs (partner)	**Expected value:** bridge university and market environments, license university-based technology, form a company around technology, support local development. **Circumstances and relationships:** university ownership in company can prevent other funding, IP or connection to university R&D is a must for TTO to be interested.	Bradley et al., (2013), Good et al., (2019).
Educators (partner)	**Expected value:** younger teacher motivated by working with children and their subject, older teachers with long holidays and social hours. **Circumstances and relationships:** low teacher motivation can prevent entrepreneurship education, a principal's leadership style has big impact on teachers, autonomous motivation is a predictor, negative influences are socio-economic status, student behavior, and examination stress.	Chiu (2013), Eyal and Roth (2011), Gorozidis and Papaioannou (2014), Alam and Farid (2011), Kyriacou et al. (1999).
Users (partner)	**Expected value:** benefit from the innovation, remain ahead of the trend, curiosity, desire to innovate. **Circumstances and relationships:** users with diverse knowledge base are most valuable.	Harmaakorpi et al. (2017), Miller et al. (2018), Urban and Von Hippel (1988) Füller (2006), Frey et al. (2011).

Next, each partner stakeholder type in this category is discussed in more detail.

Incubators and accelerators

Even though an incubator earlier was previously defined as an entrepreneurship program, we also want to define it as a partner stakeholder. This is because an education-focused entrepreneurship program might need to work together with a more incubation-oriented program. Another example is when the university-managed program acts as a so-called pre-incubator, or pre-accelerator, for the main incubator in the region (Deutschmann, 2007).

Good et al.'s review (2019) found the main purpose of incubators to be supporting the development of local economy and supporting "the formation and development of technology-based startup companies” (Good et al., 2019, p. 5). However, as previously discussed, many different types of accelerators exist with varying purposes and expected outcomes. The analysis of Cohen et al. (2019), and also Bruneel et al. (2012) amongst others, have revealed how the revenue model of the accelerator plays a big role in defining its purpose and focus. Thus, designers of a university-managed entrepreneurship programs should carefully study and understand the specificities of other local entrepreneurship programs in order to best serve local participants.

Mentors

Cohen et al. (2019) discovered that the majority of US accelerators included mentors in the accelerator program. St -Jean (2011) explored the functions a mentor has for novice entrepreneurs in more detail. Of the three main functions recognized by previous literature (psychological function, career-related function, and role-model function), St-Jean observed the presence of all of them. He also went further and observed several sub-functions for both psychological and career-related support: reflector, reassurance, motivation, and confidant with the psychological support, and integration, information support, confrontation, and guide with the career-related support.

Mullen and Noe (1999) write that, traditionally, information and expertise are seen to flow from mentor to the one that gets mentored (i.e. protégé), but in their study, they looked at the phenomenon where the act of mentoring is a process wherein the mentor receives knowledge from the protégé. Mullen and Noe discovered that “perceived appropriateness of mentor information seeking, perceived protégé competence, vocational mentoring functions and protégé influence contributed significantly to the prediction of mentor information seeking among the mentor sample” (Mullen & Noe, 1999, p. 1).

We see here that the expectations of a stakeholder are reflected in their activities. Like investor-sponsored accelerators, mentors motivated by new information want to work with more competent protégés. In Mullen and Noe’s data, the personal growth or psychological support function was not related to mentor information seeking behavior.

Interestingly, in their 2002 study, Waters et al. discovered that mentors working with new business startups were providing more psychological than career-related support. Waters et al. raise several possible explanations for this from literature, including early-stage entrepreneurs’ higher levels of anxiety and the relative ease of providing only psychological support, but Waters et al. do not mention one obvious point — new businesses are exploring uncharted waters and by definition, people can only have partial expertise on related challenges.

A mix of internal and external motivations can motivate people to take on the role of a mentor. Aryee et al. (1996), in their study of mentoring inside corporations, discovered that personal psychological characteristics such as altruism were important predictors along with situational factors. Situational factors in Aryee et al.’s model were the existence of an employee development-linked reward system and opportunities for interaction on the job. Bear and Hwang (2015) had similar results, confirming the importance of prosocial motivation. Interestingly, proximity to retirement had a negative relationship with prosocial motivation. This could reflect mentors' non-altruistic reasons to mentor.

Morales et al. (2017) studied faculty motivation to mentor students and had results in line with Bear and Hwang and Aryee et al — mid-career faculty were more willing than late-career faculty. Additionally, when faculty experienced that the reward systems in place did not support mentoring, they were likely to not want to mentor. Interestingly, Morales et al. discovered that "faculty who placed greater value on the opportunity to increase diversity in the academy through mentorship of underrepresented minorities were more likely to be interested in serving as mentors" (Morales et al., 2017).

Experts

Hackett and Dilts (2004) report that access to a network of experts has been one of the main sources of value received by the incubatee. In addition, Nabi et al. (2017) report that in entrepreneurship education, so-called competence model pedagogies can push students to consult external experts such as legal, accounting, and sales experts. These educational programs are however working with students who are starting up their businesses and thus, it could be seen as an incubation process. Lackéus and Middleton (2011) report that in venture creation programs, employees are close at hand to help student teams to commercialize R&D based IP.

The motivation of experts to participate beyond monetary compensation is not a widely studied topic, but luckily some research exists. Nimmolrat et al.´s 2011 study uncovered via interviews that experts can be motivated by the tacit knowledge they receive when participating or observing the prototyping, or business idea testing, activities. One can also speculate that expert participation in an incubation process can be a form of future customer acquisition, when helping out emerging entrepreneurs translates into these businesses buying the expert's services after their businesses start to earn a profit or receive enough funding.

Managers/operators

Cohen et al. (2019) recognize five different types of accelerators in founding managers' backgrounds: investor (has worked for investment companies), entrepreneur (co-founder of a company), corporate, university, and government. The least common background experiences of founders were university and government, while corporate and entrepreneur backgrounds were most common and around one third had investor experience. Correlations between founding managing directors' backgrounds were very small and/or insignificant, indicating many possible background combinations. There are an average two founding managers per accelerator. (Cohen et al., 2019)

Cohen et al. (2019) reported that accelerator managers or founder backgrounds were reflected in accelerator design choices. For example, accelerators with managers who had worked in the VC sector, took high percentages of equity from the startups as an exchange for participating in the accelerator process. Accelerator programs with founding manager directors with university background were more likely to include formal education component in their acceleration process. Cohen et al. conclude:

> These characteristics may lead to distinctive of accelerator designs, each optimized to meet the founders' objectives; for example, government-sponsored accelerators founded by directors with public service backgrounds may well focus on economic and regional development, while investor-led accelerators founded by former risk capital investors focus instead on the maximization of returns. (Cohen et al., 2019, p. 34)

TTOs

University Technology transfer offices (TTO) typically focus on either licensing R&D based IP or forming a company around it (Bradley et al., 2013). Good et al. (2019) note that the TTO's role in making sure the university has ownership in the companies can prevent companies from gaining additional funding. This would then minimize chances of "generating the (social or financial) returns" (Good et al., 2019, p. 5) expected by other stakeholders. In their review, Good et al. (2019) report a TTO's purpose as to "Act as a bridge between university and market environments. Protect university proprietary rights in order to generate returns. Support pre-commercialization of inventions. Support local or regional development" (Good et al., 2019, p. 5).

Given previous discussions about TTOs and the information above, we can conclude that TTO's expectations are heavily defined by their organizational function and role. Business ideas without university IP and/or connection to university R&D are likely seen as less attractive for TTOs.

Educators

Chiu (2013) writes that teacher motivation is one of the main barriers in entrepreneurship education. Eyal and Roth (2011) reported that in school-settings, principals leadership style has an impact on teacher motivation and well-being. Gorozidis and Papaioannou (2014) reported that when teacher had so-called autonomous motivation, they were more likely to participate in training and to teach an innovative academic subject. In general, a teacher's motivation to do their job is negatively affected by their perceived socio-economic status, student behavior issues and examination stress (Alam & Farid, 2011).

Kyriacou et al. (1999) examined student teachers and teachers doing postgraduate training courses and discovered that for older already working teachers, long holidays and social hours were valued aspects of the job, while younger student teachers emphasized working with children and using the subject they love in their career. Kyriacou et al. write that "the data here suggest that more could be made of the fact that teaching enables people to continue working in a subject area they enjoy.” (Kyriacou et al., 1999, p. 380).

Users

Harmaakorpi et al. (2017) argue that innovation policy should broadly include different types of innovation activities, including those with customers. According to Miller et al. (2018), the inclusion of users of societal innovations was a step that expanded so called triple-helix models to quadruple-helix models. As the name suggests, these stakeholders are the would-be users of the innovations.

Lead users (Urban & Von Hippel, 1988) are special type of users who benefit from the innovations but are also ahead of normal users in terms of in how demanding a context they need to benefit from the innovation. Innovation by lead users were shown to be more likely to become profitable (Urban & Von Hippel, 1988). In his 2006 study, Füller investigated the reasons behind people’s participation in new, virtual product developments and discovered that “Intrinsic interest in the innovation activity and curiosity are found to be the most important motives for consumers’ willingness to engage in further virtual development activities” (Füller, 2006, p. 1).

Frey et al. came to similar conclusions in their study of participants’ motivations in online innovation projects: “We identify the most valuable contributors as those who combine high levels of intrinsic enjoyment in contributing with a cognitive base fed from diverse knowledge domains” (Frey et al., 2011, p. 1).

5.1.5 Expectation in the Finnish context

As explained in section 4.2.4, as a third step of literature-based stakeholder analysis, selected stakeholders in the context of Finnish higher education were looked at. The stakeholders included in this more detailed analysis are: 1. Finnish government, 2. Finnish universities, 3. students in Finnish universities eligible for social security, and 4. entrepreneurs in Finland eligible for social security. Table 5.7 summarizes the context-specific expectations of these four select stakeholders.

Government

The government’s role in the Finnish higher education landscape is very dominant as all universities are public and there are no tuition fees for Finnish or EU students (Eskola et al., 2018). The government allocates money to universities based on a university-specific annual score (Minedu, n.a.). How well a university scores is dependent on how well other universities perform. This is discussed further in the university stakeholder section.

For the Finnish government, education and R&D policy is part of the current and previous government programs that also have economic growth as one key goal (Finnish Government, 2019a). Prior to COVID-19 crisis, the current government had an explicit goal of raising the employment rate to 75 % and lowering the unemployment rate to 4,8 % by 2023 (Finnish Government, 2019b). The current government aims for the diversification of business structures via entrepreneurship:

> The threshold for starting and growing a business will be lowered by fostering an atmosphere that promotes entrepreneurship, and by building skills for working life. This could be achieved by promoting understanding of entrepreneurship and working life and the skills they require, at various levels of education and in public services. Appropriate training will be provided to strengthen world-class business competence. (Finnish Government, 2019b)

Likewise, the previous government's program from 2015 (Finnish Government, 2015) had great emphasis on entrepreneurship as a way towards growth and prosperity and emphasized the commercialization of research results. As a large and relatively sparsely populated country, entrepreneurship is emphasized as key for all areas (Finnish Government, 2019b):

> The conditions for living and entrepreneurship must be secured in all parts of Finland in a diversity of ways, taking into account the different needs of regions and cities: metropolitan area; large cities with a population of more than 100,000, also university towns; medium-sized urban areas in regional centres; regional cities; and sparsely populated areas… The objective of regional policy is to reduce the level of divergence between regions and within municipalities. (Finnish Government, 2019b)

One of the measures emphasized is the RDI invesments relative to GDP: "A roadmap will be drawn up to raise RDI investments to 4 per cent of GDP" (Finnish Government, 2019b). Universities can be seen to be on the receiving side in the upcoming years. As mentioned above, the government also has a student financial aid program for all students in higher education (Kela, 2020a). The details of the financial aid program is detailed in the student stakeholders section.

Universities

There are two main types of public universities: academic research universities (or simply universities) with bachelor, master's and PhD degree programs, and universities of applied sciences with bachelor and master's degree programs. How much core funding all the universities receive together is decided annually by the government, and the budget is distributed to universities mostly based on their research and education performance relative to other universities. (Minedu, n.a.).

The fact that university performance is assessed relative to other universities means that when one university improves its performance, other universities will receive less funding as the increased funding for the performance-increasing university came from their share (Eskola et al., 2018). Eskola et al. write about the funding allocated for universities of applied sciences (UAS): "In other words, it is possible to increase the financing only by improving results more than other UAS" (Eskola et al., 2018, p. 38).

de Boer & Jongbloed (2015) report that such competition has led to a reduction in collaboration between universities. It is important to note here is that performance-based funding models are not only limited to Finnish higher education; they are a growing phenomenon (de Boer & Jongbloed, 2015).

Besides performance-based core funding, universities can also apply for so-called strategic government funding or, for example, for EU structural funds in the form of projects (Minedu, n.a.). The latter is a big funding instrument for entrepreneurship initiatives in the Finnish higher education sector, as evidenced by the 2016 report that summarizes good practices of entrepreneurship support in all Finnish universities (Viljamaa, 2016). This type of external project funding can allow the university to operate beyond the confines of the core funding model and performance metrics.

Both the previous and upcoming funding model for universities and universities of applied sciences had several student and graduate-dependent performance measures. The proportion of these performance criteria in the 2017–2020 funding model and the 2021– funding model for both types of universities are presented in Table 5.5.

Table 5.5: Study-related criteria in funding model of Finnish universities based on Minedu (n.a.).

	Universities of Applied Sciences, 2017–2020	**Universities, 2017–2020**	**Universities of Applied Sciences, 2021–**	**Universities, 2021–**
Bachelor's and Master's degrees	44 %	20 %	62 %	30 %
Number of students who have gained at least 55 study credits	23 %	10 %	n.a.	n.a.
Number of employed graduates (and quality of employment 2021 -)	4 %	2 %	6 %	4 %
Study credits in open university education and in non-degree programmes (continuous learning 2021 -)	5 %	2 %	9 %	5 %
PhD degrees		9 %		8 %
Student feedback	3 %	3 %	3 %	3 %
TOTAL	**79 %**	**46 %**	**80 %**	**50 %**

As the table shows, student and graduate-related performance is much more significant for universities of applied sciences with 79 % (2017 – 2020 funding model) and 80 % (2021 – funding model) of the total core funding, while for academic research universities the proportions are 46 % and 50 % respectively. For universities, the rest of the core funding comes from, for example, scientific publication and competitive research funding performance (see Table 5.6).

From the perspective of universities and universities of applied sciences, given the importance of what students do during and immediately after graduation, let's assume that whether an entrepreneurship program is targeting students and the activities register on the performance measures in Table 5.5, is a big factor explaining entrepreneurship program survival. However, other funding opportunities do exist.

Table 5.6: Other criteria in the funding model of Finnish universities based on Minedu (n.a.).

	Universities of Applied Sciences, 2017–2020	**Universities, 2017–2020**	**Universities of Applied Sciences, 2021–**	**Universities, 2021–**
(Scientific for universities) publications	2 %	13 %	2 %	14 %
External research funding / Competitive research funding	8 %	9 %	11 %	12 %
Strategic development	5 %	12 %	5 %	15 %
National duties	n.a.	7 %	n.a.	9 %
Degrees on vocational teacher training	2 %	n.a.	2 %	n.a.
Field-specific funding	1 %	9 %	n.a.	n.a.
Student mobility	1 %	2%	n.a.	n.a.
Teacher and expert mobility	1 %	n.a.	n.a.	n.a.
International teaching and research personnel	n.a.	2 %	n.a.	n.a.

Students

In Finnish public higher-education, students do not have to pay tuition, with the exception of international students beyond EU (Eskola et al., 2018). Besides receiving free education, the government provides study grants via KELA - The Social Insurance Institution of Finland (Kela, 2020a). For a student who lives alone and is 18 years old or older, the grant is 252,76 € per month in 2020; if the student is a guardian of a minor child, the grant is about 100 euros higher (Kela, 2020b).

To be eligible for the financial support, a student needs to be admitted to a school, be in full-time study, and have academic progress (Kela, 2020a). Study progress is defined as the fulfillment of both of the following factors (Kela, 2020c): at least 5 credits on average for each month of financial aid, and at least 20 credits in each academic year (the minimum requirement). In addition to the study grant, besides a few minority conditions, study progress also defines a student's eligibility for a government-guaranteed study loan. As another perk, if the student completes their studies in the target time, which depends on the extent of the degree program measured in credits, the government will pay 40 % of the study-loan as compensation (Kela, 2020d). Taken together, these aspects form a strong incentive to study well and graduate on time.

One of the reasons for these incentives can be assumed to be the relative high age of Finnish graduates relative to many other countries. In 2011, the OECD average of graduate median age was about 23 (OECD, 2014). According to Statistics Finland (Statistics Finland, 2009), in Finland, the median age of universities of applied sciences students is 24 and the median-age at graduation is 25. For universities, the same numbers are 25 and 27 respectively. For universities of applied sciences, this graduation age is for bachelor’s degrees and for universities for master’s degrees.

Even in Finland, with a relatively high age of graduation, these numbers mean that if you take a random student, they are likely to be a young person compared to the national median age of 42,5 years in 2015 (Statista, 2020). This is an important detail as we consider the findings of Azouley et al. (2020) regarding how startups founded by young people are less likely to find success than older people’s businesses.

As the mean age of first-time mothers in Finland in 2017 was 29,2 years (Statistic Finland, 2018), we can assume that a small minority of students had their first child as a student. In fact, in 2016 only 6,4 % of university or universities of applied sciences students in Finland had a child (Kunttu et al., 2017).

In 2018, 56 % of university students had a part-time job and 59 % of universities of applied sciences students had a part-time job (Statistics Finland, 2020). 2,5 % of students said that they work as an entrepreneur, and 19 % estimated that they would likely be entrepreneurs after graduation (Lauronen, 2019).

Entrepreneurs

Entrepreneur were discussed as a stakeholder type, to some extent, in the earlier part of this chapter. As mentioned, an entrepreneur is defined as a person, or in some cases a team, who is explicitly in the process of developing a new business or managing or improving an existing one. We also argue that the entrepreneur is a key stakeholder and the main beneficiary of the entrepreneurship program. What an entrepreneur does is directly linked to what the government cares about, namely GDP growth and employment, as GDP and employment by definition is largely dependent on the performance of its businesses on average.

We see entrepreneurs’ relationships to students stakeholders as two-fold: 1. businesses that entrepreneurs run hire students when they graduate, and 2. a student can be an entrepreneur. This means that a student entrepreneur is experiencing almost the same context as the non-student entrepreneur. However, a student’s income as an entrepreneur or as a part-time employee affects the amount of public financial support they can get. The income limit for each month the student receives financial aid is 696 euros (Kela, 2020e). We argue that this mechanism limits student entrepreneurs' motivation to grow a small business during their studies. Of course, the same applies to having a part-time paid job. The Finnish unemployment benefits system has a similar mechanism where above a certain limit, more income from a job lowers the amount of benefits received.

As also discussed previously, businesses and universities have multiple channels of collaboration (Galan-Muros & Davey, 2019). In the Finnish system, universities are indirectly dependent on the overall performance of the economy, as the taxes governments collect are allocated to universities on an annual basis (Minedu, n.a.).

Table 5.7: Context-specific stakeholder expectations in the Finnish higher education.

Stakeholder	Details	References
Government	**Expected value:** Economic growth is a key goal, specific goals for raising employment and lowering unemployment, education and RDI policy is emphasized with the goal to raise RDI spending relative to GDP to 4 %, having good conditions for entrepreneurship in all parts of the country is a goal as entrepreneurship is seen as a key for growth. **Circumstances and relationships:** government funds universities via performance-based model, government provides support for students based on study progress.	Finnish Government (2019a), Finnish Government (2019b), Finnish Government, (2015), Minedu (n.a.), Kela (2020a).
Universities	**Expected value:** Universities receive their annual core funding from the government based on their performance relative to other universities, student and study related outcomes (credits production, graduation numbers) are the biggest metric in the funding model, other project-type funding sources also exist. **Circumstances and relationships:** There are two main types of universities: academic research universities (universities), and universities of applied sciences (UAS), there are no tuition fees for Finnish and students from other EU countries.	Minedu (n.a.), Eskola et al. (2018), Boer and Jongbloed (2015).
Students	**Expected value:** Students can receive financial aid from the government: the student needs to be admitted to a school, be in full-time study, have academic progress; academic progress is minimum 5 credits on average per each month of support, and at least 20 credits per academic year. Study grant is 252,76 € per month and government can also guarantee a study loan, if studies are complete on time, government pays 40 % of the loan taken. **Circumstances and relationships:** Student median age is 25 for universities and 24 for UAS's, 6,4 % of students have children. 56 % of university students had a part-time job, and 59 % of universities of applied sciences students had a part-time job. 2,5 % of students said that they work as an entrepreneur, and 19 % estimated that they would likely be entrepreneurs after graduation.	Kela (2020a), Kela (2020b), Kela (2020c), Kela (2020d), Statistics Finland (2009), Kunttu et al., 2017), Lauronen (2019).
Entrepreneurs	**Circumstance and relationships:** 696 euros is a monthly income limit, including income as an entrepreneur, for students receiving financial aid.	Kela (2020e).

Now that the results of the stakeholder analysis have been presented, the results from the next step: functional analysis, will be covered.

5.2 Purpose and function of entrepreneurship programs

In this section, the results of functional analysis are presented.

5.2.1 Stakeholder specific models

In the following section, the results from the first step in functional requirements identifying process are presented. Stakeholder expectations for each stakeholder were taken and converted to corresponding OPM diagrams. The emphasis was on using the "expected value" part of each stakeholders' expectations.

Depending on the diagram size, the diagram is presented here alone or together with several other diagrams. However, the number of figures remains large, but this can be seen as unavoidable, because this step is critical. As a result of this step, we created 17 new OPM models in total, one for each stakeholder type.

Participant stakeholders

Figure 5.8 is an OPM-diagram based on student stakeholder's expectations. It is noteworthy that there are very few direct business-related benefits, and the main operand is the student themselves. At the bottom of the diagram (grey color), the financial aid model in Finland was modelled, wherein study credits produced yield in financial aid.

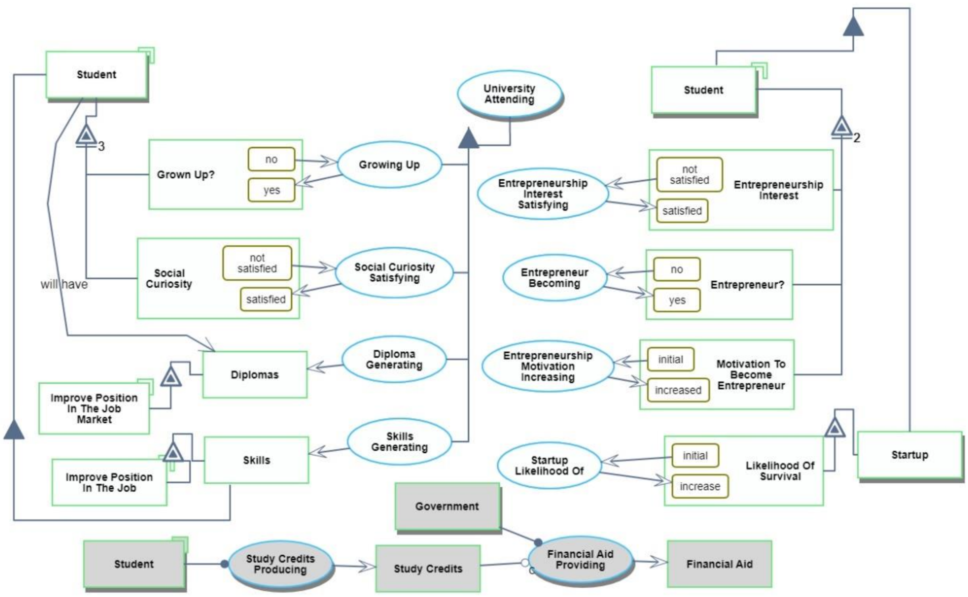

Figure 5.8: System diagram based on student stakeholders' expectations.

Figure 5.9 represents the expectations of an academic stakeholder as an OPM diagram. “Funding” was modelled as an informatical object that was yielded by the “funding acquiring process”.

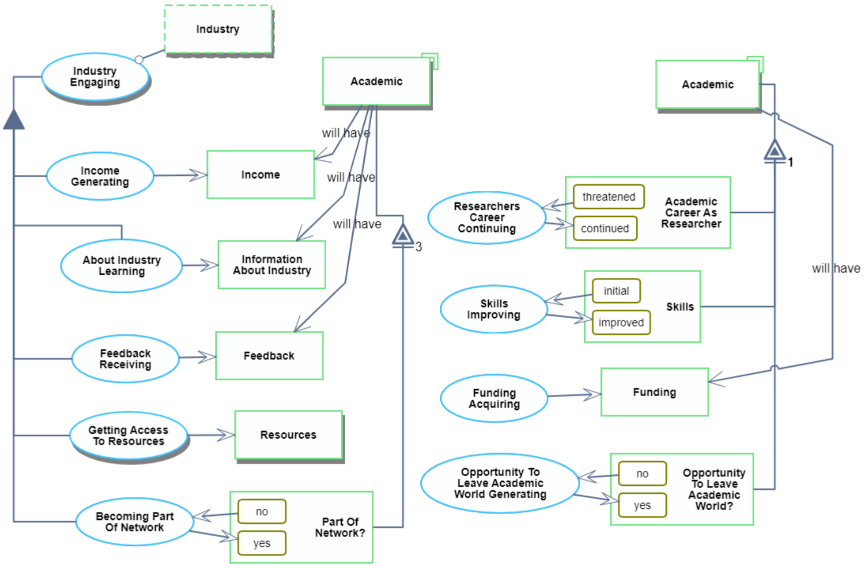

Figure 5.9: System diagram of academic stakeholders' expectations.

