

MASTER

Entrepreneurial decision making causal and effectual reasoning in the new venture life cycle

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Eindhoven, September 2012

**Entrepreneurial Decision Making:
Causal and Effectual Reasoning in
the New Venture Life Cycle**

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in partial fulfilment of the requirements for the degree of

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Management Summary

Introduction

Entrepreneurship is the key driving force in the global economy, but how do new ventures come to be? And what is the basis behind their success, or the reason for their failure? Getting a better understanding of the way entrepreneurs make decisions and whether certain methods of decision making are more successful in certain situations than other methods is a step towards improving the field of Entrepreneurship.

Theoretical Framework

As mentioned by Sarasvathy (2005) professionals as well as researchers have often wondered about what makes entrepreneurs entrepreneurial? One field of study concerns the process of entrepreneurial decision making in creating and managing a new venture.

The study of the reasoning used by entrepreneurs when taking these decisions has resulted in two main theories: causal reasoning and effectual reasoning, where causal reasoning assumes the existence of central artifacts, like the firm, the market, and the economy, and adopts a method of search and selection, while effectual reasoning adopts a method of transformation to create these central artifacts. Causal reasoning is described as being based on the logic "To the extent that we can predict the future, we can control it." Effectual Reasoning is based on; "To the extent that we can control the future, we do not need to predict it." (Sarasvathy 2001, p. 251,252; 2008) Furthermore entrepreneurial decision making can be divided into five principles as shown in the following table:

Issue	Effectual reasoning	Causal reasoning
View of the future	Creative: The future is co-created (at least in part) by willful agents that may include investors, partners, and customers who "pre-commit" to the venture.	Predictive: Causal reasoning casts the future as a continuation of the past. Accurate prediction is both necessary and useful.
Givens	Means: Goals emerge by imagining courses of action which start from available means.	Goals: Goals, even when constrained by limited means, determine sub-goals and actions.
Attitude toward others	Partnerships: Build your market together with customers, suppliers, and even prospective competitors, by sharing what you have.	Competitive analysis: Protect what you have and maximize your share of the opportunity.
Predisposition toward risk	Affordable loss: Limit downside potential and risk no more than you and your stakeholders can afford to lose.	Expected return: Pursue new opportunities based on the (risk adjusted) expected value. The focus is on the upside potential.
Predisposition toward contingencies	Leverage contingency: Surprises can be positive. Leverage unexpected events into new opportunities.	Avoid: Surprise is negative. Prediction, planning and focus enable the firm to minimize the impact of unexpected events.

Research proposal

The literature on causal and effectual reasoning hints that during the lifecycle of a new venture entrepreneurial decision making shifts from an emphasis on effectual reasoning in the beginning to an emphasis on causal reasoning when the new venture reaches maturity. However, there are few studies supporting this hypothesis, creating a gap in the current literature. This study therefore proposes to fill this gap in the literature by examining the relation between the new venture life cycle and the emphasis on causal or effectual reasoning in entrepreneurial decision making.

Because effectual reasoning covers a broad range of entrepreneurial theories, this question can and should be divided by each effectual principle and researched separately. This resulted in five hypotheses, which can be found in the table in the summary results.