Figure 5.10 shows the system diagram that resulted from the conversion of entrepreneur stakeholders' expectations to OPM. Already for this diagram, many specific functions were classified under the general "Running a Business" function. Operands range from income to experienced pleasure from work, which was modelled as an attribute of the stakeholder.

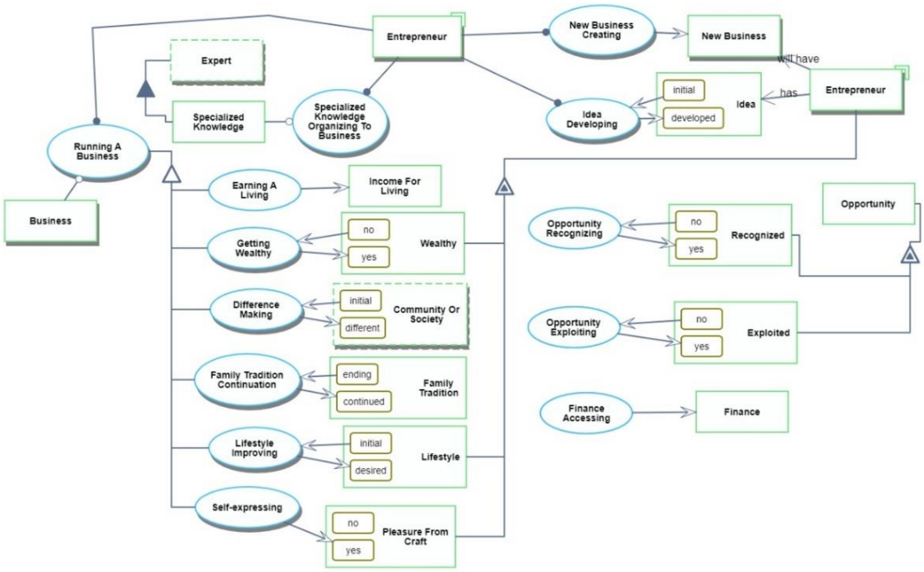

Figure 5.10: System diagram of entrepreneur stakeholders' expectations

In Figure 5.11, the expectations of startups have of accelerators was modelled. This diagram will later become important as it differentiates between the process of starting up and the process of speeding, which changes the speed of the starting up process. In other words, the speeding process has a control-relationship with the starting up process. The diagram also differentiates between two sub-processes of the starting up process: profitability finding, and scalability finding.

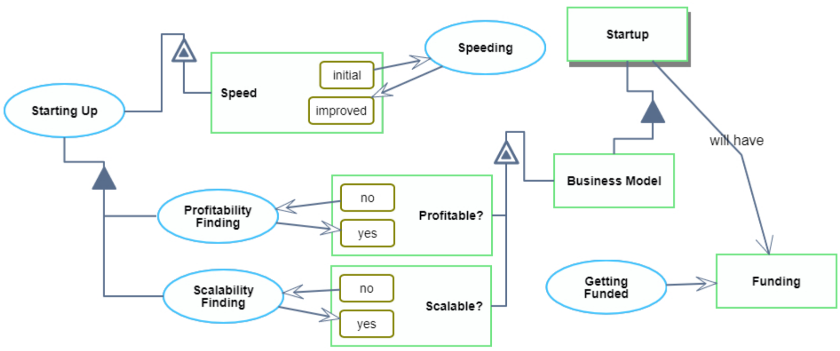

Figure 5.11: System diagram of startup stakeholders' expectations.

As the last diagram of the participant stakeholder category, the business stakeholder type was modelled. Figure 5.12 shows the results of this modelling step. It includes a lot of operands and transformations that past research has seen as something businesses value, especially in their relationship with universities. The diagram includes two general processes: incubator participating and university cooperating, that have several specialized processes categorized under them.

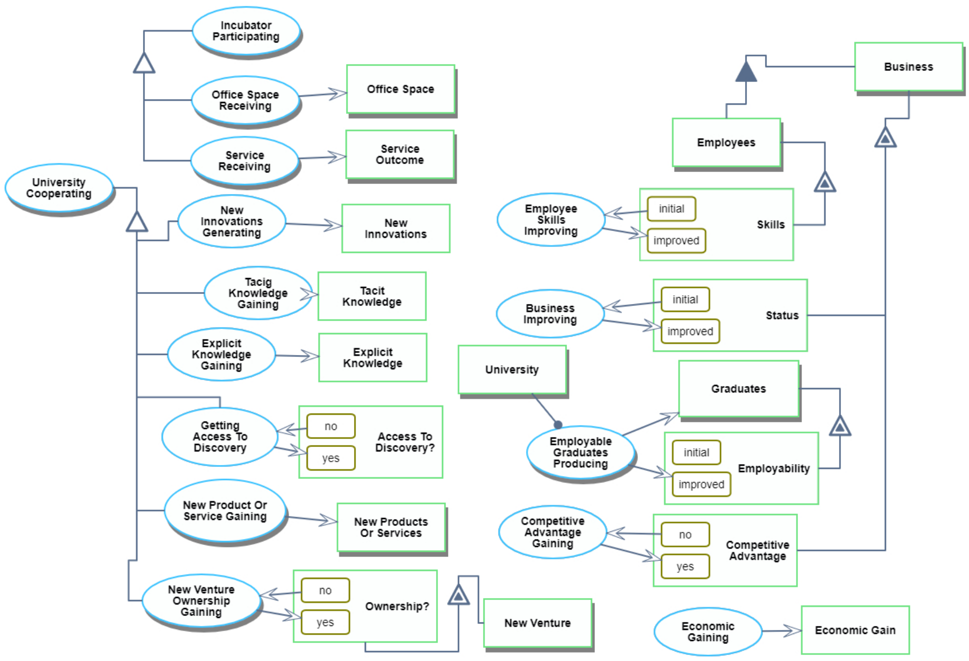

Figure 5.12: System diagram of business stakeholders' expectations.

Sponsor stakeholders

In Figure 5.13, the expectations of university stakeholder type are modelled. It includes processes that are connected to university funding. The first one is the process wherein alumni, after becoming successful, donate to universities. The second, visualized with gray color, is the Finnish funding model in which the government provides funding based on study results as measured by the number of graduates and credits.

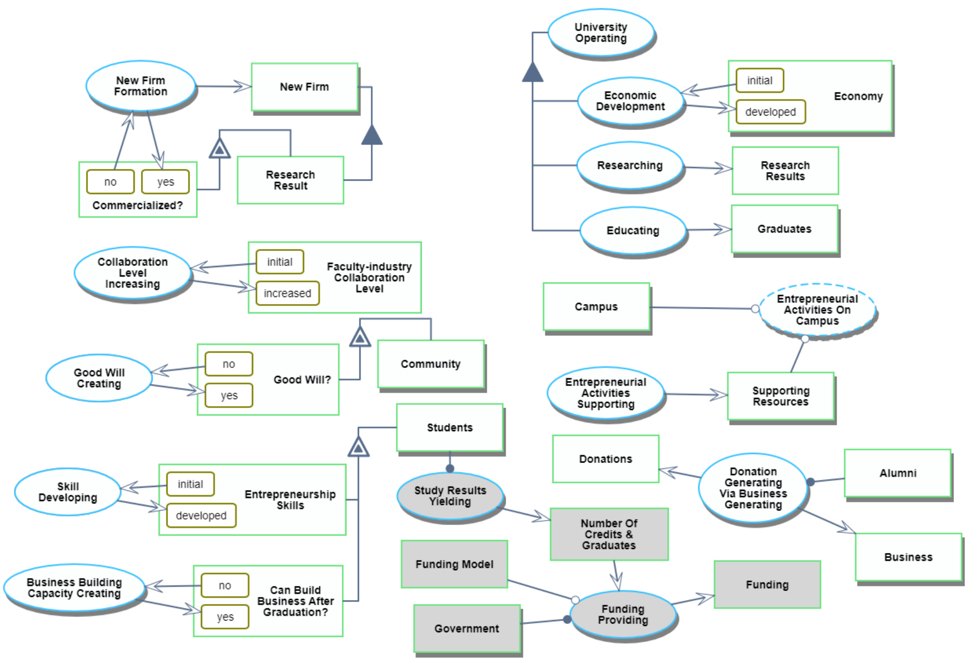

Figure 5.13: System diagram of university stakeholders' expectations.

Figure 5.14 shows how the government stakeholders’ expectations are modelled. A point of note is how the economy and related attributes standout as the operand for government stakeholders.

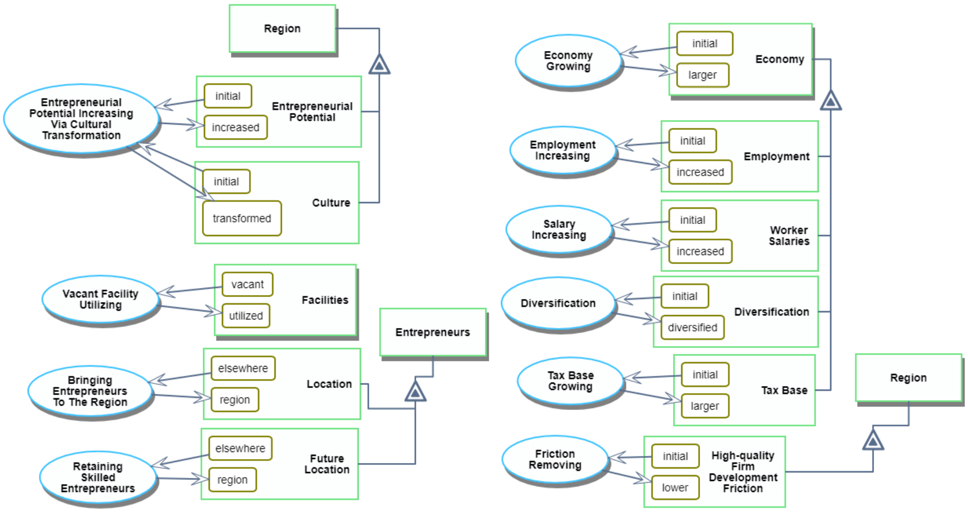

Figure 5.14: System diagram of government stakeholders' expectations.

Figure 5.15 includes system diagrams of corporation and science park stakeholder expectations. For both stakeholders, real estate appreciation stands out as one of the motivations.

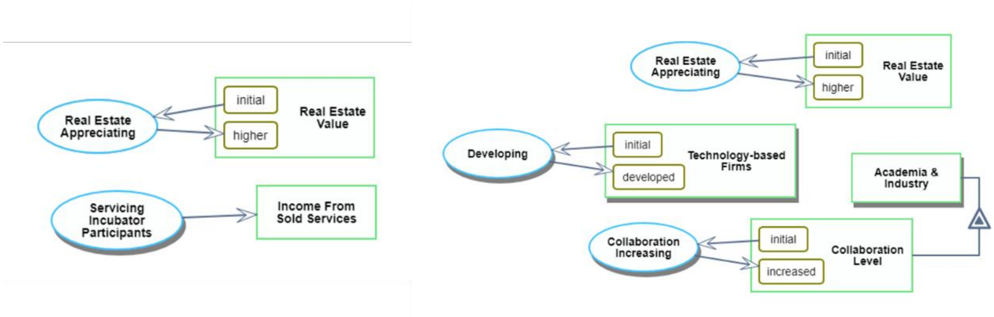

Figure 5.15: System diagrams of corporation and science park stakeholders' expectations.

Figure 5.16 shows the system diagram based on investor stakeholders’ expectations including university-based VC-funds.

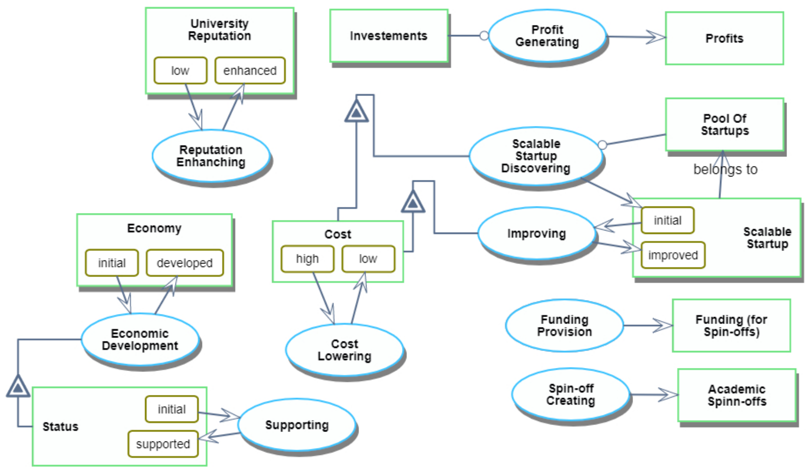

Figure 5.16: System diagram of investor stakeholders' expectations.

Partner stakeholders

Figure 5.17 shows OPM models based on incubator, mentor, expert, and manager stakeholder expectations. Besides experts, the other three stakeholder types have at least partly altruistic or community-related motivations or purpose.

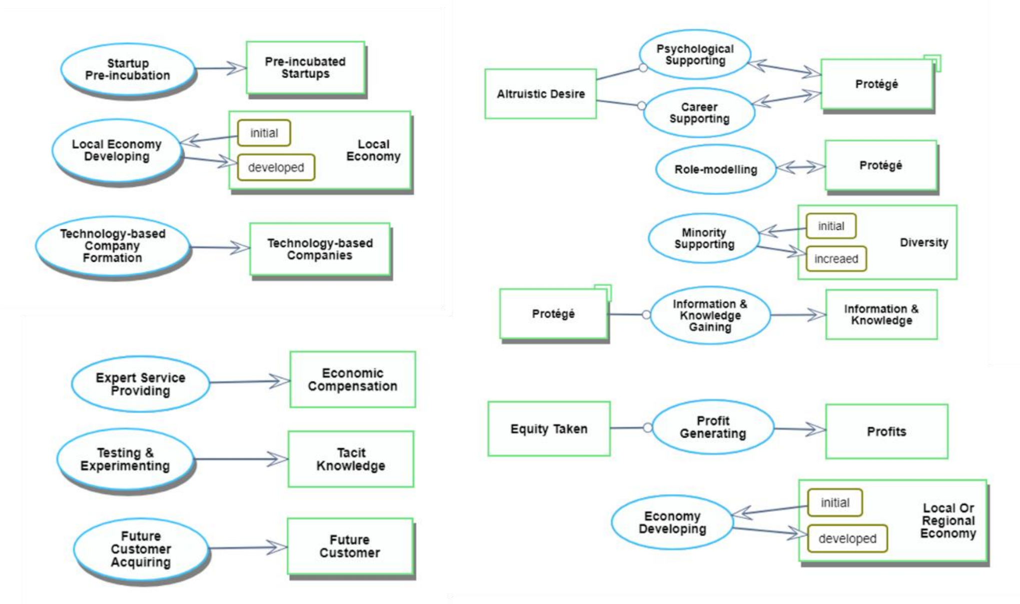

Figure 5.17: System diagrams of incubator (top left), mentor (top right), expert (bottom left) and manager (bottom right) stakeholders' expectations.

Finally, Figure 5.18 shows the systems diagrams that were created based on the expectations of TTO, educator, and user stakeholders.

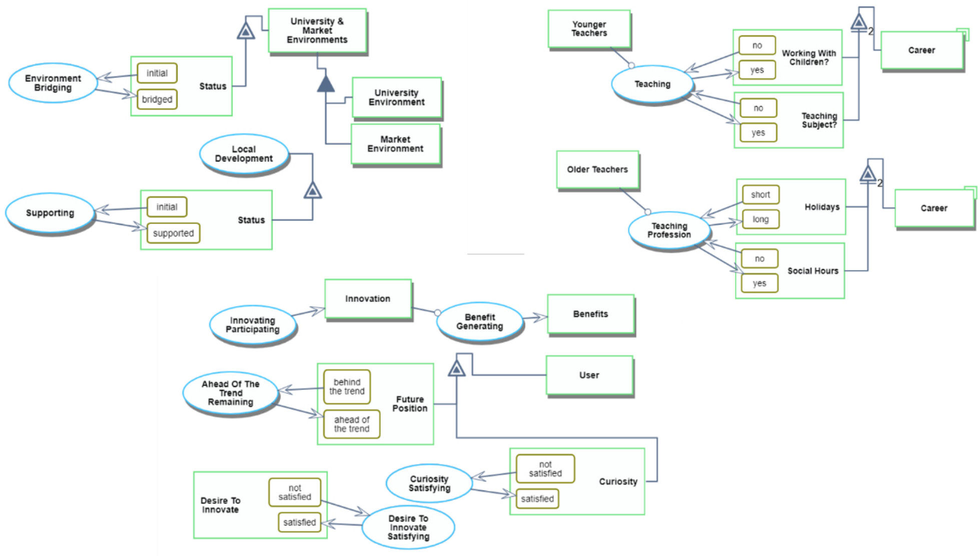

Figure 5.18: System diagrams based on TTO, educator, and user stakeholders' expectations.

5.2.2 Business operating function

After implementing the first step in the functional analysis process, the move to the classification step was done. In this step, the 17 new diagrams from the previous step were used as well as the diagrams created during the stakeholder analysis stage and the diagrams created during the literature review stages of this dissertation.

As described in chapter 4, the fundamental structural relationships in object-process methodology were used to develop three distinctive high-level functions, or functional categories. In this and the following sub-sections, the details of each main function are explained.

The first major functional category or main function interpreted, or induced, from the non-categorized stakeholder models is called business operating.

Figure 5.19 and Figure 5.20 show how the business operating function emerged as a result of the classification process. In Figure 5.19, the main system is referred to with the title Business Operating System and the main function is called Business Operating. Based on the simpler models, at least six types of actors were classified as business operating systems: academic, corporation, business, entrepreneur, science park, and expert.

The classification was based on earlier modelling results: these actors were enabling or handling at least one of the processes classified under business operating process. The business operating process includes three sub-processes: profit generating, income generating, and value bringing. Each of these sub-processes are abstractions of the specific processes classified under them. For example, profit generating is a generalization of the economic gaining, profit generating, income generating, and getting wealthy processes. Value bringing is a process that signifies the value delivered to the beneficiary of the business operating process, that is the customer. The generalization-specialization relationship signifies that the specific versions of the process share all the attributes of the general version of the process (Dori, 2016). Using this logic, office space renting and serving incubator participants can be parts of both benefit generating and difference making processes.

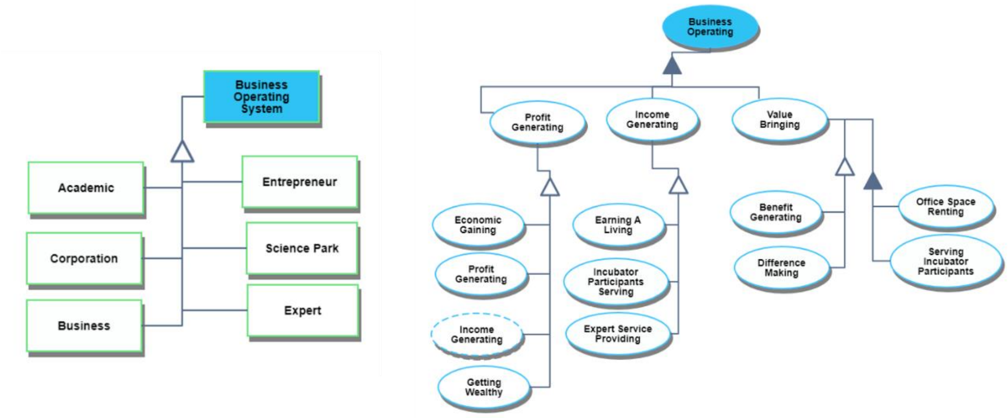

Figure 5.19: Main system and main process classifications of the business operating function.

In Figure 5.20, the classification diagrams of the operand and beneficiaries of the business operating functions based on earlier models are presented. Each of the operand objects or related attributes are linked to at least one process shown in Figure 5.19.

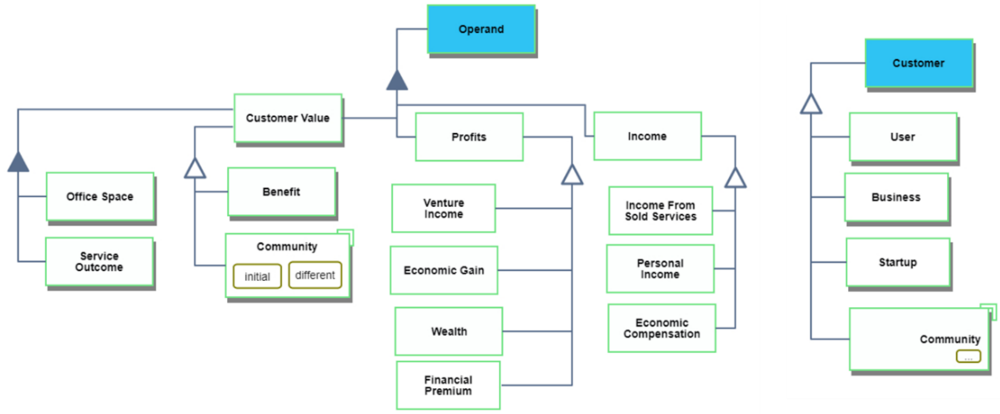

Figure 5.20: Operand and beneficiary classifications of the business operating function.

Formal definition

As a result of the classification step, it was possible to develop a formal definition of the business operating function which is represented in Figure 5.21 using OPM symbols.

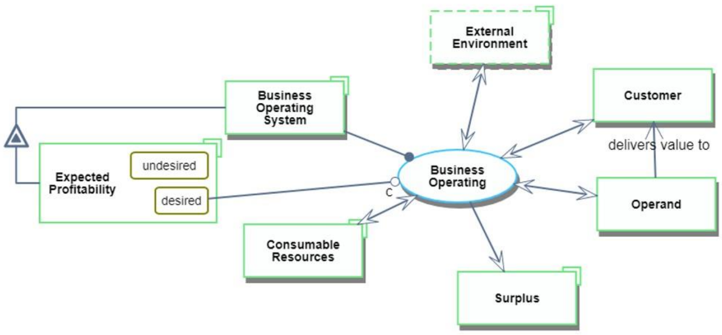

Figure 5.21: Formal OPM definition of a business operating system and business operating function.

The main function of the business operating system is to affect the operand in such a way that value is delivered to customer in a process called business operating. These elements correspond with the customer value object in Figure 5.20 and the value bringing process in Figure 5.19. For example, the renting of office space (operand) by a science park (business operating system) to more established startups (customer) would be an example of an entrepreneurship program fitting this definition.

In the definition, the value of the expected profitability attribute of the business operating system is “desired”. The word “expected” means that the business owners assume that the business produces the required profits within the time-horizon defined by the owners. The word “desired” symbolizes the subjectivity of the issue in the sense that it is the owner who defines the profits they require and the time-horizon for it. This distinction and attribute are important for understanding the business developing process (in the next section).

Another key element of the definition of the business operating process is that it generates surpluses. This is important as the higher-level processes do not generate surpluses, they require them for their operations. Surplus equals profits in Figure 5.20. Likewise, the income object in Figure 5.20 is a specialized version of the consumable resources object in Figure 5.20. Consumable resources signify the input resources the business operating process needs for its operation. In OPM, an object that is consumed, or the initial state of a transformed object, can be seen as an input (Dori, 2016). External environment object in Figure 5.21 refers to the specific environmental conditions such as market competition the business operating system is exposed to. According to Dori in OPM “The system’s environment is a collection of things that are outside the system but interact with it” (Dori, 2016, p. 90).

Internal structure of the business operating system

An implicit or explicit part of a business is the business plan, which defines the business model including key processes, resources, value proposition, and customer segments (Osterwalder & Pigneur, 2010), along with all predictable plans of growth via investments and similar that are expected to be profitable.

In Figure 5.22, how a business operating system can be seen in an abstract sense consisting of two elements has been visualized. Business operating resources are the physical resources such as people and equipment, while the business plan is an informatical resource. The business plan represents implicit and explicit knowledge and information that guide the business operating process. In Figure 5.22, the same decomposition of business developing system and business meta-developing system is presented and discussed in detail after this section.

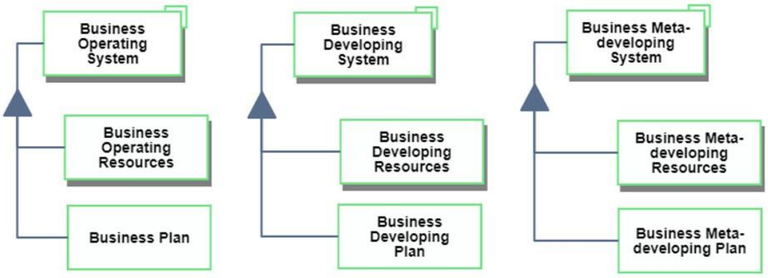

Figure 5.22: Fundamental physical and informatical components of business operating, business developing and business meta-developing systems.

5.2.3 Business developing function

In this section, the second major recognized function, business developing as a result of the classification process is presented. Figure 5.23 show how selected parts of the simple diagrams produced in the earlier stages of this dissertation can be classified under the business developing process. Unlike with business operating process, the classification diagram for the business developing system itself was not explicitly created, as almost all stakeholder types can be classified as business developing systems based on stakeholder literature.

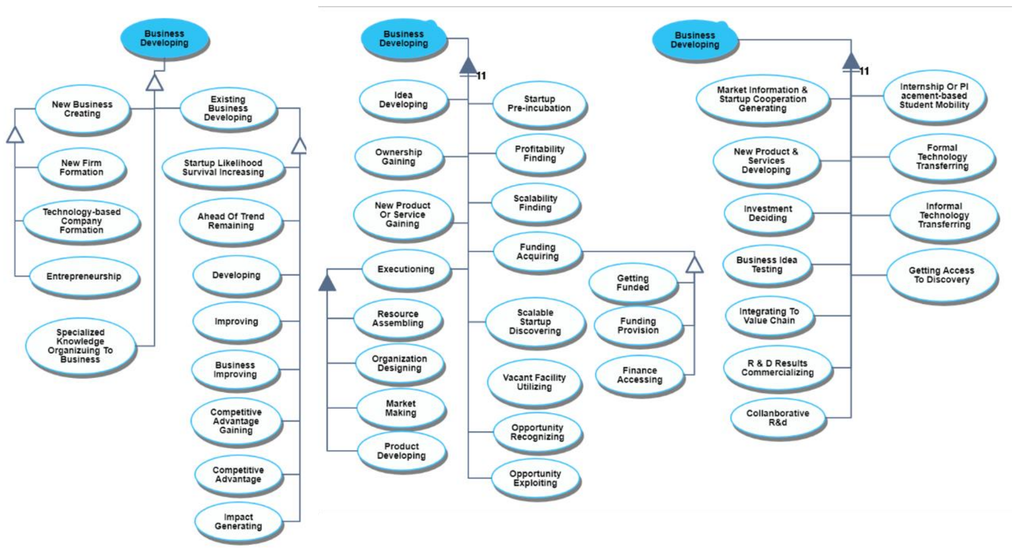

Figure 5.23: Main process classification of the business operating function.

In the left part of Figure 5.23, the business developing process is divided into two major categories: new business creating and existing business developing. Both of these process sub-categories were expressed in various ways in the earlier modelling steps based on the literature. These expressions included terms such as new firm formation and technology-based company formation, or developing and competitive advantage gaining. In the middle and left of the figure are branching representations of the sub-processes of the business developing process. These include processes such as opportunity recognizing, business idea testing, collaborative R & D, and funding acquiring.

Figure 5.24 represents the operand object, its value bringing attributes, and its sub-components. The operand of the business developing process is a business or using the earlier definition, a business operating system. Thus, a new company or an existing company are types of operands that are affected by the business developing system. Accordingly, the simpler models had many attribute objects that could be classified as attributes of the operand. These included attributes such as likelihood of survival, profitability, and venture stage. Finally, the right-most diagram in Figure 5.24 shows the objects from simpler diagrams that were classified as components or parts of the operand (i.e. business operating system). This classification is partially based on the abstract classification of the business operating system's structure in Figure 5.22. Here, idea, innovation and technology license agreement belong to the informatical part of the business operating system (or the business plan), and for example employees, entrepreneur, and value chain belong to the physical part of the business operating system.

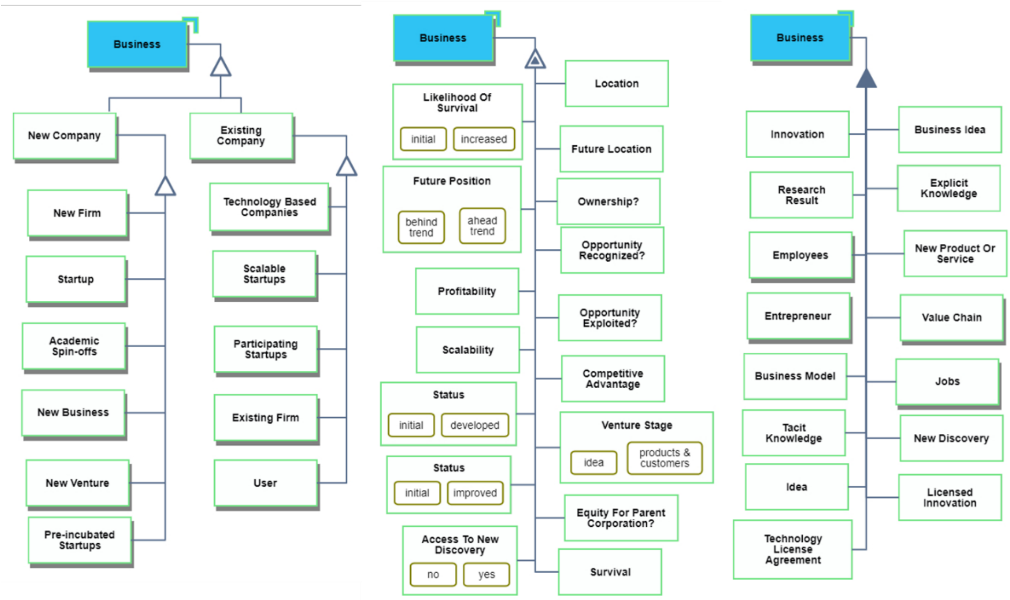

Figure 5.24: Operand and beneficiary classifications of the business developing function.

Formal definition of a business developing function

As a result of everything being brought together from Figure 5.23 and Figure 5.24, the following formal definition of the business developing function an entrepreneurship program can have was induced (see Figure 5.25).

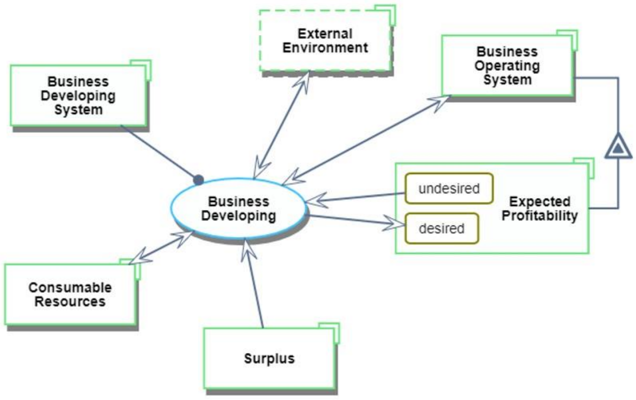

Figure 5.25: Definition of the business developing function of the business developing system.

The main function of the business developing system is to transform the expected profitability attribute of the business operating system (a business) from undesired state to a desired state. Using the classification in Figure 5.24, we can see that the definition also includes the development and creation of new firms. For example, a simple business idea with high uncertainty can be abstractly seen as a business operating system in a very undesired state of expected profitability.

A key distinction of business operating process is that the business developing process consumes surpluses. In other words, business operating system needs an input of external resources in order for it to be operational. Fund acquiring from Figure 5.24, can be seen as a sub-process that is related to acquiring surplus financial resources. The surpluses are then consumed by converting them to various consumable resources such as salaries or material expenditures.

5.2.4 Business meta-developing function

In Figure 5.26, the results of classifying selected elements from the simpler diagrams as meta-developing systems or as meta-developing processes are shown. In this classification, in many cases entrepreneurship education is classified as a meta-developing process (i.e. a process that improves the developing process because it increases the entrepreneurial skills). Other terms, used in the simpler diagrams and which were classified as meta-developing processes are, for example, entrepreneur becoming, business building capacity creating and knowledge absorbing.

Specific systems that were enabling these processes and as such could be classified as meta-developing systems were, for example, accelerator, university, and entrepreneurship education program. In the diagram, absorptive capacity is defined as an attribute of the meta-developing system as, according to Eckermann et al. (2020), knowledge absorption taking place within an accelerator improves its performance (i.e. its business developing ability).

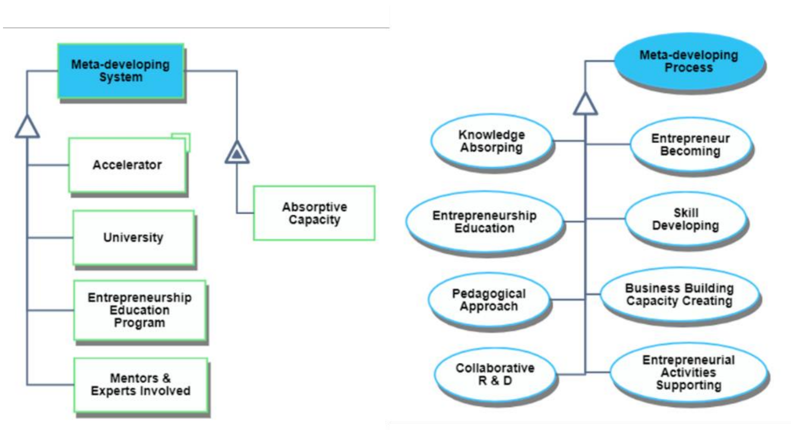

Figure 5.26: Definition of a meta-developing system and meta-developing function.

Objects, processes, and attributes classified as the operand of the meta-developing processes are shown in Figure 5.27. The operand is actually the business developing system, or the business developing process, which was defined in the previous section. What meta-developing does is transform the system or the process as defined by the attributes such as competitiveness, cost of making an investment decision, and speed (of the business developing process). Examples of the business developing system that is transformed by the meta-developing process are accelerator, academics, supporting resources etc. objects that are specialized versions of the business developing system.

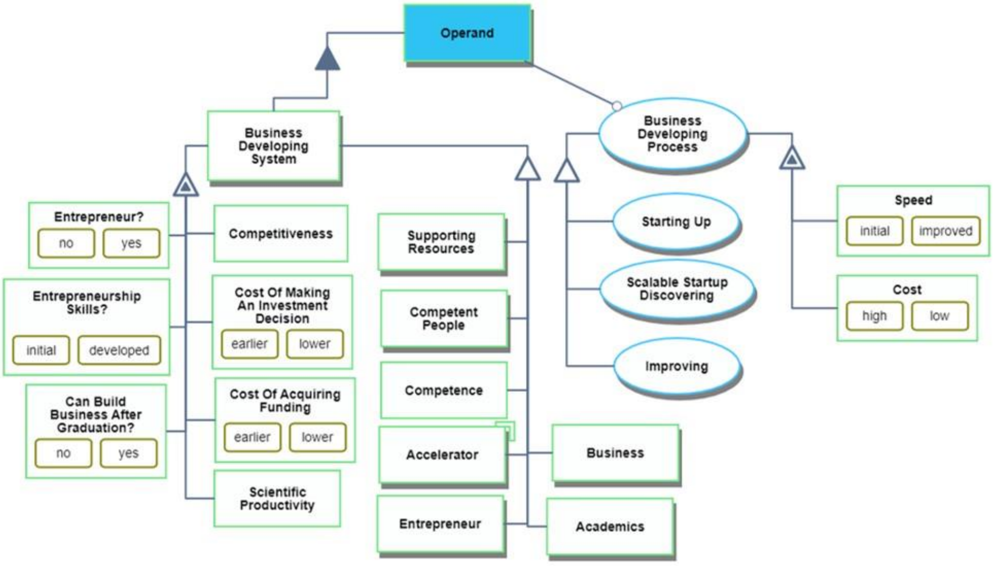

Figure 5.27: The operand of the meta-developing process.

Formal definition of the meta-developing function

As a result of the classification steps shown in Figure 5.26 and Figure 5.27, it was possible to create a formal definition of the meta-developing function, which is shown in Figure 5.28.

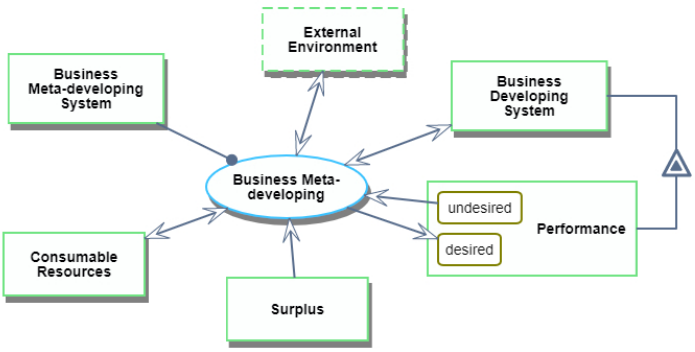

Figure 5.28: Definition of a meta-developing system and meta-developing function.

The main function of the business meta-developing system is to affect a business developing system by transforming its performance attribute from an undesired state to a desired state. In other words, meta-developing is about improving business developing systems and processes. For example, when a startup enters an accelerator and, as a result, learns and improves its internal developing processes such as by adopting the lean startup approach (Ries, 2011), a meta-developing process has taken place. An example of an externally implemented meta-developing process step is in a research paper by Belt et al. (2009), who compared existing product development practices of ICT companies to Toyota new product development principles, and thus suggested improvement on the ICT companies' processes. A meta-developing process is similar in nature to a business-developing process in that it is also dependent on surplus resources generated by the business operating processes.

5.2.5 Relationship modelling of main functions

In this final step of the identification of entrepreneurship programs' main functions, the relationships between the three main functions were studied. Figure 5.29 shows an insight that emerged during the previous modelling step; how entrepreneurship program is an entrepreneuring system. The main function of an entrepreneuring system is entrepreneuring, which, as a process, is divided into three sub-processes: business operating, business developing, and business meta-developing. The corresponding sub-systems of an entrepreneuring system are the business operating system, business developing system, and business meta-developing system. An important detail in this model is that entrepreneur and entrepreneurship programs are both classified as specialized versions of the entrepreneuring system. Thus, the definitions of each sub-system are applicable for both organized programs and individual entrepreneurs operating alone.

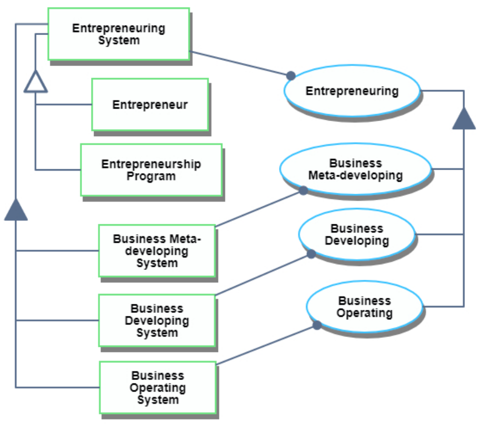

Figure 5.29: Three main functions of an entrepreneurship program.

Hierarchical control-relationship

In the second step of studying the relationships between the three functions, the OPM-based definitions of each function were used and the model presented in Figure 5.30 was produced. At this level of detail, we see how the business operating system is the operand of the business developing process and that the business developing system is the operand of the meta-developing system.

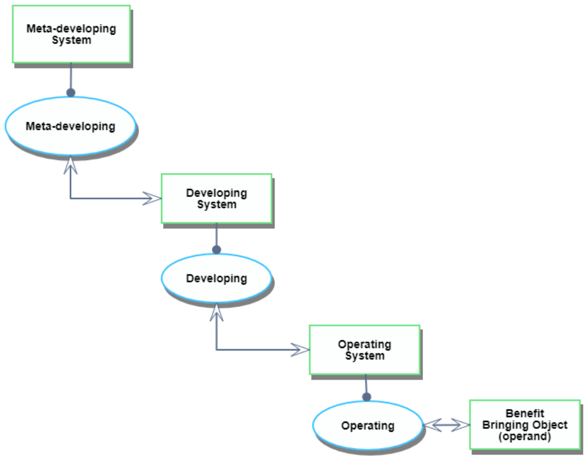

Figure 5.30: Hierarchical control-relationships between the three entrepreneurship program functions.

Heylighen (2011) defines control or regulation as:

> …the process by which an agent continually neutralizes deviations from its goals, by effectively counteracting disturbances [Heylighen & Joslyn, 2001]. Regulation implements negative feedback: deviations in one direction are compensated by reactions that push the state in the opposite direction, so as to reduce their effect (Heylighen, 2011, p. 26)

From this perspective and based on model in Figure 5.30, the relationship could be classified as a control-relationship in the sense that the higher-level systems control the lower-level systems.

Detailed model of relationships

Figure 5.31 shows a detailed model of the relationships between the three functions that emerged by combining the three defining models of each function.

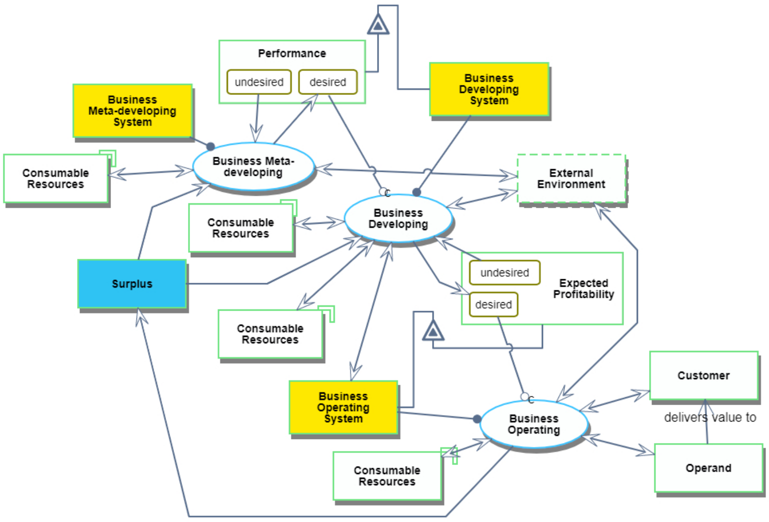

Figure 5.31: Detailed model of relationships between the three functions.

Besides the control-like relationship visualized in Figure 5.30, the abstracted systems responsible for each of the functions also interact via the surplus object. Specifically, the business operating process yields the surpluses that are then consumed by business developing and the business meta-developing processes.

5.2.6 Decomposed model

After the initial step of functional analysis, which yielded the results described above, functional decomposition was implemented as the next step. Figure 5.32 captures the main results of the functional decomposition process using the unfolding mechanism of OPM. Unfolding is a mechanism where the *refinees* of a *refineable* are presented using the one of the structural relationship-links (Dori, 2016). In this case the refineables are the main system and processing process, while the refinees are the three sub-systems and sub-functions. In Figure 5.32, the main system object and main processing process are placeholders for any of the main functions and corresponding systems.

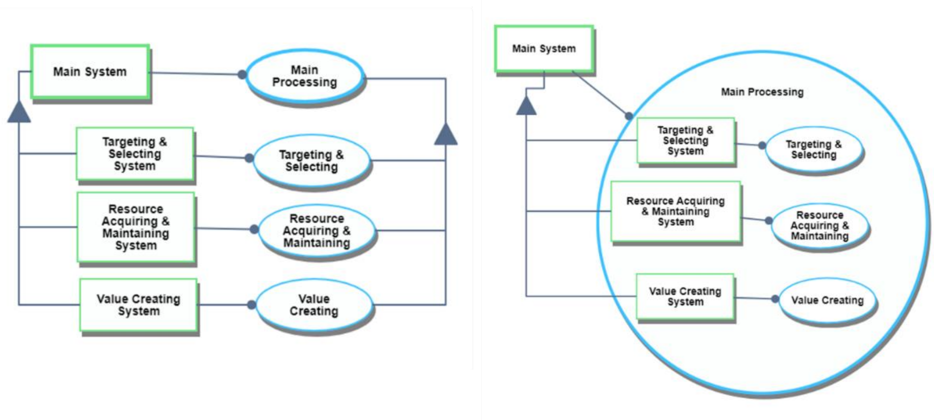

Figure 5.32: Sub-systems and sub-functions

The main function, whether it is business operating, business developing, or business meta-developing, has three sub-functions: value creating, targeting and selecting, and resource acquiring and maintaining. There are corresponding sub-systems that handle these sub-functions. In the following three sections, how each of these sub-functions were deduced from fundamental definitions of our framework is described.

Value creating

The value creating process is defined as the process that actually transforms the operand (i.e. the object that is associated with the value) in a way that is valuable to the beneficiary (e.g. customer). This definition is aligned with the definition of value creating process in OPM (Dori, 2019). It corresponds with the satisfaction of the main functional requirement of the system (NASA, 2017; de Weck, 2015b). Value creating's relationship to other two sub-processes is that the resources acquired and maintained by the resource acquisition and maintaining process are transformed or consumed by the value creating process, or they enable or handle the value creating process. The targeting and selecting process triggers the value creating process when the right conditions are met.

Figure 5.33 was created as a result of utilizing the fundamental definitions. It is a system diagram of a universal value creating process, where this process transforms the operand. Also visualized in the diagram is an external problem occurring process, which in an abstract sense is responsible for the initial state of the operand (Dori, 2019). The difference between the initial state and goal state can be called the need,the problem or a challenge (Heylighen, 2011). The value creating system is a subsystem of the main system, which can be the business operating system, for example.

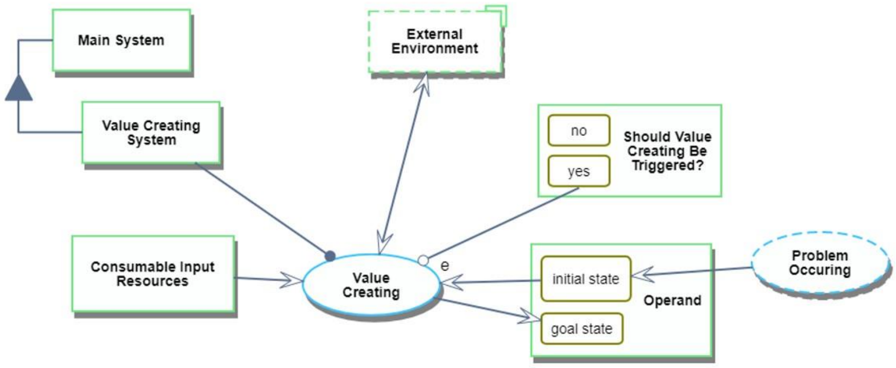

Figure 5.33: Definition of a value creating process.

A baker is a simple example. The act of baking bread from ingredients and then handing it to a customer is an example of value creating.

Targeting and selecting

Targeting and selecting is the process of choosing when, where, and for whom to implement the main value generating process so that it will be effective and efficient. Targeting and selecting triggers the actual value creating process. In OPM, triggering is handled by agents or triggering events which correspond with the correct input conditions for the actual process to be triggered (Dori, 2016). Fundamentally, all processes or behaviors have triggering conditions (Bar-Yam, 1997). This means that in the most abstract sense, the name of this sub-process should be Value Creating Process Triggering Deciding, which in simple terms means that the function of this sub-process is to make a decision about whether the value creating system should be triggered or not. However, as the name above is somewhat cumbersome, the choice was made to simply call it Targeting and Selecting.

Figure 5.34 illustrates this process name simplification with a white structural triangle, which is a specialization structural link. It reads: Targeting and Selecting *is* Value Creating Process Triggering and Deciding. All the links and attributes that apply to the more abstract version of the process apply also to the specialized version (Dori, 2016). In Figure 5.34, the targeting and selecting process sets the state of “should value creating be triggered?” to “no” or “yes” based on the internal state of the main system and the external state of the external system.

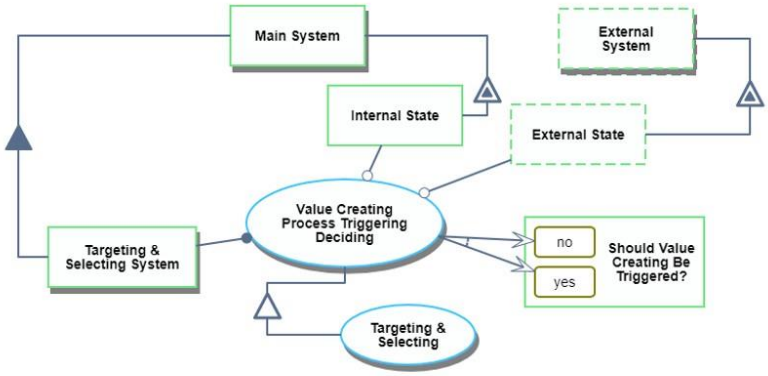

Figure 5.34: Definition of targeting and selecting sub-function.

A baker can again be thought of as an example. Whether or not the baker starts baking depends on whether there has been an order and the baker has the correct ingredients and skills to fulfil that order. Making this decision is a targeting and selecting sub-process.

Resource acquiring and maintaining

Resource acquiring and maintaining is the process of acquiring the inputs a process needs in its value delivering process, and acquiring and maintaining the resources or assets that enable the value delivering and other sub-processes to take place. This is in line with fundamental definitions of a system, which state that sub-systems of systems include “support elements” (Walden et al., 2015) or that systems are “The end product (which performs operational functions) and enabling products (which provide life-cycle support services to the operational end products) that make up a system” (NASA, 2017, p. 192).

As an example, at the level of business operating, a café needs to acquire coffee beans, water, and electricity as inputs, and maintain its coffee maker in good working condition and maintain the group of employees working at the café. The resource acquiring and maintaining process accomplishes this by charging the customer and covering the costs with the revenue.

In OPM, objects that enable or handle processes are those that need to be maintained, while objects that are consumed or transformed are the inputs that need to be acquired. All tasks need the required tools and resources to be acquired in order for the processes to take place (Bettencourt & Ullwick, 2008). Resources are also key element in business model models such as the business model canvas (Osterwalder & Pigneur, 2010) and the four-element business model by Christensen et al. (Christensen et al., 2016). In Adam Smith’s Wealth of Nations (1776), the definition of capital corresponds with the definition of resources here. Some capital is fixed , such as tools and equipment, while some is circulating, like the input of production that get consumed.

Figure 5.35 shows the definition of a general resource acquiring and maintaining process that is handled by the resources acquiring and maintaining system, which is part of the main system (e.g. business developing). What the resource acquiring and maintaining does is change the state of the status attribute of the main system from depreciated to operational, and it generates the resources that are consumed by the consuming process. This process is an abstraction of all the processes under the main system that consume resources. An abstract external process called depreciating changes the status attribute from operational to depreciated. For example, employee turnover or equipment wear are examples of a depreciating process. The depreciated state is an event that triggers resource acquiring and maintaining processes, as does the consuming process. In the latter case, the consuming process evokes (i.e. triggers, noted with a jagged arrow) resource acquiring and maintaining directly.

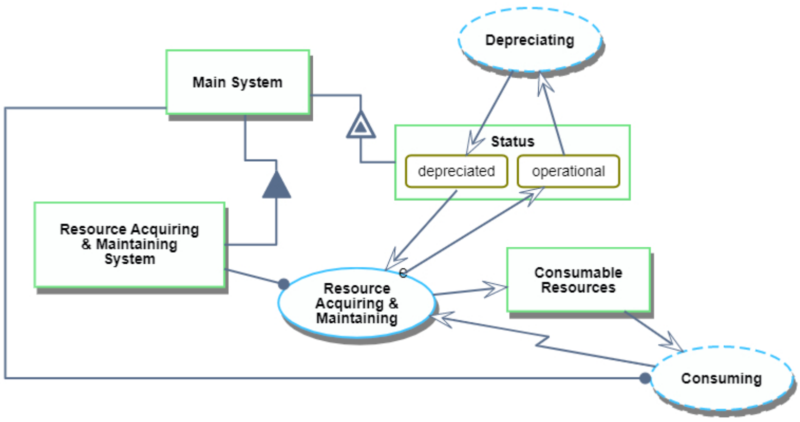

Figure 5.35: Definition of a resource acquiring and maintaining sub-function.

Depreciation is explicitly included in economic models (Liberto, 2019) and is also a key concept in accounting where is reflects the de-valuing of equipment and infrastructure (Tuovila, 2020). Next, the results of the next step in functional decomposition will be described: evaluating sub-functions for each main function type. This will be done by dedicating one section to each sub-function.

5.2.7 Value creating sub-function

Value creating and business operating

At the level of business operating, value creating is what business is all about. A manufacturer of tables converts boards and screws and varnish into tables. A massager manipulates a customer’s body so that targeted muscles relax and they experience a lessening of pain. When the benefits to the customer are valuable enough so that it matches the price the customer has to pay, and said the price is high enough for profitability given enough customers, we have a business. The outcome of the value creating process is also captured in the customer need part of the value proposition concept (Carlson, 2006). As form and function are separate, the number of possible value creating processes is defined by the number of needs that exist and the unique ways each specific value can be delivered.

Figure 5.36 is a general representation of a value creating process as a sub-process of business operating. It was decided to call the process Producing, which in this example creates a product. The customer handles need satisfying, which is enabled by the product. If the business would be a service, then the need would be transformed directly by the producing process. These definitions are in line with general definitions of product and service in OPM (Dori, 2016).

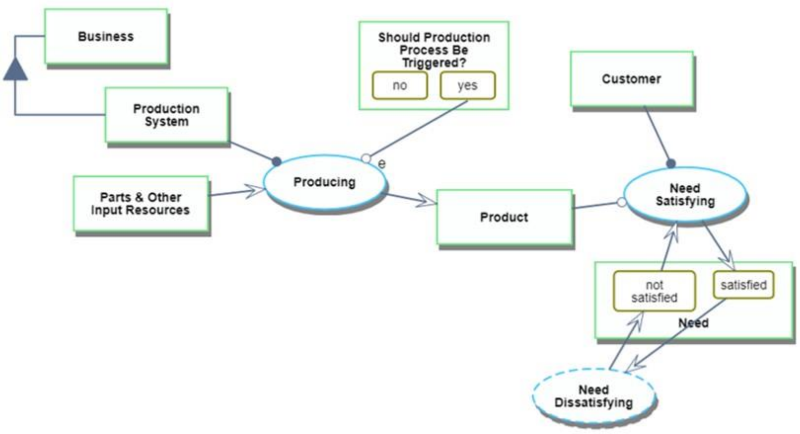

Figure 5.36: Value creating as a sub-process of business operating.

Value creating and business developing

Value creating as part of a business developing process is about creating a business with predictable profitability. Referring to earlier results, many formal and informal approaches and methods of value creating at this level exists, such as lean startup (Ries, 2011), lean manufacturing (Bicheno & Holweg, 2016), outcome-driven innovation (Ullwick, 2005), and discovery-driven planning (McGrath & MacMillan, 1995).

Figure 5.37 represents the value creating process as a sub-process of a business developing process. Here in the operand is the business operating system and its expected profitability attribute, which is transformed by the profitable business creating (i.e. value creating) process from undesired to desired. Prototype components are an example of resources consumed by the creating process in profitable business. In a broader sense, profitable business creating achieves its function by affecting the business operating system and the external (market) environment.

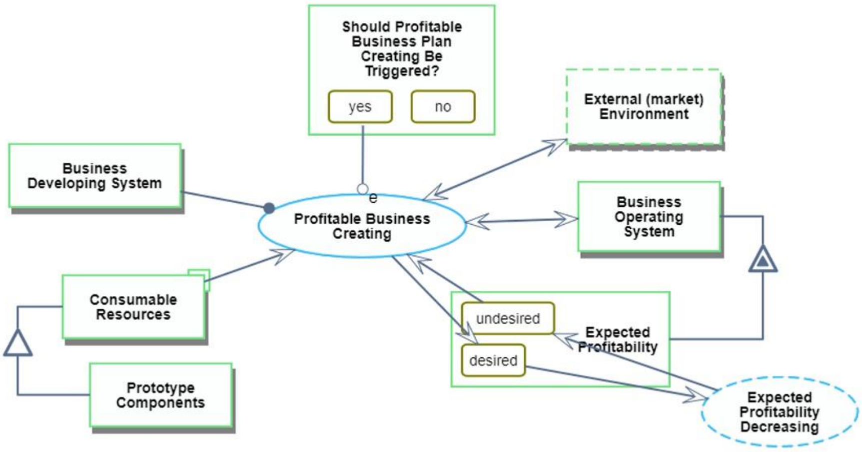

Figure 5.37: Value creating as a sub-process of a business developing process.

Value creating and business meta-developing

As a sub-process of a business meta-developing process, value creating transforms an existing and poorly performing developing process into an improved version. We can imagine an incubator, which helps each of its customer startups to create a circumstance-specific innovation and development strategy. An idea for a new ice cream kiosk and a project to develop a new kind of an ultra-light airplane need different types of development processes to be effective. The field of innovation management studies the art of choosing an optimal innovation management approach (Karlsson & Magnusson, 2019). In a similar way, a university could contribute to the development of a partner company's R&D strategy on the basis of its expertise and facilities.

Figure 5.38 shows value creating as a sub-process of business meta-developing. Here in the operand is the business developing system and its performance attribute, which is transformed from undesired to desired by the "business developing system improving" process. This process is handled by the system of the same name, also known as the meta-developing system. It is not visualized in the diagram, but it can be understood in an abstract sense, that the business developing system consists of both physical resources such as people, and informatical resources such as the (implicit) understanding of how to do business developing as shown in Figure 5.22. Performance lowering is a process that transforms the performance from desired to undesired. We can imagine this happening as a result of the business developing process weakening, or as the business developing process remaining the same physically but demands of performance growing

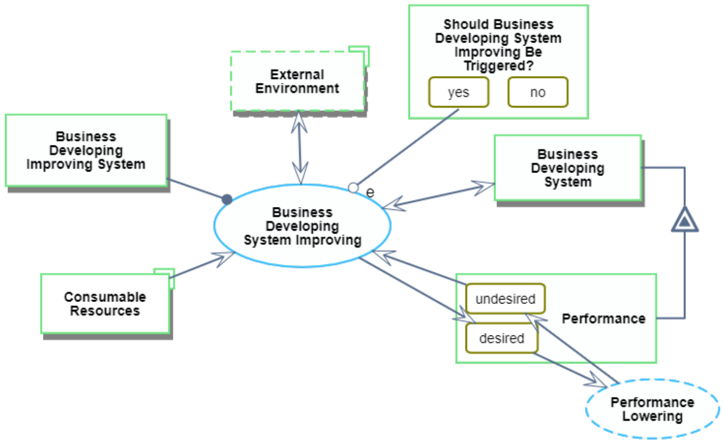

Figure 5.38: Value creating as a sub-process of business meta-developing.

5.2.8 Targeting and selecting sub-function

Now, the results of what is the role of targeting and selecting sub-process in delivering the main functions of operating, developing, and meta-developing are presented. Figure 5.39 illustrates how, at each level, a more common or intuitive name was over the abstracted title of the function from the perspective of the entrepreneur. Normally in systems engineering, the function's title is written from the perspective of the beneficiary in the sense that the process title reflects the transformation of the operand (Dori, 2016). For example, for the business operating process, instead of using the title of Production Process Triggering Deciding process, it was called the process Sales and Marketing.

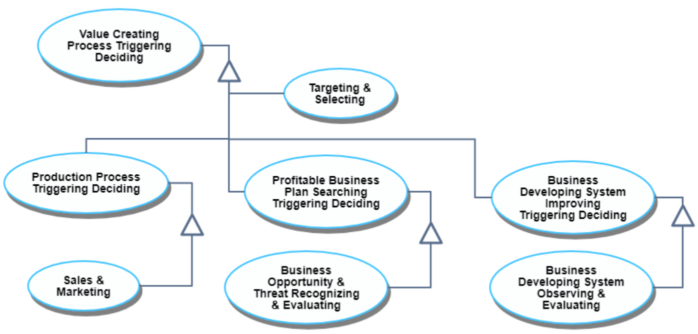

Figure 5.39: Targeting and selecting as a sub-process of the three main functions.

Targeting and selecting and business operating

As a sub-process of business operating, this sub-process is best captured by marketing and sales activities. The purpose of actions in these early sales channel activities is to make the customers aware of the product and help them to evaluate whether to buy or not (Osterwalder & Pigneur, 2010). In this sense, the targeting and selecting is a process involving both parties; the company, which provides information about the product, and the customer, who evaluate whether enough value will be generated.

Christensen et al. (2016) write that it is in companies' interests to serve only customers who actually benefit from the offering, as misplaced purchases can be harmful to the customer and result in poor reputation for the company. In the natural world, an animal has the ability to recognize what plants or other animals it can eat. A tree can sense light and moisture and direct the growth of leaves and roots. A molecule can "sense" when there is a "right" other chemical and a chemical reaction takes place. In object-process methodology (OPM), targeting and selecting corresponds with the conditions required by the process to take place (e.g. state specified enabling or consumption links).

Figure 5.40 shows the targeting and selecting (i.e. sales and marketing) process as a sub-process of business operating. Production readiness and "state of the customer" influence the result of the sales and marketing process. As an example, the state of the customer is divided in to three parts: need, awareness, and value. "Need" refers to the existence of an actual customer need. If there is no need, customer won't buy (Anthony, 2014). "Awareness" refers to the whether or not customer is aware or not of the offering of the business. If we would look closer at sales and marketing, we would see that it affects the state of the awareness. If a potential customer is not aware of the product, it cannot buy it (Osterwalder & Pigneur, 2010). Finally, whether the offering is value producing relative to the competition for the customer affects the end result of sales and marketing. "Value" in here refers to whether or not the costs are acceptable for the customer relative to the importance of the need to the customer. Cost vs. performance is a common tradeoff also in systems engineering (de Weck, 2015b).

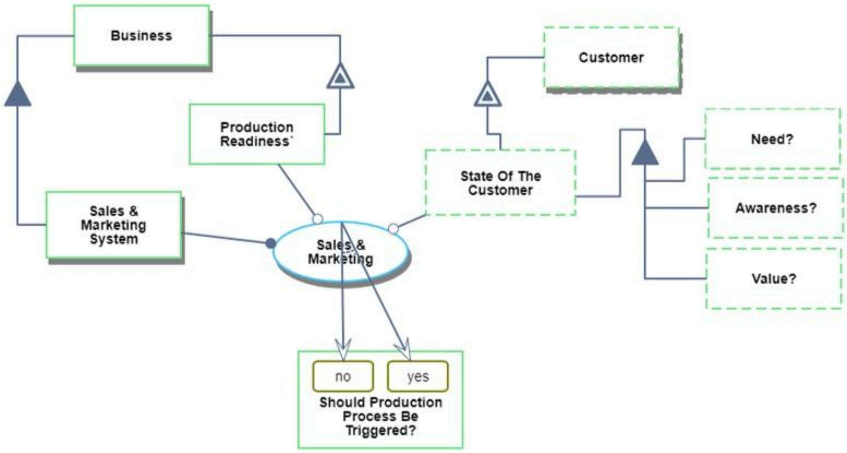

Figure 5.40: Targeting and selecting as a sub-process of business operating.

Targeting and selecting and business developing

The key insight here is that as a part of the business developing process, we can see that targeting and selecting is a process of recognizing the emergence and significance of opportunities and threats. Targeting and selecting as a part of the business developing process is about recognizing when the business plan and reality do not match, and when development actions should be initiated.

This is not trivial task as most business plans have the robustness to tolerate some fluctuations in demand and other variables. In simpler situations, it is easier to see an error. A person with a map in a strange city quickly realizes if they are lost. Likewise, a software developer knows that something is not right when there is a bug. If there is no awareness or ability to read any forewarnings, the illusion is broken only at the moment of ruin when it is already too late. As a generic example of an innovation process that can be likened to targeting and selecting is "seek insightful knowledge to identify opportunities" (Karlsson & Magnusson, 2019, p. 85), or opportunity recognition (Shane et al., 2003).

Targeting and selecting as a sub-process of business developing is visualized in Figure 5.41. The main function of targeting and selecting (i.e. business opportunity and threat recognition) at this level is to make decisions on whether to trigger the profitable business plan searching process or not. Some initial conditions that affect the business opportunity and threat recognizing process are the state of expected profitability of the business, readiness of the business developing system, and the state of the external market environment.

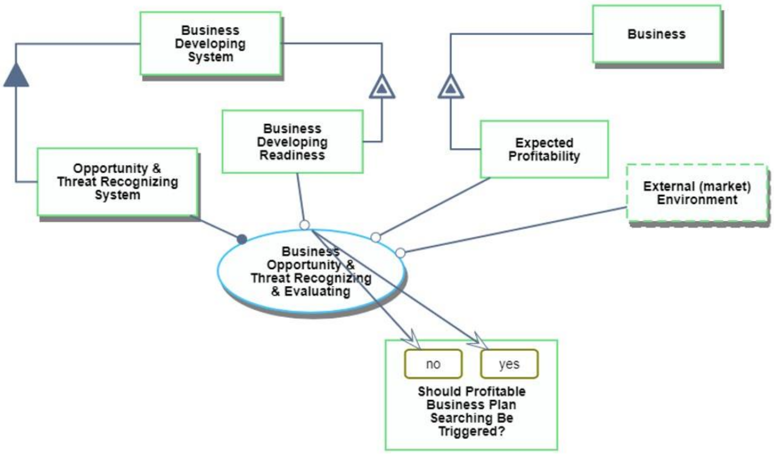

Figure 5.41: Targeting and selecting as a sub-process of business developing.

Targeting and selecting and business meta-developing

As a sub-process of meta-developing, targeting and selecting is about seeing when the current development actions are not effective and efficient enough, and that the development actions themselves should be tweaked so that a return to profitability can be hastened. This is very much in line with the practice of innovation management in the corporate world (Karlsson & Magnusson, 2019). This requires the ability to monitor the performance of the current development process.

A recent popular example is the way SpaceX revamped its rocket development practices when it moved from Falcon 9 and Falcon Heavy rockets to the development of Starship. With Starship, SpaceX has invested early in the fast and continuous production of rocket prototypes that can be tested quickly (Berg, 2019). Figure 5.42 illustrates how the information about the business developing performance and information about the change-rate of the external environment are needed for the business developing system observing and evaluating process, which corresponds with the targeting and selecting at the meta-developing level. This process decides whether the business developing process improving should be triggered or not.

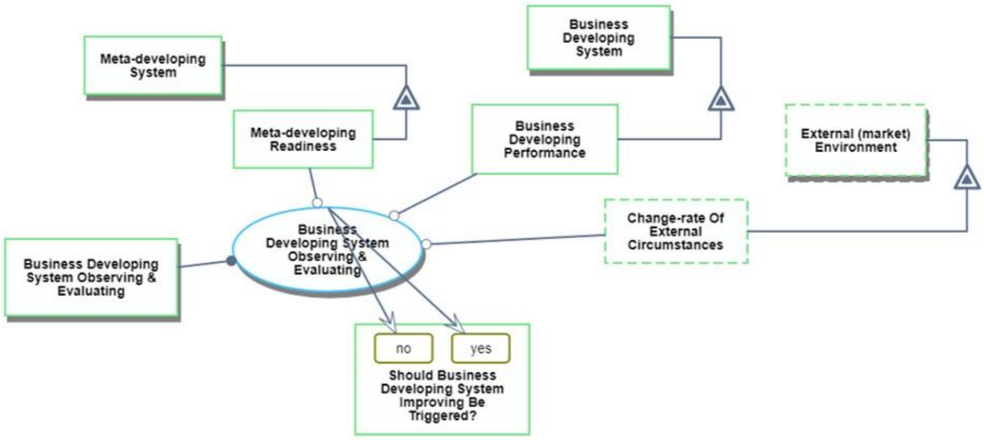

Figure 5.42: Targeting and selecting as a sub-process of business meta-developing.

5.2.9 Resource acquiring and maintaining sub-function

Resource acquiring and maintaining and business operating

Figure 5.43 shows the resource acquiring and maintaining process as a sub-process of business operating. The only differences to the general representation are the addition of the customer and surplus objects as additional details. Based on the definition, only business operating is able to generate surpluses that are needed for the developing and meta-developing processes. In business, the customer is needed for the resource acquiring and maintaining as the money needed to keep the business up and running (i.e. to cover variable and fixed costs) is coming from the customer. Ontology-based resource management (Kantola, 2009) is an example of an advanced component of a resource acquiring and maintaining system.

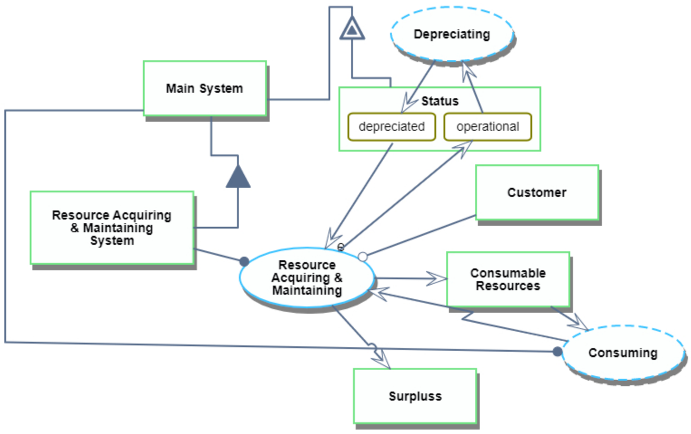

Figure 5.43: Resource acquisition and maintaining as a sub-process of business operating.

Resource acquiring and maintaining and business developing

The tools and assets required in business developing can be channels for receiving new knowledge and information, methods of analysis, tools for building prototypes, and for example environments to test those prototypes. A network of acquaintances can be a channel of receiving new knowledge, while a simple spreadsheet with profitability calculations can be a method of analysis. A chef can develop new recipes in their kitchen, which needs to be maintained in good order and stocked with ingredients. These are then tried out with family members, who need to be kept happy and motivated to act as test subjects.

Sometimes a value creating process as part of business operating does not demand the full use of the equipment and tools, or even the input resources. This allows development actions to be taken that are within the already available means, which was a characteristic of expert entrepreneurs who were engaged in development of new opportunities (Sarasvathy, 2001). At the other extreme, a development process, such as NASA's approach to systems engineering (NASA, 2017), is documented in detail, and considerable effort is being put forward to train people in the correct practices, build and maintain the required information and communication systems, and maintain the laboratories, prototype workshop and testing environments. Of course, all this needs funding, which NASA acquires from the US government (NASA, 2017). A business in trouble needs to find the funds from whatever surplus it has.

Figure 5.44 shows resource acquiring and maintaining as sub-process of both business developing and business meta-developing. The difference to the general representation is that, at these levels, the resource acquiring and maintaining process consumes surpluses generated by some internal or external business operating processes. These surpluses can, for example, take the form of profits the company has generated earlier, investments from venture capitalists, excess equipment capacity at the factory, or access to laboratory equipment provided by a local university.

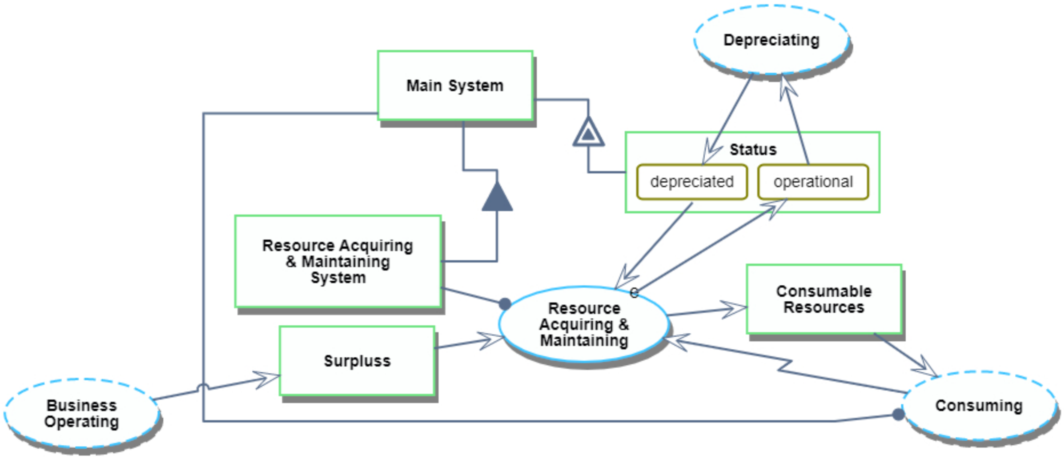

Figure 5.44: Resource acquiring and maintaining as a sub-process of business developing and meta-developing.

Resource acquiring and maintaining and business meta-developing

In business meta-developing, the resources and tools are the information collection systems to gain knowledge and the people armed with knowledge to use this information and suggest improvements (Karlsson & Magnuson, 2019). When a company hires an innovation consultant, it is acquiring a tool that enables a meta-developing process to take place in their organization.

Project management tools that track progress, schedule, and budget would be valuable tools for a meta-developer. Training an executive team to understands the theory of disruptive innovation would allow the team to evaluate current innovation strategy on the basis of the theory (Christensen & Raynor, 2003).

5.2.10 Sub-function dynamics

As the final step of functional analysis, the relationship between different sub-processes was examined.

Two examples of sub-functions relationships

The analysis of the relationships of sub-functions was started by creating two example cases of business operating systems at the level of each individual sub-system (see Table 5.8). The first example has no direct link to a university, while the second example is connected to a local, fictional university. Both examples are fictional.

Table 5.8: Two examples of business operating system.

	Business Operating		
	Targeting and Selecting	**Resource Acquiring and Maintaining**	**Value Creating**
Example	A Café is located on a busy street with visible signs and menu with pricing visible, which the customer views and decides to step in and buy a cup of coffee	Café manager uses revenue from customers to pay existing employees and train new employees, pay for coffee beans, paper cups, water, electricity, pay rent, and equipment maintenance. Owners receive profits.	When the order comes, café employee prepares a cup of coffee using the coffee making equipment. This process consumes coffee beans, electricity, water, and a paper cup. An employee serves the cup to the customer.
Example with university-involvement	An advertising agency updates its website and social media on regular basis. It also uses paid online ads and ads in the local newspaper. Every so often a direct call campaign is utilized. The marketing actions are based on customer segments and value proposition of the ad agency. A local university communications manager (aka. the Customer) is exposed to these ads and becomes aware of the agency. The next time the Customer needs to update its marketing, it calls the ad agency. This results in short sales negotiations and deals being reached	The ad agency has partnered with the local university's graphics design degree program for years, which sends third year students to do a 4-month internship at the ad agency. As the students are not paid, the ad agency has been able to reduce its personnel costs. The ad agency also sometimes rents a futuristic looking auditorium from the university to be used in its customer relationship program events.	After the account manager has closed the deal with the local university's communication's manager, the ad agency's design team starts working with the help of feedback from the communications manager. The team creates a set of short, animated videos which the university will utilize in its recruitment campaign.

Model of sub-functions relationships

Next, a zoomed-in version of a business operating system was created, which maps the relationships between different sub-functions.

Figure 5.45 shows the initial high-level model of business operating system, while Figure 5.46 is the version of the same system with all the sub-processes and their interactions visible.

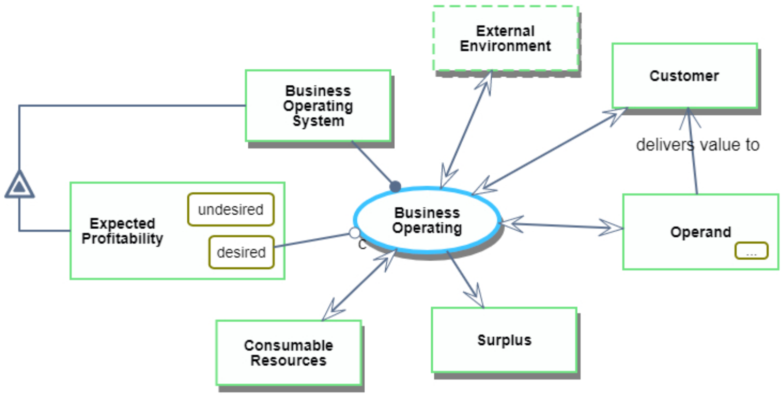

Figure 5.45: High-level (SD) model of a business operating system.

In Figure 5.46, all the three sub-processes and their interactions are visible in the same model. In order to avoid overcrowding, the model is simplified for the resources acquiring and maintaining with only the consumable resources consumed by the value creating process and the status of the value creating system being visualized. In reality, corresponding objects would also be needed for the targeting and selecting process.

An insight gained from these dynamics is that a resource acquiring and maintaining system cannot fix itself. A broken repair mechanism cannot repair itself, if repairing requires a non-broken repair mechanism. Should there be depreciation in its status, an external repair mechanism is needed (e.g. business developing system).

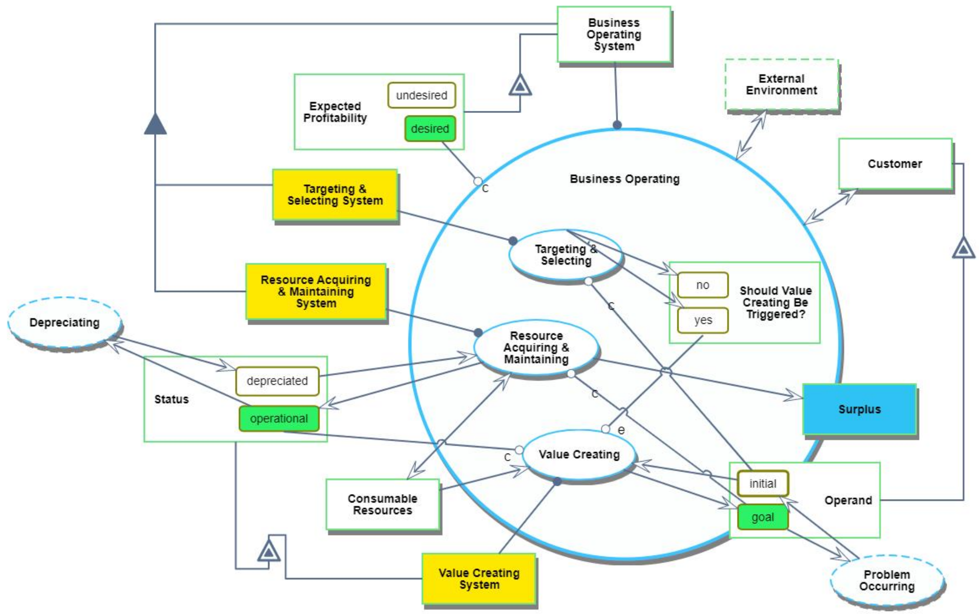

Figure 5.46: Zoomed-in model (SD1) of a business operating system.

The second major modelling step, functional analysis, is now complete and the results from the third step, analysis of value delivering mechanisms in Finnish higher education context, will be presented.

5.3 Phenomena which entrepreneurship programs can harness

5.3.1 Levels of scale

For this stage, the simple diagrams produced in the first step of functional analysis were used to see what other systems at other scales were visible in the models.

Identification of shared objects across scales

Figure 5.47 shows how three scales are detectable in the simple diagrams based on the entrepreneurship program literature and stakeholder expectations. At the highest level in this model, there is economy, or local economy. Representing the lowest scale in this figure, there are businesses or entrepreneurs, which themselves can be parts of a cohort, the middle scale.

Additionally, in the figure there are added attributes linked to the economy as an operand. Attributes include status of the economy, employment, worker salaries, and the tax base.

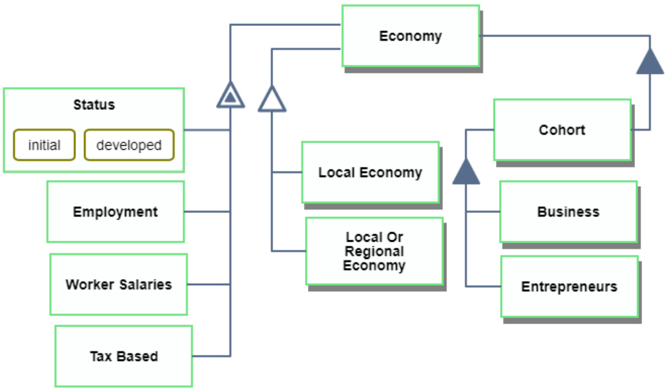

Figure 5.47: Economy, cohort, and business.

Classification of specific stakeholder functions into meaningful categories at the different scales

Next, it was examined how the three functions related to the lowest scale, business-level, apply to the highest level, the economy. As a result, two resulting models are shown in Figure 5.48 and Figure 5.49.

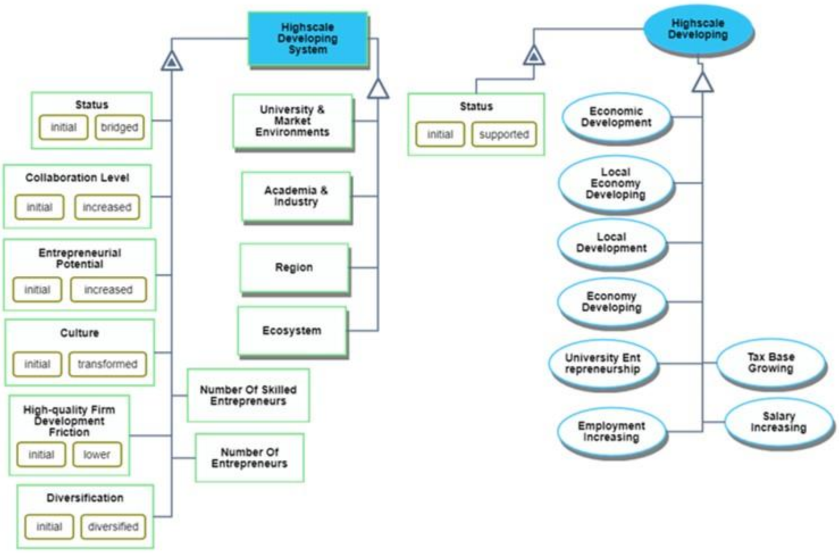

Figure 5.48: High-scale developing system and process.

In Figure 5.48, the main function of the high-scale developing system is high scale developing. The operand of this process is the economy object with its attributes in Figure 5.47. Figure 5.49 includes the high-scale meta-developing system and the corresponding process. The operand of the high-scale meta-developing process is the high-scale developing system in Figure 5.48 with several possible attributes such as culture, collaboration level, and entrepreneurial potential that affect the performance of the high-scale developing system in improving the economy. An interesting contradiction here is that based on the previous system diagrams, the operands of the high-scale meta-developing system (i.e. the high-scale developing system) were large-scale systems such university and market environments, academia and industry, region, and ecosystem. This is opposed to lower-scale institutions or organizations such as "economic development unit". These types of organizations, such as an accelerator or science park, are only mentioned at the meta-developing system level. This could be a sign that the literature assumes you cannot develop the economy directly, but only improve the performance of the self-organising development forces.

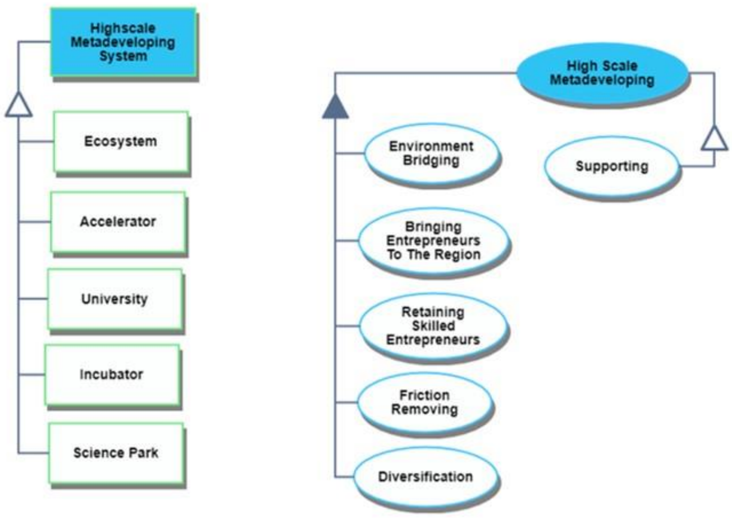

Figure 5.49: High-scale meta-developing system and process.

5.3.2 Categorization of literature-based phenomena

Table 5.9 and Table 5.10 summarize the results of literature of phenomena that could be harnessed in the developing and meta-developing processes at business, cohort, and (local) economy scales. This includes theories and thinking that entrepreneurship program founders, designers and managers use to base their design decisions and approaches on.

Table 5.9: Business, cohort and economy developing phenomena.

	Business / Entrepreneur	Cohort	Economy
Value creating via developing	Encouragement of quick exposure to market (Cohen ,2013), Uncertainty reduction (Anthony, 2014; Ries, 2011), Combination of available competitive/proven means (Jacobs, 1969; Arthur, 2009), (Sarasvathy, 2009; Kauffman, 2019; NASA, 2017), technical advice and support (Cohen et al., 2019), Experience the need (Von Hoppel, 1986; Urban & Von Hippel, 1988; Lilien et al., 2002; Christensen et al., 2016; Ullwick, 2005).	Picking the winners (Cohen et al., 2019).	Network theory from sociology or resource-based view (Rothaermel et al., 2007), institutional economics, endogenous-growth theory Schmitz et al. (2017): knowledge capital Guerrero et al. (2016), entrepreneurship capital (Audretsch & Keilbach, 2004).
Resource acquiring and maintaining	Assisted learning, Bruneel et al. (2012), Hathaway (2016a), Martin et al. (2013); Part-time job (Raffiee & Feng, 2014).	Economies of scale when BI's offer resources to many, Bruneel et al. (2012), Hacket & Dilts (2004), Deep craft — getting access to tools and information from peers speaking the same "technical" language (Arthur, 2009), Cohorts attract investors (Cohen et al., 2019).	Utilize vacant facilities (Hacket & Dilts, 2004).
Targeting and selecting	Focus on older individuals and/or individuals with more means (Azoulay, 2020), problems in own production are opportunities (Ellerman, 2002; Bicheno & Holweg, 2016), or from existing customers (Brown & Mason, 2014).	Select participants to cohort from similar fields (Cohen et al., 2019).	New technology (i.e. business) creates an opportunity to do the same thing cheaper or more efficiently. New businesses or technologies create opportunities for supporting products or services. Negative side-effects new businesses or technologies create opportunities. (Arthur, 2009; Christensen et al., 2019).

The review was more explorative in nature rather than comprehensive. The goal was to show how the functional decomposition and scale can be used to categorize various phenomena, and that this framework allows entrepreneurship program designers' and future scientists to engage in deeper analyses most relevant for their context.

Table 5.10: Business, cohort, and economy meta-developing phenomena.

	Business / Entrepreneur	Cohort	Economy
Value creating via meta-developing	Assisted learning, access to resources via network, Bruneel et al. (2012), Hathaway (2016a), Martin et al. (2013), Hacket & Dilts (2004), Hybrid entrepreneurship strategy (Raffiee & Feng, 2014), More means available, more innovations possible (Arthur, 2009; Kauffman, 2019; Steel et al., 2020); Social support and advice via mentorship (Cohen et al., 2019) Make things easier and simpler (Fogg, 2009), lower cost of tinkering (Taleb, 2012), affordable loss (Sarasvathy, 2009); deadline effect (Cohen, 2013; Steel & König, 2006).	Psychological support from peers and peer-learning (Cohen, 2013; Cohen et al., 2019), adopt open innovation strategy (Chesbrough & Bogers, 2014), absorptive capacity mechanisms at accelerator-level (Eckermann et al., 2020).	TTO's increase interaction between university and industry, Rothaermel et al. (2007), Increase in city size (Bettencourt & West, 2010) and population density (Pan et al., 2013) result in improved idea flow, which increases innovation (Pentland, 2014). Improve flow of capital to local investments (Hathaway, 2016a), (Bar-Yam, 2018).
Resource acquiring and maintaining	Maximize equity offered to investors (Cohen et al., 2019).	Economies of scale in making easier for mentors to meet many startups at once (Cohen et al., 2019).	Utilize accumulated social capital (Harmaakorpi et al., 2017).
Targeting and selecting	Choosing approach based on life-cycle stage (Mirand et al., 2018), choosing support agent based on risk profile (Hacket and Dilts, 2004), Implement innovation management standard (Karlsson & Magnusson, 2019).	Idea flow measurement and analysis (Pentland, 2014).	Broad-based innovation policy choices based on recognized weak points (Harmaakorpi et al., 2017).

In addition to the two tables, each phenomena or theory mentioned will be briefly discussed.

Economic growth mechanisms. In their review of university entrepreneurship, Rothaermel et al (2007) found out that those papers with any theoretical lens on economic growth were mostly based on either network theory from sociology or resource-based view of the firm from strategic management. Schmitz et al. (2017) report a group of studies that use institutional economics and a resource-based view and also papers based on endogenous-growth theory as a model for socioeconomic impacts. Guerrero et al. (2016) explain that, as according to endogenous-growth theory new knowledge is key to economic growth, the role of universities is to produce new knowledge and then facilitate its utilization by society either directly as spin-offs (or graduates etc.) or indirectly via spillover effects. Knowledge or technology is brought in as another important element alongside labour and capital.

Audretsch and Keilbach (2004) expanded the theory with the inclusion of yet another type of capital, called entrepreneurial capital, which is measured as the number of new startups per capita.

The entrepreneurial university fulfilling its third mission is seen as an operator in the entrepreneurial economy. In other words, the entrepreneurial university's economic impact is explained via the endogenous growth theory's production function, that is the university generates new knowledge capital and entrepreneurial capital, key inputs in the entrepreneurial economy. (Guerrero et al., 2015)

Impact via knowledge capital. According to the endogenous growth theory, the economic impact of the university can be delivered by generating new knowledge in the form of human capital (e.g. graduates) or by producing new knowledge via research, which would then lead to commercialization of knowledge and yield positive economic impacts. This knowledge capital is one of the key variables, alongside physical capital and labour, in the production function economists have developed to describe the growth of economies. The knowledge capital is quantified as "number of employees engaged in R&D in the public and in the private sector", (Audretsch & Keilbach, 2004, p. 4). The logic is that as universities produce new knowledge and technologies, the economy will grow (Audretch, 2012).

Impact via entrepreneurship capital. Growth and creation of "entrepreneurial thinking, actions, institutions…" is the job of the new entrepreneurial university (Audretsch, 2012, p. 319). A university that is able to influence the creation of new startups should increase entrepreneurial capital of the region, for example, and thus impact the regional economy (Audretsch & Keilbach 2004). Audretsch and Keilbach (2004) added entrepreneurship capital as a new variable to the production function describing the economic output of an economy. In their paper, they quantify entrepreneurship capital as the "number of startups in the respective region relative to its population" (Audretsch & Keilbach, 2004, p. 11). Simply put, if a university influences the creation of startups in the region, the local economy will grow as a result.

Meta-developing economy by creating linkages. Rothaermel et al (2007) report that two broad theoretical perspectives exist that define TTO's role. The first emphasizes that TTOs are the ones that create the link between university and industry. The second view argues that a TTO's role is not so important as academics are already interacting formally and informally with people in industry.

Economies of scale as a resource acquiring process. BIs offering access to infrastructure is based on economies of scale and the idea that when many small companies share the resources, the cost per company is smaller (Bruneel et al., 2012). In this way, and also when subsidies are involved, incubators are a systematic way to reduce the costs linked to starting and establishing a new business, which then leads to survival and success (Hacket & Dilts, 2004).

Assisted learning boost entrepreneurship skills. The logic of offering business support in the form of coaching, mentoring, and training is that this enables companies to speed up their learning curve, allowing new entrepreneurs to learn and adopt the required business skills and practices more quickly. This view is also reported by Hathaway; that accelerators are efficient because they "compress years' worth of learning into a period of a few months" (Hathaway, 2016a). Martin et al. (2013) use a dynamic version of human capital theory to describe entrepreneurship education. Their model has three components: investments (e.g. time and money required by an EE course), assets, (e.g. the acquired competences), and outcomes (e.g. creation of a new business or growing an existing one).

Access to resources via network. Finally, according to Bruneel et al, the theory guiding the third type of BI value proposition (i.e. access to technological, professional and financial network) is that knowledge, resources, and legitimacy accessible through the network will again improve new company survival and growth. The pattern of the network in which the BI is an important node thus affects firm survival. Again, Hathaway (2016a) offers a similar explanation for the success of accelerators. According to him, one part of the success of accelerators is based on the innovation ecosystem's actors "exposure to one another". Hacket and Dilts (2004) write that the emphasis of the network perspective was important development since it expanded the scope of the incubation process to include the broader community, and the incubator is in and the structure of the network.

Exposure to market environments prevents negative effect of resources in business developing. Cohen (2013) argues that incubators' value propositions in the form of resources, among other things, can also be a weakness and not good for the creation of new growth companies and long-term survival. She points out that these resources can shield emerging companies from market forces, that would normally force the team of entrepreneurs to adapt or pivot their plan. Cohen reports that accelerators are doing the opposite in the sense that they encourage quick exposure.

Uncertainty reduction. It would seem that the conflict between providing resources and market exposure would be best cleared by adopting the dimension of uncertainty for new firm creation. When there is still a lot of uncertainty regarding the business idea, the accelerator approach works, but when evidence has accumulated and the challenge becomes more about business plan implementation, the business incubator approach works. This is in line with approaches as seen in *The First Mile* by Anthony (2014) or the *Lean Startup* by Ries (2011). Miranda et al (2018) call for more research on choosing the approach based on life-cycle stage of an academic spin-off.

Hacket and Dilts (2004) use risk (i.e. uncertainty) as one of two axes to link type of new businesses with different supporting agents. Emerging businesses with low risk and low associated rewards/growth opportunities are supported by various small business development centers. Those on the extreme high risk, high reward end of spectrum are supported by venture capitalists, while the business incubators operate on the middle ground, with medium risk and medium rewards for success.

Interestingly, Raffiee & Feng (2014) explain that because new entrepreneurs still have a part-time paid job, they do not have to make their current business idea work and can switch to a new and better business ideas, unlike new entrepreneurs who quit their job. According to Raffiee & Feng (2014), this results in the finding that companies started by part-time entrepreneurs have better chances of survival. This would suggest that, when possible, people would naturally move away from poor opportunities, but an artificial support structure such as a business incubator can somehow prevent this process from happening if the support is based on the initial business idea the team had when they entered the incubator.

New business from combination of available competitive means. By definition, a new type of business is different from other businesses. The means correspond with different elements of the company's business model (Osterwalder & Pigneur, 2010) or more broadly, the business plan.

Using OPM terminology, the means are the sub-systems (i.e. objects) that make the whole business system. In our abstracted model, the business operating system consists conceptually of three sub-systems: the value creating sub-system, the targeting and selecting sub-system, and the resource acquiring and maintaining sub-system. In systems engineering, the choices made about actually delivering these (sub-)functions define the systems architecture (De Weck, 2015d). The choices correspond with the term form, as in form and function, and the means or technologies in Arthur's language.

Several authors have reported that new businesses are combinations of existing means (Arthur, 2009; Kauffman, 2019). Arthur (2009) and Kauffman (2019) describe how the technologies, or more broadly businesses, are combinations of technologies that existed before them. In a convincing manner, Steel et al. (2020) show how the mathematics of this type of combinatorial evolution explain the explosive growth of human technology and economy in the recent history. The more means you have, the more chance of novel useful combinations you have. Kauffman (2019) calls this process of creating novelty out combinations of what already exists as the adjacent possible. Both Arthur and Kauffman highlight that the means used in these combinations need to be "competitive" in the sense that they need to exist in active production and use in the economy.

Sarasvathy (2009) studied the thinking of experienced and successful entrepreneurs, and especially how they make business decisions. She reported that one of the principles that successful experienced entrepreneurs use is the Bird in Hand principle. She writes: "This is a principle of means-driven (as opposed to goal-driven) action. The emphasis here is on creating something new with existing means rather than discovering new ways to achieve given goals" (Sarasvathy, 2009, p. 15).

It is a very simple yet true statement that at any moment you can use only what is available to you at that moment. The movie Apollo 13 told the story of how astronauts had to fix their carbon dioxide removal system (Opt, 1996). They could only use components and tools present in the space craft. In her 1969 book The Economy of Cities, Jane Jacobs described her view on how new work gets created by adding it to old work. She writes: "picture, for example, a large manufacturer of metal dies whose abrasive-sand department has taken on the work of making sandpaper and masking tape. The personnel department has added the service of supplying part-time office workers to banks and publishers" (Jacobs, 1969, p. 72). Using this same kind of logic, Jacobs continues by saying how first cities came to be and then economy evolved.

It is as if NASA and others got it wrong. The technology readiness level (TRL) classification starts from TRL 1, and the goal is to reach TRL 9, which is defined as "Actual system flight proven through successful mission operations" (NASA, n.a., p. 1). However, what was discussed above means that you would start from the top with already proven technologies (i.e. TRL 9) and combine them in novel ways, moving to lower levels only when needed. Of course, this is what NASA also emphasizes; the use of technologies with proven track-record (NASA, 2017). Moving to lower TRL levels is done only when needed. However, we feel that in common innovation discourse, emphasis is always in starting with idea of great uncertainty. Methods such as *Lean Startup* (Ries, 2011) or *The First Mile* (Anthony, 2014) are built on this thinking.

Target older with more experience or those with more means. The phenomenon that new means emerge as combination of existing means could also explain the findings of Azoulay et al. (2020). The combination of available means phenomenon could explain one of the main reasons of why the likelihood of new business success is highest when founders are between 40 and 50. Azoulay et al. write: "A founder at age 50 is approximately twice as likely to experience success" (Azoulay et al., 2020, p. 74). Logically, a 50-year-old version of John knows more and has more skills than the same John at the age 20. It could even be argued that 20-year-old university students with no work experience or semi-professional experience in some hobby or interest actually have no "competitive" means at their disposal.

In the targeting and selecting stage, entrepreneurship programs should consider putting more emphasis on the quantity and quality of the means the potential participants have, and less emphasis on the quality of the initial idea. Whether or not the idea overlaps with the competitive means of the team could be used as a proxy for a good idea.

Too much equity and you lose those with most means -phenomenon. Accelerators vary based on how much funding they provide for startups and how much equity they take. Funding provided during the program varies between \$0 and \$600,000. With close inspection of Cohen et al.'s (2019) data, there is skewedness here since for minimum funding provided by the accelerator, top accelerators represent about 5 % of the mean, and for maximum funding provided by the accelerators, top accelerators represent about 6 % of the mean. This means that few accelerators are in much better position financially to fund their startups during the program. The equity stakes accelerators take vary between 0% and 15 %. Here again, Cohen et al. speculate the existence of an interesting dynamic. A large equity stake is attractive for investors, but the best, non-naïve teams are not willing to let so much of their company go. For an accelerator that is sponsored by venture capital or angel groups, this is a problem. On the other hand, accelerators who rely on non-investor sponsorship do not have to worry about maximizing their ownerships.

To summarize, the combinatorial innovation phenomenon that business developing systems should harness is the realization that novel businesses and technologies emerge as combinations of what already exist and are at the disposal of the entrepreneurs themselves. Innovation is discovery, not manufacturing. The larger the area of your search, the more likely you are to find something useful. An entrepreneurship program (entrepreneur and any support systems) should focus on building something useful with the means available. However, the means possessed need to be solid.

This would suggest that, for a young person, the best strategy is to acquire competitive means as fast as possible and postpone business experimentation to later life. There is actually evidence to indicate that this is a natural phenomenon. Joensuu et al. discovered that “entrepreneurial intentions of higher education students seem to decrease during their studies” (Joensuu et al., 2013, p. 1). The way these findings support our suggestion that young people’s tendency to avoid entrepreneurship due lack of means is evident from the way Joensuu et al. explain their results. They write that intention development is:

> …a complicated process during which young people can realize their true potential vis-a`-vis entrepreneurial opportunities. From an educators’ point of view, such realization generally means a decrease in an individual’s entrepreneurial intentions, which is a phenomenon that does not provide much encouragement for educators. On the other hand, one of the aims of any entrepreneurship education is to give younger people a more realistic picture about entrepreneurship. When someone is willing to start a new business in this kind of context, the authors, as educators, can be a degree more confident that such an individual is not launching his/her venture because of idealistic dreams. (Joensuu et al., 2013, p. 1)

In other words, when you have not yet mastered the simple means, you are not motivated to try out more complicated means (combinations). This would suggest that entrepreneurship programs targeting younger audiences should actually be more focused on helping participants learn practical and competitive skills and less higher-level “innovation” skills. This way, professional or vocational education from the perspective of the learner could be seen as a resource acquiring and maintaining process at the business developing level. If existing means, resources, and skills are the inputs for creating new businesses, then acquiring these skills corresponds with the resource acquiring and maintaining in business developing.

Receiving technical advice and support. Cohen et al. define mentorship as “the provision of technical and business feedback, advice and social support” (Cohen et al., 2019, p. 22), with a goal of speeding up the learning and experimentation process. Cohen et al. report that the main variety in mentorship practices is about whether the accelerator uses external mentors or mentoring done by internal staff. Almost 90 % of accelerators in Cohen et al.’s data set had external mentors. According to Cohen et al. accelerators use a variety of methods for facilitating and coordinating the interaction patterns between mentors and startups.

City size, density, and idea flow. Increasing the speed of this learning process could be seen as a meta-developing process. In fact, there are very strong findings that are related to the meta-developing process and the ease of acquiring and getting access to new means. Pan et al. showed how the social-tie density of cities is linked to “how far information travels and how fast its citizens gain access to innovations or information” (Pan et al., 2013, p. 4), and then this is connected to the higher rates of innovations and economic output. Pan et al. write: “We, therefore, suggest that population density, rather than population size per se, is at the root of the extraordinary nature of urban centres” (Pan et al., 2013, p. 6).

It had been previously shown that larger cities are denser, and also that when you increase the city size, you increase the economic output and innovation output per capita (Bettencourt & West, 2010). For an entrepreneurship program this would suggest that affecting the structure and quality of information flow can speed up innovation (Pentland, 2014). Thus, people would gain access to new means faster and become aware of possible needs faster as well (see next phenomenon).

Open innovation as a cohort phenomenon. Of course, increasing the amount and diversity of communication has been one of the cornerstones of many innovation models from triple helix (Miller et al., 2018), open innovation (Chesbrough & Bogers, 2014), modes of knowledge creation (Harmaakorpi et al., 2017) to detailed best practices of university-business cooperation (Pertuzé et al., 2010). Open innovation is categorized as a cohort-level phenomenon, because it takes at least two to tango.

Needs are experienced, not imagined. An element of a new business is that there is a paying customer, which implies that there is a need. The need in our model corresponds with the operand and the desired change in the main function of the business operating system. The question is then how entrepreneurs find a need to focus their business on.

The phenomenon or condition evident in the literature driving this discovery of potential needs seems to be that customer needs must be experienced first-hand, not imagined. This phenomenon is the second cornerstone of the lead user methodology of innovation (Von Hippel, 1986; Urban & Von Hippel, 1988). Lead users are users of a product that would benefit greatly from a solution to their needs. Lead users are also ahead of the trend in the sense that they experience some needs earlier than the masses, and accordingly, no solutions yet exist. (Von Hippel, 1986). Thus, lead users are motivated to develop solutions themselves. Lilien et al. (2002) found that new products based on the ideas developed by lead users were on average much more successful than traditional methods where developers from the company were not the (lead) users themselves.

The reason a need should be experienced rather imagined seems to be the highly contextual and multi-dimensional nature of needs. Christensen et al. (2016), and Ullwick (2005) explain how the need is not just a simple function, such as satisfying thirst (by drinking a glass of water), but it is actually very much dependent on the circumstances and the unique abilities and resources of the user (Fogg, 2009). Solving the problem of thirst-satisfying for astronauts on Mars is much a different problem than thirst-satisfying in the homes of most people living in developed countries.

As we know, in systems engineering, needs are defined as a collection of requirements. De Weck (2015b) describes how, depending on the situation, a list of requirements might contain thousands. This fact captures the multidimensional nature of the need well. Having many requirements means that there are also tradeoffs. When you improve on one dimension, you fail on another (de Weck, 2015b). We argue that without experiencing the need yourself, your ideas for the solution cannot reflect the circumstances correctly, or may be too far-fetched.

Arthur (2009) points out that, with his example of the difficulty of adopting electric motors to factories, the means really need to be in the same head or no new businesses are likely to emerge. Arthur reported that it took decades to adopt electric motors in factories because this required the factories to be redesigned. It took decades before architects understood electric motors and electric engineers understood factory architecture. Logically, a multi-disciplinary team is no good if the team members do not know and understand the skills and capabilities other team members have. If you put an engineer and a nurse in the same room, no health tech innovations will come out unless the nurse gets educated by the engineer, and the engineer educated by the nurse.

In a way, the detailed and slow-going innovation processes such as NASA’s systems engineering approach aim to understand the circumstances via continuous modular and parallel experimentation (NASA, 2017). As there are no first-hand experiences in experiencing the hazards of space directly, the progress is slow. In similar way, so called user-based innovation methods and policies are based on the idea that by including the users in the process, no key issues are forgotten (Harmaakorpi et al., 2017). The phenomenon is that it is best to start with needs that you have experienced yourself or you may discover that it is not a need at all.

Problems in production are opportunities. Ellerman describes how the problems a company experiences in its own production process forces it to innovate new solutions (Ellerman, 2002). The case Ellerman describes is the case of Mondragon group cooperative in Spain. Ellerman writes: “The group started with a single company in the mid-50s producing a kerosene heater. Then it systematically started filling out the backward linkages, producing the machines to make the heaters and then the machines to make those machines" (Ellerman, 2002, p. 19). Ellerman writes how these solutions then could, and did, become spin-off businesses themselves.

Similarly, the famed lean development process originating from Toyota is based on the idea that the workers themselves innovate to make small improvements continuously (Bicheno & Holweg, 2016). The point here is that the workers experience the need and the benefits of solving it themselves. Necessity is the mother of all inventions.

Opportunities via existing customers. Brown and Mason (2014) challenge the prevailing technology entrepreneurship policies by studying the real nature of technology-based firms in Scotland. They write:

> The qualitative data reveals that typically these firms are corporate rather than university spin-offs; most do not undertake large amounts of in-house R&D, most do not have protected IP, and only a small minority are VC-backed. Most derive their main competitive advantages from open innovation sources such as relationships with end-users and customers. (Brown & Mason, 2014, p. 1)

Emergence of new technologies at the economic level. From the perspective of targeting and selecting, Arthur (2009) again provides some guidance. If we assume that a natural place for targeting and selecting in business developing is when an important enough problem or need emerges, the question is then when and where new problems emerge. Arthur provides an overview of three mechanisms that connect the emergence of needs to the adaptation of new technologies: 1. New technology, creates an opportunity to do the same thing cheaper or more efficiently, 2. New businesses or technologies create opportunities for supporting products or services, 3. Negative side-effects of new businesses or technologies create opportunities.

Mechanism number two aligns especially well with what Christensen et al. (2019) describe in their book "The Prosperity Paradox." In the book, the authors argue that real prosperity and development is caused by the adaptation of a new market creating innovation aided by numerous innovations and improvements that make initial changes easier and the business itself more profitable. Christensen et al. give the example of mobile money transfer in Africa, which created the need to install mobile antenna towers, which required power sources, and so forth. From the entrepreneurship program's perspective then, special attention should be paid when and where new technologies are adopted as they are bound to create new opportunities.

Lowering the cost of searching leads to discovery and affordable loss. According to our definition of the value creating process of the business developing system, the goal is to have an expectedly profitable business. As previously discussed, the expectedly means that there is no uncertainty and everything is predictable (for the desired time-frame).

Even when using available means and understanding the problem personally, there is an element of uncertainty associated with the novelty of trying out a new combination of old means. In a deep sense, the uncertainty is always there. Taleb writes:

> Further, it is in complex systems, ones in which we have little visibility of the chains of cause-consequences, that tinkering, bricolage, or similar variations of trial and error have been shown to vastly outperform the teleological —it is nature's modus operandi." (Taleb, 2012, p. 1)

According to Taleb (2012), a key to tinkering is to have the ability to choose what works and keeping the exposure to downside minimal, such as the cost of the attempt being minimized. He says that this "optionality" trumps learning or knowledge in some circumstances. Sarasvathy (2009) discovered that experienced successful entrepreneurs do just that. They utilize the so-called affordable loss principle when dealing with uncertainty. She writes that "this principle prescribes in committing in advance to what one is willing to lose rather than investing in calculations about expected returns to the project" (Sarasvathy, 2009, p. 15). When you invest only as much as you can afford to lose, you can try again.

It might be that we as humans are built for this. Psychologically, we are loss averse (Kahneman, 2011). This means that loosing something hurts more than gaining something of equal value. This is of course counter to the common discourse that entrepreneurs should boldly sacrifice everything (Sarasvathy, 2009).

Simpler and easier things make behavior more likely. There seems to be a connection between this principle and the two earlier principles. First, it is safe to say that we can only do experiments that we have the means to do. In other words, our means define the experiments we can do. When those means are linked to resources that are scarce (such as time and money), the cost of experimentation limits how many experiments we can do. There is likely a connection between how well your means adapt to small experiments and your innovation performance. Behaviorally, the lower the cost or required ability, the likelier you are to do the behavior (Fogg, 2009).

There is also a connection to the "experiencing needs first-hand" phenomenon. When you understand the problem deeply, as in having defined requirements, you are better able to decide the experiments you should do and how to measure success. From all this we can see that, if a lower cost of experimentation means better business developing performance, then lowering the cost of experimentation can be seen as a meta-developing process. The question is then if there are natural ways for this to happen.

Deep craft and access to resources. As discussed previously, density and access to both information and means speed up innovation (Pan et al., 2016). Arthur calls this location specific *deep craft*. When tools and knowhow are close by, innovation is increased (Arthur, 2009). Since the earliest incubators, entrepreneurship programs have utilized economies of scale in the sense that cost per startup is decreased when many startups share the same resource (Bruneel et al., 2012; Hacket & Dilts, 2004).

According to Cohen et al. (2019), whether or not the accelerator provides a workspace for the startups is the seventh source of variation in accelerator design choices. In their data set, 77 % offer workspace. Cohen et al. point out that accelerators typically offer co-working space-type facilities and claim that the utilization of group space can be a major socio-cultural factor that influences the startup firm.

With corporation-sponsored accelerators, Cohen et al. raise an interesting dynamic: the alumni startups will reach higher valuations relatively, but raise less capital. Cohen et al. explain that this reflects the resources and partnership with the corporation, thus explaining the high valuation, but less need for capital. When you have many resources at hand, you do not need to buy them.

Picking the winners phenomenon -making investments easier. Cyclical competitive selection is an important feature, as some accelerators, according to Cohen, can pick the best candidates from a large pool of applicants. Cohen et al. (2019) report that one of the oldest accelerators, the Techstars, is able to pick startups from thousands of applicants. One could argue that the success of the selected ventures is irrelevant to what happens during the actual program. The biggest issue is accelerators' ability to select the winners. Cohen (2013) reports that the key advantage of accelerators, when compared to angel investors not part of an accelerator, is this "picking winners" phenomenon. An accelerator with thousands of applicants can basically run their ongoing experiments and research to look for signals of future success in a startup.

The cohort-nature of the accelerators' process allows investors interested in certain types of startups to efficiently assess multiple startups (Cohen et al., 2019). This leads to agglomeration of support and resources relevant to the type of startups that form the cohort. Mentors can meet many startups during one visit and investors have many potential targets for their investments. Cohen et al. (2019) define the cohort structure of admission as "one of the most important design innovations introduced by accelerators".

Perhaps this feature attracts investors and results in increased investments in early-stage companies, which is mentioned by Hathaway (2016a). We can interpret that a key stakeholder group which accelerators are serving is actually the investors themselves. Hathaway (2016a) speculates that accelerator ability to increase local investments is the reason behind policymaker and region interest in innovation ecosystems, including accelerators. Cohen (2013) also reports that accelerators excel in social network building between a large pool of mentors and the participating entrepreneurs.

Deadline effect. Cohen (2013) emphasizes that the key difference between incubators and accelerators is the duration. Accelerators' programs' short duration and clear deadlines (e.g. the demo day) bring intensity and as a result, a lot gets done. When resources such as education, physical space, funding etc. are only available for short time, with a clear deadline in the form of Demo Day, startups are forced to experiment quickly and expose their business models to market forces, Cohen et al. (2019) reason. The Demo Day itself can be anything from a public entertaining event to a meeting with potential investors behind closed doors (Cohen et al., 2019).

The deadline effect is in line with research on the effect of deadlines on motivation (Steel & König, 2006). We can speculate that given the 24/7 nature of accelerators, only younger entrepreneurs without family obligations are drawn to them. This contradicts a very important finding regarding startup founder age and startup success by Azouley et al. (2020), that is successful startups are founded by middle-aged people with past industry experience.

5.3.3 Model of Finnish higher education incentive dynamics

Figure 5.50 is the resulting conceptual model of an entrepreneurship program in the Finnish higher education context. The model was created implementing the five complex systems modelling steps. The information used in the modelling process largely came from the simpler models that had already been completed and in some cases from additional references. In the following paragraphs, the model formation is described step by step. In the first step, the relevant object across scales were differentiated. Based on the details of the Finnish higher education funding model and student financial support model, these were: entrepreneurship program, which is a part of university, student, which is part of all the students, and government.

In the next step, the relevant attributes and states were added, which in this case were simple informatical objects, that are either created or consumed by the processes. The informatical objects are: number of credits (student produces), number of credits and graduates (which all the students produce), total funding received by the university and the funding consumed by the entrepreneurship program, and financial support received by the student. At this conceptual level of analysis, the interactions between components are simple input-output relationships in which the output of one process is consumed (or enables) by another process. The model reveals the strong directionality of interactions and how the entrepreneurship program is dependent on the production of credits.

Implementation of the last two steps was limited by the detail of the available information and the resulting accuracy of the conceptual model. An additional piece of information was provided by Nenonen (2020), whose dissertation produced evidence of the drop in the quality in education as a result of the intra-university competition in the Finnish system. As the universities get paid by their results relative to other universities, and there are very limited objective measures of teaching quality, an inflation of the amount and quality of learning indicated by a single credit or degree can be the result.

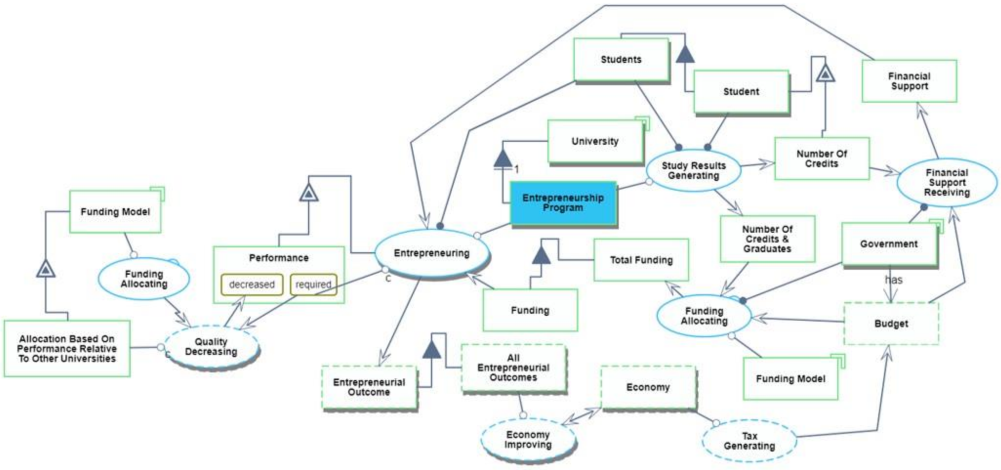

Figure 5.50: Entrepreneurship program in the Finnish higher education context.

Thus, this element was included in the model as a drop in the entrepreneurship program's performance attribute, assuming that the teaching quality also drops in the program. Then, a hypothetical assumption that there is a minimum level of performance required for the entrepreneuring process to deliver its entrepreneurial outcomes was included. If this threshold is breached, then no outcomes that can improve the economy are yielded.

5.4 Summary and assessment of conceptual findings

The conceptual results and findings covered in this chapter were the result of the utilization of three analytical methods with origins in systems engineering and complexity science. The use of OPM as a modelling technique then brought everything together coherently.

Stakeholder expectations via stakeholder analysis

Based on analysis of existing research findings, three generic stakeholder categories were recognized, and information about expected value and information regarding specific circumstances and relationships with other stakeholder types was compiled for each stakeholder type. This information was captured in simple OPM-models (see Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5, Figure 5.6, and Figure 5.7) and category-specific tables.

The categories and stakeholder types belonging to each category are as follows. First, the sponsor-category (see Table 5.2): university, government, corporation, investor, science park. Second, the participant category (see Table 5.3): student, academic, entrepreneur, startup, business. Third, the partner category (see Table 5.4): incubator or accelerator, mentor, expert, manager or operator, TTO, educator, user. Additional information regarding the government, university, student, and entrepreneur in the Finnish context was recorded (see Table 5.7). The results confirm that entrepreneurship programs, and more broadly universities, exist in complex socio-economic environment with multiple stakeholder types and many more expectations.

Model of entrepreneurship program purpose and functions with functional analysis

Based on a thorough process of functional analysis, it was discovered that conceptually, entrepreneurship programs can be seen as a means to fulfill at least one of the three main functions: business operating, business developing, or business meta-developing. These three main functions were created by first generating OPM of the expectations of stakeholder types that were not yet created (see Figure 5.8, Figure 5.9, Figure 5.10, Figure 5.11, Figure 5.12, Figure 5.13, Figure 5.14, Figure 5.15, Figure 5.16, Figure 5.17, and Figure 5.18).

This step was followed by a process of classification where information from the models was brought together and developed in to general functions (see Figure 5.19, Figure 5.20, Figure 5.23, Figure 5.24, Figure 5.26, and Figure 5.27). The classification step led to formal definitions of each function. Business operating signifies predictably profitable business activity (see Figure 5.21). Business developing is defined as the creation or discovery of a predictably profitable business activity (see Figure 5.25). Business meta-developing is defined as improvement of the performance of the business developing process from not satisfactory to satisfactory (see Figure 5.28).

With the help of formal definitions, it was possible to study the relationship between these three functions (see Figure 5.22, Figure 5.29, Figure 5.30, and Figure 5.31). At the highest level, all the three functions could be categorized as parts of an entrepreneuring function. Together, these three purposes are in a hierarchical relationship such that the business operating system is the object of business developing, and business developing system is the object of business meta-developing. Importantly, business operating yields surpluses that are consumed by the developing and meta-developing processes.

Finally, a process called functional decomposition yielded three abstracted sub-functions (see Figure 5.33, Figure 5.34, and Figure 5.35) that are shared by all the three main functions (see Figure 5.36, Figure 5.37, Figure 5.38, Figure 5.40, Figure 5.42, Figure 5.43, and Figure 5.44). These are value creating, targeting and selecting, and resource acquiring and maintaining. The way in which the three sub-function enabling systems interact were then modelled for a business operating system (see Figure 5.46) and two decomposed examples were created in a table (see Table 5.8).

Taken together, the results of the functional analysis indicated that an entrepreneurship program can be seen as an instrument or agent for fulfilling any number of the main functions or sub-functions in an entrepreneuring process. This hints that a proper unit of study in the future would not just be the actions entrepreneurship programs take, but the role of these action in the larger process.

Analysis of harnessable phenomena

In the third stage of conceptual analysis, the focus was on understanding the role of scale and its role as tool for categorizing naturally occurring socio-economic phenomena that program designers could harness. As a first step, initial stakeholder-specific OPM models were used to study what other scales are presented in past research findings. By following similar classification and generalization steps, it was discovered that beyond the scale of a single business, two larger scales, cohort and economy, are also recognized by past authors (see Figure 5.47). It was also discovered that three analogous functions exist (operating, developing, meta-developing) for the economy scale too (see Figure 5.48 and Figure 5.49).

After conducting an analysis of scale based on the stakeholder expectations, and a focused literature search, a number of phenomena were recognized and organized according to scale and function. The three scales used were the startup, the cohort, and the economy. The findings demonstrated the logic of implementing literature searches based on function and scale. The discovered phenomena summarized here in two tables (see Table 5.9 and Table 5.10) highlight the importance of skills and knowledge already in possession of the entrepreneurs. Finally, a detailed OPM model of the Finnish higher education financial incentive phenomena was created, showing the centrality of credit production in the Finnish higher education context (see Figure 5.50).

6 Empirical findings

In this chapter, the empirical findings from the case study and the longitudinal study are presented. Together, the findings of these two studies directly answer research question 2. At the same time, the findings also more indirectly provide evidence for the validity of OPM as a methodology and an answer to research question 1.

6.1 Stakeholder expectations and program value propositions

The findings of the first case study consisting of qualitative and quantitative analysis of 45 entrepreneurship programs are presented. Together, these findings answer the first half of research question 2, that program formation is explained by stakeholder expectations and stakeholder-based social phenomena.

6.1.1 Results of the qualitative content analysis

Table 6.1 presents the results from the qualitative content analysis of 45 entrepreneurship program websites and other publicly available information. The left-most column has the title of each of the 21 features, or variables that emerged from the 4-step coding process that started with the creation of OPM models of 30 Finnish entrepreneurship programs. The second column contains a brief description of the variable, including examples of statements on the website. The third column shows the number and proportion of programs in the sample that included that element.

Table 6.1: Descriptions and number of programs of entrepreneurship program features.

Title	Description	Number of programs (% of total)
UAS-managed	The program is managed by university of applied sciences (UAS).	28 (62 %)
UNI-managed	The program is managed by academic research university (UNI).	18 (40 %)
non-university-managed	The program is managed by an external non-university organization.	19 (42 %)
student-targeting	Program is explicitly targeting students. Example statements: “higher education students”, “vocational students”, “team of students”.	27 (60 %)
business-targeting	Program is explicitly targeting “entrepreneurs”, “early-stage technology entrepreneurs”, “startup/young business”, “company”. Not necessarily a registered company.	24 (53 %)
idea-required	Program requires or assumes that the applicant has an existing “new, interesting, viable, clear idea”, “strong technology”, “concept”, “research result”.	28 (62 %)
credits	Program emphasizes study credits, a minor or full degree as an outcome.	19 (42 %)
broad-skills	Program emphasizes broad skills as an outcome. For example: “ability to do stuff entrepreneurially”, “working-life skills”, “new/useful skills and knowledge”, “entrepreneurship skills/knowledge”.	19 (42 %)
specific-skills	Program emphasizes specific skills as an outcome. For example: “teamworking skills”, international project skills”, “ability to establish a business”, “business model searching knowledge”.	17 (38 %)
skills	If a program emphasizes either broad skills or specific skills or both skills as an outcome, it belongs to this category.	28 (62 %)
idea changes	Program emphasizes that as an outcome, the business idea will develop or be evaluated or new one will emerge. For example: “business plan outline”, “tested idea”, “finding out business potential”, “idea to concept”, or “new business idea”.	28 (62 %)
new business	Program emphasizes that as an outcome, a new business will be created. For example: “commercialized invention”, “self-employment”, “new business”, “startup”, “company”, “acquired company”.	23 (51 %)
business growth	Program emphasizes that as an outcome, business will grow or will be ready for growth. For example: “development of existing business for growth”, “scale-up readiness”, “growth company”, “internationally expanded company”.	15 (33 %)
new network or team	Program emphasizes that as an outcome, the person will belong to new networks or will have team expanded. For example: “community membership”, “network abroad”, “future business partner”, “team”.	24 (53 %)
mentors	Program emphasizes that mentors, coaches or experts are utilized in the programs. For example: “mentors”, “subject-matter experts”, “coaches”, “university staff”, “business mentors”.	36 (80 %)
facilities	Program emphasizes that participants will get access to facilities during the program. For example: “co-working space”, “office space”.	13 (29 %)
travel	Program emphasizes that travelling is part of the program. For example: “trips”, “travel to Cambridge”, “travelling”.	5 (11 %)
tools	Program emphasizes that various tools will be utilized in the program. For example: “tools”, “working kit”, “business design tools”.	8 (18 %)
networks	Program emphasizes that networks or community will be utilized in the programs. For example: “network”, “community”, “university campus network”.	20 (44 %)
funding	Program explicitly promises to offer funding to participants. For example: “grant”, “funding”, “40 kEUR of total funding”.	7 (16 %)
scarce	If a program offers at least one of the three resources: facilities, travel, funding, it belongs to this category.	21 (47 %)
selection	Program has an explicit selection and/or application process mentioned on the website.	30 (67 %)
cohort-based	Program has a cohort-based structure.	25 (56 %)

The six most common features in the sample were: 1. mentors and other experts (80 %), 2. selection process (67 %), 3. managed by university of applied sciences (62 %), 4. idea required for participation (62 %), 5. skill improvement as an outcome (62 %), 6. idea develops as an outcome (62 %).

The five least common feature in the sample were: 1. participation included travelling (11 %), 2. program offers funding to participants (16 %), 3. program emphasized and offered specific tools (18 %), 4. program emphasized business growth as an outcome (33 %), 5. program emphasized "specific" skills as an outcome (38 %). These results indicate a rough pattern wherein offering scarce resources and emphasizing real business results is much rarer.

6.1.2 Qualitative results and conceptual findings

In the following paragraphs, we discuss how each of the features in Table 6.1 are connected to the conceptual findings: stakeholder expectations, functions, and harnessable phenomena.

UAS-managed (i.e. university of applied sciences) and **UNI-managed** (i.e. academic research university) are university sponsor-type stakeholders. In the Finnish context, resource acquiring and management process with a university-sponsor should be dominated by the funding model (i.e. performance criteria) the Ministry of Culture and Education uses to allocate annual funding for universities. Conceptual findings suggest that study-related outcomes are important for the Finnish universities.

Non-university-managed. External non-university organization is a sponsor-type stakeholder.

Student-targeting. Student is a type of program participant, and as such, a stakeholder. Conceptual findings suggest that credit production would be valuable element for student participants. Communicating the participant type on the website can be seen as a form of targeting and selecting sub-process.

Business-targeting. Business is a type of program participant and therefore a stakeholder.

Idea-required. An idea can be defined as a business in an undesired state (i.e. the main operand) of the development process. Evaluation of the idea in the application process is part of the targeting and selecting sub-process. An idea, or more broadly a business plan, is an informational object that either implicitly or explicitly represents the description of how the operating process of a business happens and with what resources, including all the sub-processes.

Credits. Credits are an outcome (i.e. an informational object) that is created as a result of program participation. Conceptual findings suggest that in the Finnish context, credit creation can be a key component in the resource acquiring and maintaining process.

Broad-skills, specific-skills, skills. Broad skills (and other) are an outcome of the program's value creating process that can be seen as an informational object or attribute of the participant (i.e. operand). The value creating process that creates or transforms the operand could be called "broad skills acquiring" or "broad skills improving". These skills (informatical object) can enable the participant to handle operating, developing or meta-developing processes in the future. Defining the main function correctly would require a more detailed study.

Idea changes. Idea changes are an outcome of the value creating process of the program part of the business developing process. The operand of the value creating process is the idea, which gets transformed and/or new expanded versions (e.g. business plan are created by the process). For example, testing can be seen as a specific form of the idea changing process that transforms the "uncertainty" attribute of the idea from high to low.

New business. New business is an outcome (i.e. an operand) and result of the program's value creating process part of the business developing process.

Business growth. Business growth is an outcome of the program. In other words, business is the operand, an object that is transformed by the value creating process of the program, and "business size" or "growth readiness" can be seen as an attribute of the operand that gets transformed through the "business growing" process of the program.

New network or team. New network or team is an outcome of the program. A team can be interpreted as an object that gets created or expanded by the program's value creating process. New network can be interpreted from three perspectives: 1. new network is an informational object representing knowledge about different people or organizations that the participant acquires as a result of the program. 2. an informational object representing knowledge that different people acquire about the participant. 3. an attribute that changes the rate and quality of the interactions between the participant and other people or organizations. People or organisations in the network or new members in the team can also been seen as stakeholders.

Mentors. Mentors belong to the partner stakeholder type. For participants, they are a resource that enable and/or handle some parts of developing or the meta-developing process. Acquiring and maintaining these resources is a sub-process that the program handles or enables for the participant. Mentors can be seen as a part of the program.

Facilities. Facilities are a component of the program that participants have access to.

Travel. Travel is specific process that is enabled by the program. As tickets and accommodation are needed for travelling, it consumes money.

Tools. Tools are knowledge-based objects (i.e. informational objects) which enable some elements of the value creating process of the program to happen for participants with or without other program stakeholders. For example, transforming an idea to a business concept or helping a participant to learn a certain skill.

Networks. Networks are physical objects and groups of various stakeholders that enable certain parts of the program's processes. They can, for example, play a role in the resource acquiring and maintaining process at the developing level by helping the participant get funding for developing actions.

Funding. Funding is an informatical object which gets consumed by the developing or meta-developing process.

Scarce. Scarce is resource that is consumed by the process. For example, the budget for travelling, funding for developing process, or costs associated with physical (or digital) facilities.

Selection. Selection corresponds with a targeting and selecting process. It includes at least the main two stakeholders: participants and program managers. An example of a simple model for a selection process can be seen as first: transform the value of the "idea quality" attribute of a "business idea" object to "good enough." Secondly, transforming the "application status" attribute of the "applicant" physical object from "initial" to "application completed", and thirdly, from "application completed" to either "accepted" or "rejected". The first and second step would be handled by the applicant (i.e. potential participant) and the third step by the program managers. This model is just one possibility.

Cohort. A cohort represents a physical object, which has individual participants (e.g. students or businesses) as parts. The cohort or certain values of a cohort's attributes can be seen to enable certain sub-processes. For example, cohorts could enable resource acquiring and maintaining of network or mentor resources via the economy of scales phenomena.

6.1.3 Results of the quantitative analysis

Table 6.2, Table 6.3 and Table 6.4 show the results of the quantitative analysis. The contents of each table is discussed separately.

Patterns related to student stakeholders

To see how programs that targeted or did not target students were different, the sample of 45 programs was divided to those programs that are targeting students (27 programs, or 60 %), and those that are not (18 programs, 40 %). The results of this division are presented in Table 6.2.

67 % of programs (18 programs) targeting students also offered credits, while only 1 program (6 %) which did not explicitly target students mentioned credits on their website. In other words, programs targeting students were 12 times more likely to offer credits. This is very much expected and also in line with conceptual findings. Importantly, 10 of the 18 programs not targeting students were university-based, which means that in the university context, programs targeting students are very likely to offer credits.

It was also observed that 23 programs (85 %) targeting students emphasize skill-based outcomes, while only 5 programs (28%) not targeting students emphasized skill-based results. Thus, programs targeting students are three times more likely to emphasize skill-based outcomes than programs not targeting students. The difference was even bigger for “Broad” skills: 17 programs (63 %) vs. 2 programs (11 %), which means that programs targeting students are six times more likely to emphasize “Broad” skills.

Next, how student and non-student programs differ in terms of offering scarce resources was looked at. As described above, “scarce” resource was one of the three resources: facilities, travel, and funding. In the sample, 10 programs (37 %) targeting students emphasized scarce resources on their website, while 11 programs (61 %) not targeting students explicitly mentioned scarce resources. Given our small sample size, this is not a large difference. However, when looking at the variation between different types of scarce resources, interesting details come to light.

First, we see that only student-targeting programs offer or mention travelling as an explicit component of the program. In a way, it makes sense that younger people like students are attracted to travel. Of the five programs that offer travel, none emphasize “new business creation” or “business growth” outcomes while all of them emphasize “skill”-based outcomes. Based on careful review of program websites, it seems that for two programs, the travel is paid by the program, but for two others, the students pay the travel themselves with the money they earn in their mini companies.

This means that in the latter case, the universities are not actually paying for the travel. Still, it seems that two programs are able to fund travel (one international, one national) from their budgets. For “funding,” the difference is also large: two programs (7,4 %) vs. six programs (28 %), which equals to more than three times more likely. When we examine the program websites, we discover that the two programs offering funding and targeting students were actually offering only small grants of about 1000 €, while the non-student-targeting programs offered proper (pre-)seed-funding of at least tens of thousands of euros. However, given the small sample sizes, no conclusions can be made. For facilities, the difference does not seem significant in our small sample: non-student-targeting programs are only 1,8 times (39 % vs. 22 %) more likely to emphasize facilities.

In short, no student-targeting programs offer meaningful funding, while no non-student-targeting program emphasizes opportunity to travel during the program.

Do student-targeting programs utilize, or at least emphasize, less networks than non-student targeting programs? The answer seems to be yes, as only 5 (19 %) students-targeting programs emphasized them, while 15 (83 %) non-student-targeting programs did the same. This is a difference in likelihood of 4,5 times of utilizing networks. Is student-targeting irrelevant for programs emphasizing "mentors" or coaches? Based on the data, the answer also seems to be yes. Non-student-targeting programs were only about 10% more likely (83 % vs. 78 %) to emphasize "mentors" being part of the program.

Table 6.2: Differences in frequencies of variables between student-targeting and not student-targeting programs.

Type A	Number of programs	Type B	Number of programs	Ratio
student-targeting: credits outcome	18 programs (67%)	not student-targeting: credits outcome	1 program (6%)	12 : 1
student-targeting: skills outcome	23 programs (85%)	not student-targeting: skills outcome	5 programs (28%)	3 : 1
student-targeting: broad skills outcome	17 programs (63%)	not student-targeting: broad skills outcome	2 programs (11%)	6 : 1
student-targeting: scarce resources	10 programs (37%)	not student-targeting: scarce resources	11 programs (61%)	less than 1 : 2
student-targeting: travel resource	5 programs (19%)	not student-targeting: travel resource	0 programs (0%)	n.a.
student-targeting: funding resource	2 programs (7%)	not student-targeting: funding resource	5 programs (28%)	1 : 3,8
student-targeting: facilities resource	6 programs (22%)	not-student-targeting: facilities resource	7 programs (39%)	less than 1 : 2
total number of resources 3 or more: student-targeting	3 programs (23%)	total number of resources 2 or less: student-targeting	24 programs (75%)	1 : 3,3
student-targeting: networks resource	5 programs (19%)	not student-targeting: network resource	15 proggrams (83%)	1 : 4,5

Patterns related to business stakeholders

First of all, in general, only 38% of programs targeting “businesses” were also targeting students, while 86% of non-business-targeting programs were targeting students. Thus, there is only a limited overlap between these two groups. Are programs targeting “businesses” (i.e. startup teams, startups, entrepreneurial individuals) more likely to emphasize “growth” outcomes? In our dataset, business-targeting programs were 5,7 times (54 % vs. 9,5 %) more likely to emphasize those results. See Table 6.3.

Five (21 %) business-targeting programs offered credits, while 14 (67 %) non-business-targeting offered them. On closer inspection, we discover that no business-targeting program (15 programs total) which did not target students emphasized or offered credits.

When it comes to programs emphasizing skills as an outcome, the pattern is not clear, as 76% of non-business-targeting programs emphasized skill-based outcomes, while 50% of business-targeting programs did. On closer inspection, we see however, that student-targeting programs that also did not target business were ten times more likely to emphasize “broad skills” as an outcome compared to business-targeting programs that did not target students. Thus, key element here seems to be whether or not students are targeted.

Of programs that are managed by universities, 38% (10 programs) seem to be targeting businesses. For non-university-managed programs the percentage is 75%. 13 programs (54%) offer scarce resources, but the difference to non-business-targeting programs is not large as 38% of those programs also offer these resources. However, we also see here that all significant funding is targeted at businesses while all program offering travel-opportunity belong to the non-business-targeting programs.

Table 6.3: Differences in frequencies of variables between business-targeting and not business-targeting programs.

Type A	Number of programs	Type B	Number of programs	Ratio
business-targeting: business growth outcome	13 programs (54%)	not business-targeting: business growth outcome	2 program (10%)	5,7 : 1
business-targeting: credits outcome	5 programs (21%)	not business-targeting: credits outcome	14 programs (67%)	3,2 : 1
business-targeting: skills outcome	12 programs (50%)	not student-targeting: broad skills outcome	16 programs (76%)	less than 1 : 2
business-targeting, not targeting students: broad skills outcome (N = 18)	1 program (7%)	student-targeting, not business-targeting: broad skills outcome (N = 15)	12 programs (67%)	1 : 10
university-managed: business-targeting (N = 19)	10 programs (38%)	not university-managed: business-targeting (N = 26)	14 programs (74%)	n.a.
business-targeting: scarce resources	13 programs (54%)	not business-targeting: scarce resources	8 programs (38%)	less than 2 : 1

Patterns related to existence of a selection process

86 % of scarce-resources-offering programs do have an explicit selection process in place, which makes sense, as scarce resources need to be handled carefully. However, as 46% (11 programs) of non-scarce resource offering programs also have a selection process, the scarce resource is not the only explanation. When these 11 programs were looked at, 10 of them were cohort based.

In fact, programs that have a selection process are 12 times more likely to emphasize cohort structure on their website (80 %) than programs that do not have an explicit selection process (only 1 program or 7 %). In other words, when a program emphasizes a cohort structure, it almost always has an explicit selection process in place. As an interesting detail, programs that have a selection process mentioned on their website are nine times more likely to be managed by a non-university entity than programs that do not have an explicit selection process (18 programs vs. 1 program).

Table 6.4: Differences in frequencies of variables between selection process including and not including programs.

Type A	Number of programs	Type B	Number of programs	Ratio
scarce resources: selection process	18 programs (86%)	no scarce resources: selection process	12 program (50%)	less than 2 : 1
selection process: cohort structure	24 programs (80%)	no selection process: cohort structure	1 program (7%)	12 : 1
selection process: not university-managed	18 programs (60%)	no selection process: not university-managed	1 program (7%)	9 : 1

6.1.4 Assessing the results

The results presented in Table 6.2, Table 6.3 and Table 6.4 answer the first half of research question 2, that program formation is explained by stakeholder expectations and stakeholder-based social phenomena. The conceptual findings indicate that in the Finnish context, the higher education financial incentive model places credits (and graduate) production in a position of high importance as both university' and student income is highly dependent on it. This was also evident in the results, as the student targeting programs emphasized credit production.

Also evident was a big divide between programs that target businesses or entrepreneurs and those that did not. For the former, the emphasis was on actual business outcomes, while for the latter, the emphasis was on skills. Similarly, student-targeting programs emphasized skill over programs that did not target students. Interestingly, seen through the conceptual findings and especially the decomposed functional model, it is as if student and non-business targeting programs are mainly focused on the meta-developing process in the sense that they are improving students' competence in handling a business developing process. Meanwhile, business-targeting programs are engaged in actual business developing processes, though with an element of meta-developing. These results clearly align with the stakeholder profiles created as result of the conceptual stakeholder analysis, echoing past findings from the literature.

The findings regarding the strong connection between cohort structure and explicit selection process, and on the other hand the connection between selection mechanism and non-university managed programs, cannot be so easily explained with the conceptual findings. Connection between cohort structure and selection process can likely be explained by the desire to use resources more efficiently as cohort structure enables economics of scale (i.e. maximizes resources per participant) and a selection process yields the best candidates and thus, is connected to the "picking the winners" phenomenon. Both of these are cohort level phenomena.

6.2 Stakeholder expectations and program survival

Table 6.5, Table 6.6, and Table 6.7 present the results from the study about how good practices of entrepreneurship support in Finnish universities survived four years later.

6.2.1 Descriptive statistics of the sample

Table 6.5 shows the overall descriptive statistics of the whole sample of 110 good practices. The practices were reported by a total of 38 universities, of which 14 were academic research universities and 24 were universities of applied sciences. Overall, 77 (70%) practices had survived four years later. As the table shows, 64 (58%) practices produced credits, 20 (18%) had an external non-university organization managing the practice, 48 (44%) practices were reported by an academic research university, and 62 (56%) practices were reported by a university of applied sciences.

Table 6.5: Descriptive statistics of the entrepreneurial support good practice sample.

Variable	Value
Number of universities included in the report	38 (14 academic research universities, 24 universities of applied sciences)
Sample size (number of good practices included in the dataset)	110
Survival rate of good practices from 2016 to 2020	70% or 77 good practices
Proportion of good practices producing study credits	58% or 64 good practices
Proportion of good practices managed by external non-university organization	18% or 20 good practices
Proportion of good practices reported by academic research university	44% or 48 practices
Proportion of good practices reported by universities of applied sciences	56% or 62 practices

6.2.2 Quantitative analysis results

As the next step of the quantitative analysis, the whole sample was divided to two groups: those practices that survived (70% of all practices) and those that did not survive (30% of all practices), see Table 6.6. Of those that survived, 66% were producing study credits, compared to 39% of those that did not. Such a clear difference means that overall credit production would seem to be important for practice survival. Interestingly, 23% of those that survived had an external non-university organization managing the practice, compared to just 6% of those that did not survive, indicating that the managing organization has an important role. In this sample, academic research universities were a bit more likely to have a surviving good practice compared to universities of applied sciences.

Table 6.6: Comparison of good practices that survived and those did not survive.

Variable	Survived	Did not survive
Proportion	70% (77 of 110)	30% (33 of 110)
Produced study credits	66% (51 of 77)	39% (13 of 33)
Managed by external non-university organization	23% (18 of 77)	6% (2 of 33)
Proportion of practices reported by academic research universities	47% (26 of 77)	39% (13 of 33)
Proportion of practices reported by universities of applied sciences	53% (41 of 77)	61% (20 of 33)

Next, the sample was divided to those practices that were managed by a university (82% of practices) to those that were managed externally by a non-university organization (18% of practices). Of those practices that were managed by a university, 66% were still alive while externally managed practices had a survival rate of 90%. 64 % of university-managed practices offered credits, while only 30% of non-university managed did the same.

The sample was further divided to two groups: those practices that offered credits and those that did not offer credits. For university-managed practices, offering credits resulted in a 79% survival rate, while not offering credits resulted in a 41% survival rate. For non-university organization managed practices, the survival rate for credit offering practices was 80% and for practices not offering credits 90%. Given the small sample size of a non-university organization managed practices, conclusions regarding the importance of credit production cannot be made, but for universities, credit production seems to matter as the survival rate of credit-offering practices was nearly double.

Table 6.7: Comparison of good practices managed by university to non-university managed.

Variable	University-managed	Non-university managed
Proportion	82% (90 of 110)	18% (20 of 110)
Survival rate	66% (59 of 90)	90% (18 of 20)
Offered credits	64% (58 of 90)	30% (6 of 20)
Proportion of practices that offered credits that survived	79% (46 of 58)	80% (5 of 6)
Proportion of practices that did not offer credits that survived	41% (13 of 32)	90% (13 of 14)

6.2.3 Assessing the results

The results presented above seem to point to two issues. First, credit production seems to be a predictor of practice survival when the practice (program) is managed by a university. University-managed credit offering practices had a survival rate two times higher in the sample. This would be in line with the conceptual findings presented in the previous chapter. Specifically, the unique financial incentive model in the Finnish higher-education system has been closely connected to credit production for both universities and students. Thus, programs that do not produce credits would be in a more challenging position when it comes to attracting students and keeping universities motivated to continue the program.

Second, a surprising finding was that non-university organisation managed practices had a survival rate of 90% compared to 66% of university managed practices. From a closer inspection of the 20 non-university organization managed practices, 10 are so-called entrepreneurship societies which, according to the summaries in the Ministry report, are primarily student-run associations that get access to facilities and maybe some small grants or funding from the university. Few organizations are established organizations related to university IP commercialization, which is assumed to be connected to commercialization revenues. A few other practices are managed and/or coordinated by an external organization but university teachers actively contribute by teaching a university course under the practice umbrella. An example is an incubation service that includes university-run entrepreneurship courses. In this case. the earning logic of involvement is the same as if the whole operation would be run internally. Given these details and the small sample size (20 practices), it is not possible to conclude whether there really is a higher survival rate and what the reason might be. However, there is an indication that these organizations were utilizing phenomena in their resource acquisition and maintaining process which is different from the credit-centered financial incentive system. For the ten entrepreneurship societies, the socio-economic phenomena harnessed is some form of volunteering, wherein students invest their own time and energy to keep the societies running.

One future issue of interest to study would be the existence of a cohort-structure and the inclusion of an explicit selection process, and how these two features affect program survival. The results from the multiple case study indicated that non-university managed programs were more likely to have an explicit selection process compared to university managed programs. Thus, a selection process might provide part of the explanation.

7 Discussion

This chapter discusses the theoretical and methodological implications of the findings, which are summarized in Table 8.1 at the beginning of chapter 8 (p. 241), and the implications for practitioners and entrepreneurship program designers and managers. The quality of the research is assessed from the perspective of each research question.

7.1 Theoretical and methodological implications

This dissertation has argued that the problems faced by university entrepreneurship and entrepreneurship programs as an area of study are due to the complexity of the phenomena and limitations of methodologies used. These factors together have prevented the field from developing prescriptive theories (Christensen & Carlile, 2009) that would be practically useful for designers and managers of entrepreneurship programs. A total of eight criteria were then specified as the requirements for a new framework and methodology. It was then shown that object-process methodology incorporating techniques from systems engineering and complexity science is a conceptual framework and methodology that can overcome these hurdles. This choice was based on the fundamental definition of entrepreneurship programs as purposed systems in Arthurian terminology (Arthur, 2009), or more generally, as simply systems with specific functions. The chain of argumentation continued, and it was stated that stakeholder expectations and the socio-economic phenomena also associated with the stakeholders themselves are the key to understanding the existing forms and survival of entrepreneurship programs. The argument in its totality has several methodological and theoretical implications, of which the most important are:

1. Object-process methodology is suited for the harmonization of the discussion and more robust conceptual development.
2. Separation of form and function is a step in developing descriptive theory into prescriptive theory.
3. Program-related phenomena is highly contextual.
4. Entrepreneurship is a distributed phenomenon.
5. Meta-developing overlaps with innovation management.

Object-process methodology is suited for the harmonization of the discussion and for more robust conceptual development

As the literature review in chapter 2 revealed, the field of university entrepreneurship is a field of many angles and niches. Terminology and concepts vary and comparison between studies can be challenging. However, as the many OPM diagrams included in this dissertation demonstrate, the fundamental building blocks of the framework and methodology are more than well-suited for modelling the findings and insights presented in previous studies. Because of this, for example, separate research on 17 different stakeholder types based on numerous papers was modelled using OPM. As a virtue of the unified visual symbolism, it was then possible to observe patterns emerging from this diverse set of studies, resulting in the definition of the three main functions an entrepreneurship program can have.

The findings imply that OPM can be used to successfully model and study the relationships between multiple stakeholders at various levels of analysis and capture the diversity and balancing act of expectations and functions universities are experiencing, suggested by past researchers such as (Hacket & Dilts, 2004; Rothaermel et al., 2007), (Grimaldi et al., 2011; Ollila & Middleton, 2011; Bruneel et al., 2012; Miller et al., 2018; Miranda et al., 2018).

Additionally, this dissertation demonstrated that the structural relationship modelling tools and the possibility to zoom in and out in system models are a practical way to manage the level of analysis (i.e. scale and complexity). As discussed in the section describing some core concepts from complexity science, there is a trade-off between the scale of the phenomena and the complexity of the model needed to model its behaviour in a practically useful way (Bar-Yam, 1997). OPM captures this trade-off well as, at different scales, the details can be added as needed so that at the highest level only the relevant details are visualized. This answers the call by other researchers who have acknowledged and recognized the need to model the complexities and multi-level nature of the phenomena better (Rothaermel et al., 2007; Grimaldi et al., 2011; Bruneel et al., 2012; Chesbrough & Bogers, 2014; Pauwels et al., 2016; Guerrero et al., 2016; Schmitz et al., 2017; Miller et al., 2018b; Miranda et al., 2018).

Thus, these findings suggest that either scientists currently engaged in the study of university entrepreneurship phenomena would benefit by adopting the OPM as a tool, or that researchers from engineering fields could take on the challenge and navigate themselves towards these study topics. As one of the first things, a collective effort to create a catalogue or taxonomy of objects and processes of university entrepreneurship and entrepreneurship program phenomena could be created, as suggested by Cohen et al. (2019), using OPM dual-channel representation.

Separation of form and function is a step in developing descriptive theory into prescriptive theory

Building on Arthur's work on the nature of technology (Arthur, 2009) and findings from complexity science (Bar-Yam, 2004; Sheard et al., 2015), it was argued that entrepreneurship programs are able to fulfil their purposes only to the extent that they are able to harness naturally occurring socio-economic phenomena. This distinction between form (means, phenomena) and function (purpose) is one of the most fundamental concepts in systems engineering (de Weck, 2015a; Dori, 2016).

Systems engineering implicitly suggests that it is in fact the functional classification of phenomena (or means) that allow theory to be prescriptive rather than mere descriptive. The very definition of function defines the purpose of a given system, and using function as a categorization principle, various means and phenomena are naturally connected to whatever it is that is supposed to be achieved. This would satisfy the “cause and effect” criteria set for a prescriptive theory by Christensen and Carlile (2009). This classification would help clarify which mechanisms are of interest and thus, making the challenge, suggested by Cohen et al. (2019), of understanding the impact mechanisms of accelerators far easier.

As an example of application, consider the work on knowledge creation and innovation policy types by Harmaakorpi, Melkas and Uotila (2017). In their paper, they construct a framework wherein innovation policy makers can broadly select between modes of knowledge production, a concept originally developed by Gibbons et al. (1994). In the more advanced model by Harmaakorpi et al., there are three modes of knowledge production: science-based innovation (mode 1), practice-based innovation (mode 2a), and another type of practice-based innovation (mode 2b). Seen through the lens used in this dissertation, the characteristics of the various modes of knowledge production are different types of phenomena and means harnessing those phenomena. This means that the next step could be categorization based on function or purpose. Functional categorization would allow innovation policy makers to specifically choose an approach based on the goal and circumstance in a given situation. Moreover, as with the function (and sub-functions), phenomena could be categorized based on the scale of the outcome of interest, as some of the phenomena are highly dependent on scale. For example, the competitiveness at the level of a single company is a different phenomenon from competitiveness at the level of a cluster or regional economy.

Program-related phenomena is highly contextual

The findings of this dissertation show that the socio-economic phenomena related to entrepreneurship program stakeholders is very contextual. As demonstrated by the analysis of the Finnish higher education financial incentive scheme involving students and universities, this context-specific phenomenon plays a big role in the survival and formation of entrepreneurship programs in Finland.

These results imply that the field of entrepreneurship program research will have trouble discovering universally applicable phenomena, as the phenomena is very much dependent on the context-specific nature of stakeholders and the dynamics between them. This implication would also be in line with Bar-Yam (2004), Sheard et al. (2015) and Siegenfield and Bar-Yam (2020), among others, who argue that systems embedded in complex environments with complex phenomena cannot be developed based only on analysis but should be allowed to adapt and evolve in interaction with its environment and internal dynamics. These principles are operationalized, for example, in the so-called agile software development methods, in which it is assumed that customers themselves don’t know what they want before they experience it. As a result, only a limited amount of resources are invested in any given version of a product before its value is confirmed by the customers (Ries, 2011).

Entrepreneurship is a distributed phenomenon.

As a result of the functional analysis process implemented in this dissertation, it was discovered that entrepreneurship programs can be seen to have up to three hierarchically related main functions, and three sub-functions under each main function. Importantly, these findings should be interpreted so that the process, whether it is business operating, developing or meta-developing, is an independent process or phenomenon from the entrepreneurship program, because the function describes the desired transformation that should take place, not the system enabling the transformation. Additionally, because of functional decomposition, it becomes clear that entrepreneurship programs can also play a partial role in enabling these desired transformations to take place.

From the point of view of the entrepreneur, participating in an entrepreneurship program can be seen as a way of acquiring resources needed in the developing process, for example. Likewise, the process of scientific discovery and documenting the invention could be categorized only as being a part of the targeting and selecting process. This would seem to be in line with Mason and Brown (2014) who argue in their report to the OECD that the proper unit of analysis should be the whole entrepreneurial ecosystem. This insight could be compared to the 31st poem of Kalevala (Lönrott, 1849), in which a misfortunate man called Kullervo is tasked to build a fence around a house. In his fervour to show his talents, he builds a fence sky-high, but forgets to see the bigger picture and to include any door or gate in the fence.

Meta-developing overlaps with innovation management

As a final theoretical implication, the large similarities between the meta-developing function and the field of innovation management need to be reported. Business meta-developing was defined as the transformation of the performance attribute of a business developing process from an undesired state to a desired state.

ISO 56002 (2019) standard "Innovation Management" defines the innovation management system as the system that, on the one hand, includes the innovation operations of identifying opportunities leading to the deployment of solutions, and on the other, the plan-do-check-act cycle that monitors and improves these innovation operations. These two processes overlap to a great extent with the business developing process and the business meta-developing process.

Even though the innovation management literature is predominantly focused on single companies or organisations as their unit of analysis (Karlsson & Magnusson, 2019), entrepreneurship program managers and university entrepreneurship scholars could benefit from becoming knowledgeable in the findings and concepts of innovation management literature, as that field is interested in understanding the development of innovation processes themselves. This could lead to incubators and accelerators that are able to tailor their approaches to each startup and help startups monitor and adjust their development process as needed. On the other hand, the field of innovation management research could benefit from this expansion as, in meta-developing, the system responsible for the meta-developing and the system handling the developing process could be different organisations. In addition, instead of having only a single organisation, there would be a need to understand the dynamics of a cohort in innovation management (i.e. meta-developing).

7.2 Implications for program designers and managers

For entrepreneurship program designers and managers, the findings of this dissertation have several implications. First, the most practical suggestion is to use the derived main functions and sub-functions as a framework of analysis. Program managers could use the framework and ask what options their current or targeted tenants have for handling each function. For example, "how is the targeting and selecting process currently done?" This analysis would naturally open a way for the managers to see the bigger picture and the role of the whole entrepreneurship ecosystem, and would then help to recognize a suitable role for the program itself given the current context.

Should program designers be willing to move deeper in their analysis, they should start cataloguing and collecting harnessable phenomena from the literature and analyze the socio-economic phenomena in their context. In the case of university-managed programs, the funding model plays a big role as it is a way to handle the resource acquiring and maintaining in a predictable and systematic way. The meta-developing function challenges practitioners to resist the temptation to see the program itself as the main business developing system. Instead, the concept of meta-developing suggests that programs should help entrepreneurs recognize the business developing processes they are implementing, and then help entrepreneurs to monitor and improve the performance of those processes.

Finally, as mentioned under the theoretical implications section, because of the complexity of the phenomena, practitioners should not trust in the full, deterministic correctness of their design choices. Instead, they should make only informed guesses and let their programs evolve in response to environmental and internal demands, slowly accumulating understanding about the phenomena involved and the correct niche for the program to occupy in the larger ecosystem.

7.3 Assessing the quality and ethicality of the research

In this final section of the discussions chapter, the reliability, replicability, and validity of the research and the argument are discussed, which, according to Bell et al. (2019), are the cornerstones of assessing research quality. In this dissertation, the quality of the research and strength of the argument will be assessed on two levels. First, quality is assessed on the level of the whole research, and second, with more detailed assessments focusing on each research question. The choice to decompose the assessment using the five research questions is a novel choice made by the author. The motivation comes from the breadth of the research and diversity of implemented research designs and methods. The rationale for using the research question as a focal point of assessment is based on the central guiding role of research questions in scientific research. Bell et al. (2019) list seven valuable guiding aspects of research questions including: research design choices, what data to collect, and how to analyse data. Thus, after the assessment of the study as a whole, a more detailed assessment is completed focusing on each research question.

Quality and ethicality of the study as a whole

Internal validity of a theory "is the extent to which (1) its conclusions are unambiguously drawn from its premises; and (2) the researchers have ruled out plausible alternative linkages of the phenomena with the outcomes of interest" (Christensen & Carlile, 2009, p. 245). Bell et al. emphasize the latter point by stating that internal validity refers foremost to the confidence researchers have in the argument of the state's causality, that variables pointed out by researchers really explain the behaviour of dependent variables of interest.

Using the first element of internal validity, "conclusions are drawn from its premises" by Christensen & Carlile, the validity can be assessed as being good. The main research problem was clearly defined based on a comprehensive literature review and overall assessment of the field, which lead to the definition of eight criteria for a new conceptual framework and methodology. With much reduced ambiguity, the study introduced a novel universal ontology and formal modelling language to the field. The conclusions, including the centrality of stakeholders and function as key principle of categorization, were based on the fundamental concepts of the framework. In summary, each step from the review of the current state of the research field to the conceptual and empirical findings were presented in an arguably logical chain of thinking. Because of OPM-based formalism, arguments can be presented more rigorously, something similar to mathematical formalism. When it comes to the second aspect of internal validity, "ruling out other plausible explanations", the two empirical studies need to be in focus. Even though the data indicates a relatively strong relationship between stakeholder expectations and program survival and formation, other plausible explanations were not explicitly discussed or ruled out. In the future, studying the relative importance of various harnessable socio-economic phenomena can be expected to push this part of internal validity to higher level. An argument could also be made that object-process methodology is not the only plausible conceptual framework that could be adopted. This is of course the case, but as it was shown that the framework is compatible with multiple other system frameworks and definitions, there is less room for the existence of other, better frameworks.

External validity is another aspect of validity commonly assessed (Bell et al., 2019). A theory's external validity "is the extent to which a relationship that was observed between phenomena and outcomes in one context can be trusted to apply in different contexts as well" (Christensen & Carlile, 2009, p. 246). At the level of the whole study, it can be argued that the work demonstrated the applicability of OPM in a context where in it had not been used much. Empirical findings, and parts of the conceptual findings, were focused on the Finnish higher education context. We cannot assume that that similar patterns would be observed in other contexts, with different stakeholders and stakeholder-associated phenomena. However, it is argued that similar steps (stakeholder analysis, analysis of harnessable phenomena) are applicable in other contexts. To demonstrate this is left for future studies.

The *reliability* of a study is related to the reliability of the measures and whether same results could be acquired again (Bell et al., 2019). For example, the common measure of cognitive ability (IQ) has been criticized for not being a reliable measure, as the IQ of the same person might vary considerably. “Psychologists do not realize that the effect of IQ (if any, ignoring circularity) is smaller than the difference between IQ tests for the same individual (correlation is 80% between test and retest, meaning you being you explains less than 64% of your test results” (Taleb, 2019). For this study, a key to reliability is assessing whether other researchers would come up with the same quantitative data using the same process of OPM-based content analysis described in the study. As one of the purposes of OPM is to reduce this type of ambiguity, results can be assessed to have improved reliability. Similarly, the results of the conceptual findings rest on the ambiguity in the process that leads to the development of models from past research.

Replicability is the aspect of research’s quality that assesses whether other researchers can re-do the study or not (Bell et al., 2019). This requires that the methodology be clearly described and can be implemented by others, and the phenomena of interest is not fleeting, but can be studied at other times. The overall replicability of the study can be assessed as being good, as each step was carefully detailed and the approaches used are originally documented in the relevant literature. Again, the use of OPM can be seen to make conceptual research steps such as category-development easier to follow. On the other hand, as most of the data used came from existing documents broadly available, other researcher can verify the findings themselves. Some aspects of the two empirical studies are a bit more challenging to replicate, and these details are discussed in the following sub-sections where the quality of research is further assessed by focusing on each research question.

Ethicality of a study can be assessed according to some key aspects, including whether participants were harmed, whether privacy was violated, and is there conflict of interest (Bell et al., 2019). Even though this study did not have any individuals as subjects of the study, a decision was made to not to publish program survival data related to the second empirical study. Specifically, information regarding the survival of specific programs was omitted as this could be seen to cause reputational harm to the universities and/or individuals responsible for those programs. This data is kept safe by the researcher and can be accessed by evaluators. When it comes to the issue of conflicts of interest, it needs to be noted that at the time when this research was done, the author was employed by Karelia University of Applied Sciences, a Finnish university, and the author has been a lead developer and manager of a regional entrepreneurship program called the Draft Program. Additionally, it is highly likely that the findings of this study will influence the future work of the author. This includes the author using this study as supporting evidence for the quality of the argument in future project plans and funding applications for university entrepreneurship. However, as the methodological steps where openly documented and effort was made to have a nearly complete sample of Finnish entrepreneurship programs, it is argued that the affiliations of the researcher did not compromise the integrity of the research.

Now that the assessment of the quality and the ethicality of the research as a whole is complete, the focus is now on the quality at the level of individual research questions.

Research question 1: What conceptual framework and methodology can help university entrepreneurship research to transform from descriptive to prescriptive?

Research question 1 was based on a comprehensive literature review, presented in chapter 2, on university entrepreneurship and entrepreneurship program research. The review revealed that economic development has become one of the three main missions of the university, alongside research and education. It also showed how scholars acknowledge that various programs such as TTOs, entrepreneurship education programs, and incubators all play different roles in university entrepreneurship. One of the more important recent findings was the discovery by Azoulay et al. (2020) that younger people on average have much poorer chances of succeeding as entrepreneurs, when compared to middle-aged people with relevant industry experience. As a result, eight criteria for framework and methodology were specified that would help the field move towards prescriptive theories.

The literature review findings can be seen to well represent the field as it was based on major well-cited reviews, meta-analyses, and selected influential papers. Replicability can be assessed as being good as the steps implemented in the literature review were described at the beginning of chapter 2. Finding the evidence in support of the conclusion that university impact is controversial has an element of happenstance, as some of the papers, like the one by Azoulay et al., were discovered outside of the formal literature review.

The support for the validity to the answer of research question 1, that object-process methodology is a suitable methodology, rests on both conceptual rationale and practical implementation of the methodology in the dissertation. In chapter 3, the argument is made that object-process methodology incorporating insight from systems engineering and complexity science offers the right type of methodology and satisfies the eight criteria defined in chapter 2. The argument is based on the fundamental concepts forming the basis of these fields and especially on the work of complexity science pioneer W. Brian Arthur (2009). As these methodologies have been successfully applied in fields of high complexity, the argument can be seen as being sound. Furthermore, the successful and meaningful application of said methodology throughout the dissertation provides further evidence for the validity of the answer. Proof of external validity, or transferability, is given by the fact that the methodology was successfully utilized to model a wide variety of research findings from many different authors in a way that produced meaningful and comparable results. Due to the universality of the OPM ontology, there is no obvious reason for doubting its applicability in diverse set of fields. OPM has been utilized in fields as distant as cell biology (Dori & Choder, 2007), Mars mission planning (Do, 2016), and business process improvement (Casebolt et al., 2020). The author of the dissertation had also previously utilized OPM to model an entrepreneurship program (Immonen, 2019a).

Research question 2: Are stakeholders' expectations and the stakeholder-based socio-economic phenomena associated with the programs key to understanding the formation and survival of entrepreneurship programs?

Research question 2 was answered by conducting two empirical studies, one multiple case study and one longitudinal study, and comparing the observed patterns to the conceptual findings resulting from the answers to research questions 3 to 5 (see below). The first case study looked at the value propositions of Finnish entrepreneurship programs, while the second case study looked at the survival of so-called good practices of entrepreneurship support. For both of these studies, the reliability, replicability and validity will be inspected separately.

The reliability of the results from the first case study are defined by a few key questions: 1. would other researchers model the information on program websites as was done in this dissertation? 2. Would other researchers characterize programs similarly using the list of variables? For both questions, the biggest measure taken to support the reliability was the decision to adopt OPM as a tool in the research process. According to Dori (2016), in OPM the focus should be in the semantics of sentences and words, and not in the direct syntax. In most cases a noun can be modelled as an object, but sometimes nouns signify processes. As was described in chapter 4, in OPM, a noun can be modelled as a process when it passes "the process test". For a noun to be modelled as a process, it must meet three process test criteria: 1. object transformation, 2. time association, 3. verb association (see more detailed explanation in chapter 4) (Dori, 2016). Using the process test, it was possible to produce the model with relatively good reliability. As for the second question regarding reliability, the characterization of programs not part of the initial sample of 30 programs could be seen as a reverse version of the process test. As the characterization variables produced as part of the analysis of the initial 30 programs were based on a total of 173 different objects, the researcher could compare the content on program websites to the objects that had been classified under each variable. There remains an element of subjectivity and repeating the characterization process in the future by other individuals would be a step in further assessing the reliability of the measures.

To ensure replicability, one crucial step was taken: copies of the websites of all 30 programs in the initial sample were saved to the researcher's computer so that if the content on program websites experiences changes, the state of websites at the time of analysis would not be lost. If needed, the author can allow reviewers to inspect these versions and compare them to the models produced. When it comes to the validity, the most important question is: how well do the websites reflect what is actually being offered by the programs? According to Bruneel et al. (2012), the actual use patterns by the tenants of various services of an incubator were, to some extent, disconnected from the aspects emphasized on the websites. However, this does not negate the idea that public information offered on the websites reflects the expectations of all key stakeholders. The rationale here being that the website remains a key marketing channel for communicating what the program offers and to whom. Future studies could look more deeply at the accuracy of website content in reflecting actual program offerings, and especially if there are any systemic deviations. These assessments could be implemented, for example, by interviewing program managers or observing the programs in action ethnographically. Due to the small sample size, firm statistical conclusions are difficult to make.

As for the second study, the reliability and related measures can be assessed by looking at the reliability of characterizing good practices based on the variables. As the variables defined based on the initial report were only dependent on the information available in said report; there were only a limited number of variables that could be assessed. In order to be characterized as producing credits, or being managed by an outside organisation, these would need to be clearly indicated by the report. Whether or not the program had survived until the moment of analysis was defined by searching the university's website, Facebook, and a freeform Google search. To improve reliability, unclear cases (total 7) were excluded from the sample.

Replicability of the second study is easy for the part where programs (practices) were characterized based on the report, as the report is publicly available. However, for future survival analyses, the information available is bound to change as more and more practices disappear. By investing a bit more effort into interviewing stakeholders and searching archives, the time the practice ended could be determined. For validity, similar rationale to the first study applies. The precision in defining the status of a practice or program based on an online search is robust only to a certain extent. Validity could be further improved by engaging in additional interviews and the study of non-public documents to provide more certainty.

Research question 3: What are the expectations of entrepreneurship program stakeholders?

This research question was answered by implementing a process called stakeholder analysis. The results of the stakeholder analysis, as they rest on findings from literature done by other researchers, are highly replicable to the extent that future authors can study the same sources and replicate the same modelling steps. This also means that the reliability rests, to a large extent, on the validity of the source literature. An effort was made to select highly cited and influential studies. The conversion of these findings into simple OPM models is also highly traceable as these models are presented in this dissertation. The conversion can be seen as reliable as it followed the process test and other modelling principles to catch the semantics correctly in the models (see chapter 3).

Research question 4: Is there any universal purpose or purposes all entrepreneurship programs share? If so, what would those be?

This research question was answered by implementing an analytical process called functional analysis. In functional analysis, the source information used was the simple OPM models produced as a result of the stakeholder analysis and additional OPM models produced earlier in the dissertation. The classification of these simple diagrams into larger categories was then presented with corresponding intermediary diagrams, which then lead to the definitions of the three main functions. The reliability of this process was supported by paying close attention to inheritance, that is the specialized object would exhibit the characteristics of the general (abstracted) object. Clear documentation of these steps supports the internal validity and replicability of the results. As the stakeholder-specific models were based on a large number of different stakeholder types and many studies, there is also an indication of the transferability, or external validity, of the conceptual findings. The results from the functional decomposition step, the definitions of the three sub-functions, have high internal validity as they are derived from the fundamental definitions of the object-process methodology and systems engineering. Validity is further supported by providing examples connected to the entrepreneurship program phenomena.

Research question 5: What phenomena can be harnessed to fulfil said purposes?

The validity of the results of the analysis of harnessable phenomena (i.e. answer to the fifth research question) rest, on one hand, on the validity of the results of the two earlier steps: stakeholder analysis and functional analysis, and on the other, on the robustness of the process that was used to select the past studies in support of various phenomena. Analysis of scale was directly based on the results of stakeholder and functional analysis, especially the simple OPM models produced at that stage. This made it possible to create representations of the three main functions at a higher scale (i.e. at the scale of the economy). The literature search for the harnessable phenomena was based on the function and scales defined at earlier stages alongside the accumulated knowledge the author had of existing relevant research. There was an emphasis on selecting highly impactful studies that had produced strong empirical findings. As a last step, the unique details regarding the Finnish higher education financial incentive scheme, which were acquired from publicly available government websites and selected reports, were converted into an OPM model showing the dynamics between the three stakeholders: the student, the university, and the government, in the Finnish context. Due to the publicity of the source information, this modelling step can be defined as highly replicable. The model should also be seen as having high internal validity as it was based on statements of the cause-and-effect type in the source material.

8 Conclusions

Initially, in this study, it was shown that entrepreneurship programs and university entrepreneurship programs are a topic of increasing importance, but the universities' roles in economic development and entrepreneurship is not without contradictions. It was then argued that because of the complex and multi-scale nature of the phenomena (see for example Rothaermel et al. 2007), the field has not been able to make the transition from descriptive theory to prescriptive theory (Christensen & Carlile, 2009) which would help designers and managers make good design choices.

The main research problem was defined as conceptual and methodological, in other words, that the way forward is to adopt a conceptual framework and methodology which is able to handle the said complexities of the phenomena. Eight criteria (1. cause and effect, 2. complexity, 3. multiple scales, 4. multiple stakeholders, 5. knowledge retention, 6. universality, 7. theory developing, 8. practicality) were specified that a new conceptual framework and methodology would need to satisfy (see Table 2.1 in sub-section 2.3.4, p. 64). Object-process methodology (Dori, 2016) incorporating insights from systems engineering and complexity science was offered as the right methodology. Importantly, entrepreneurship programs were framed as purposed systems, or *means to fulfil a human purpose*, that can fulfil those purposes to the extent they can harness naturally occurring socio-economic phenomena (Arthur, 2009). The details of how this framework and methodology satisfies the eight criteria is summarized in Table 3.3 in sub-section 3.9 on page 99. This chain of thinking then lead to the statement that understanding the expectations of, and the phenomena associated with, the stakeholders of the entrepreneurship program is the key to explaining program survival and formation.

In order to produce operationalizable information regarding the stakeholders, three conceptual studies were then defined and conducted. The techniques: stakeholder analysis, functional analysis, and analysis of harnessable phenomena, were used to convert past literature-based findings into concrete conceptual results defining the main functions and sub-functions of an entrepreneurship programs, to categorize various phenomena based on scale and function, and to develop a model of the Finnish higher education financial incentive model.

In the empirical part, two studies were conducted incorporating both qualitative and quantitative methods. In the first, multiple case study stakeholder-related patterns in the value propositions of 46 Finnish entrepreneurship programs were investigated, while in the second longitudinal study, the survival of 117 so-called good practices of entrepreneurship support were looked at 4-5 years after being reported as good practice. In the discussion chapter, several implications of the findings and the quality of the research was discussed.

8.1 Answers to the research questions

Table 8.1 summarizes the findings in connection to all five main research questions. Taken together, the results indicate that object-process methodology is a potential new tool for university entrepreneurship and entrepreneurship program research. In addition, the adopted conceptual framework suggested that stakeholders have a key role in understanding causes in university entrepreneurship. This suggestion was supported by the evidence from the two empirical studies.

Table 8.1: Central findings of the dissertation.

Research question	Findings
1. What conceptual framework and methodology can help university entrepreneurship research to transform from descriptive to prescriptive?	Object-process methodology incorporating systems engineering techniques and complexity science insights is capable of conceptually modelling a wide range of university entrepreneurship-related phenomena across multiple scales. Details of how the framework and methodology satisfy the eight criteria specifying the first research question is summarized in Table 3.3.
2. Are stakeholders' expectations and the stakeholder-based socio-economic phenomena associated with the programs key to understanding the formation and survival of entrepreneurship programs?	1. Stakeholders' expectations are reflected in the value propositions of Finnish entrepreneurship programs. Specifically, programs that target students and programs that target businesses have highly distinctive offerings, the former emphasizing skills and study credits, while the latter emphasizes actual business results and related resources. 2. Context specific stakeholder-based phenomena is related to program survival. Specifically, in the Finnish higher education context, university-managed programs that harnessed the study-credits related financial incentive phenomena were about twice as likely to survive than those that did not. Interestingly, non-university managed programs had a higher-rate of survival when compared to university managed, and for which offering credits did not seem to predict program survival.
3. What are the expectations of entrepreneurship program stakeholders?	Based on literature review, three generic stakeholder categories were recognized and information about expected value and information regarding specific circumstances and relationship with other stakeholder types was compiled for each stakeholder type. This information was captured in simple OPM-models and category-specific tables. The categories and stakeholder types belonging to each category are as follows. Sponsor-category: university, government, corporation, investor, science park. Participant category: student, academic, entrepreneur, startup, business. Partner: incubator or accelerator, mentor, expert, manager or operator, TTO, educator, user. Additional information regarding the government, university, student, and entrepreneur in the Finnish context was recorded.
4. Is there any universal purpose or purposes all entrepreneurship programs share? If so, what would those be?	Based on the thorough process of functional analysis, it was discovered that, conceptually, entrepreneurship programs can be seen as means to fulfil at least one of three main purposes: business operating, business developing, or business meta-developing. Business operating signifies predictably profitable business activity. Business developing is defined as the creation or discovery of predictably profitable business activity. Business meta-developing is defined as improvement of the performance of the business developing process from not satisfactory to satisfactory. Together, these three purposes are in a hierarchical relationship, so that the business operating system is the object of business developing, and business developing system is the object of business meta-developing. Importantly, business operating yields surpluses that are consumed by the developing and meta-developing processes. The process of functional decomposition yielded three abstracted sub-functions that are shared by all the three main functions. These are value creating, targeting and selecting, and resource acquiring and maintaining. An entrepreneurship program can be seen as an instrument or agent for fulfilling any number of the main functions or sub-functions in an entrepreneuring process.
5. What phenomena can be harnessed to fulfil said purposes?	After conducting an analysis of scale based on stakeholder expectations, and a focused literature search, a number of phenomena were recognized and then organized according to scale and function. The three scales used were the startup, the cohort, and the economy. The findings demonstrated the logic of implementing a literature search based on function and scale. The discovered phenomena highlight the importance of skills and knowledge already in possession of the entrepreneurs. Finally, a detailed OPM model of the Finnish higher education financial incentive phenomena was created, showing the centrality of the credits production.

8.2 Contribution

As stated in the introduction chapter, there are several ways this dissertation contributes to the field of entrepreneurship program and university entrepreneurship research. First, the current descriptive state of the field was being diagnosed, being caused by the lack of a proper conceptual framework and methodology. It was argued that by adopting a better framework and methodology, the field could move towards prescriptive theories. Eight criteria were then defined to specify exactly what would be required from said framework and methodology. Following this, it was then shown that object-process methodology incorporating insights from systems engineering and complexity science satisfies all eight criteria. This, and the successful use of the methodology, clearly demonstrated the value of it in the research of university entrepreneurship.

The first conceptual study recognized 17 stakeholder types that an entrepreneurship program can have and compiled the expectations of these stakeholders based on literature. This effort can serve future researchers and practitioners in their work to understand stakeholders' roles better.

The second conceptual study yielded three general purposes and three sub-functions an entrepreneurship program can have, based on OPM-based analysis of existing literature on entrepreneurship program stakeholders. The value of the recognized functions is that, in the third conceptual study, they allowed the development of a categorization scheme for categorizing various phenomena based on function and scale to aid future researchers and practitioners to make choices on what phenomena to harness or study. With this categorization scheme, a diverse collection of programs such as education-oriented programs, technology transfer offices, and accelerators can be classified based on their function and targeted scale.

The two empirical studies provided evidence for the importance of understanding stakeholder expectations and associated phenomena in explaining the observable entrepreneurship program patterns and program survival. It showed the role that the resource acquiring and maintaining process plays in program survival, without the need to analyse program effectiveness and value creating mechanisms. Finally, this dissertation contributed to the field by collecting new information regarding the type and nature of Finnish entrepreneurship programs in higher education.

8.3 Further research

There are several lines of research this dissertation can inspire. First of all, studying the usability of OPM in various contexts and comparing it to other sense-making and modelling tools would be valuable. In particular, the reproducibility of models when the modeller changes would be an important topic for future investigation.

As Cohen et al. (2019) propose, one of the steps that could happen would be the development of a taxonomy of entrepreneurship program practices. This dissertation suggests that such a study would best serve prescriptive theory building by implementing a function and scale-based categorization scheme as the basis of such activities. The benefits of this would be in allowing an easy comparison of the means. For example, the function of entrepreneurship education could be handled by many different types of means including mentors, formal lectures, founder stories, trial and error, and so forth. Studies could then be conducted to investigate the effectiveness of said means in specific circumstances.

Third, a study looking into entrepreneurship program survival could be repeated in much greater detail. If done in the Finnish context, the same initial report from 2016 (Viljamaa, 2016) could be used as the initial sample, and then the survival of practices could be studied at different points in the future. Importantly, data collection could be done more holistically and more robustly by including interviews and ethnographic approaches. Program participants, founders, managers, and designers could be interviewed for possible explanations of program survival or discontinuation, and to collect information regarding the evolution experienced by the program.

Fourth, if the results from the two empirical studies are taken together and viewed in the light of the conceptual findings, an interesting possibility for a connection between programs having explicit selection processes and program survival is observed. Specifically, the first empirical study indicated that programs managed by external organisations had a high likelihood of having an explicit selection process. On the other hand, empirical study number two indicated that externally managed programs had a higher survival rate than programs managed by universities. This points to an opportunity for a future study where a program having an explicit selection process is defined as an independent variable and its significance to program survival is measured.

Fifth, the adaptation of OPM in this study allowed the author to take findings from many past authors and compile unified models based on these simpler pieces of information. In the past, such a method has been used, for example, to build a holistic model of a part of cell metabolism (mRNA lifecycle) and then use the model to deduce previously undiscovered properties of the metabolism, which were then confirmed with empirical observations (Dori & Choder, 2007). A similar approach could be used to study the fundamental role of knowledge creation and transfer in new business creation. This would mean that previous observations and models would be converted into simple OPM models, which would then be brought together in a large model. The model could then be studied to find previously empirically unobserved features or aspects of knowledge creation. This would lead to empirical studies that could verify or challenge the correctness of the hypothesised features. As an example, detailed findings by Arthur (2009) could be re-interpreted using OPM.

Finally, the author acknowledges that due to the adopted framework and methodology, this dissertation has a steep learning curve for researchers not familiar with the system concepts used. Thus, the novelty factor can be seen as hinderance to its future popularity.

However, fundamentally, wider adaptation is best supported by the successful use of the methodology and demonstrating its ability in the production of prescriptive theories.

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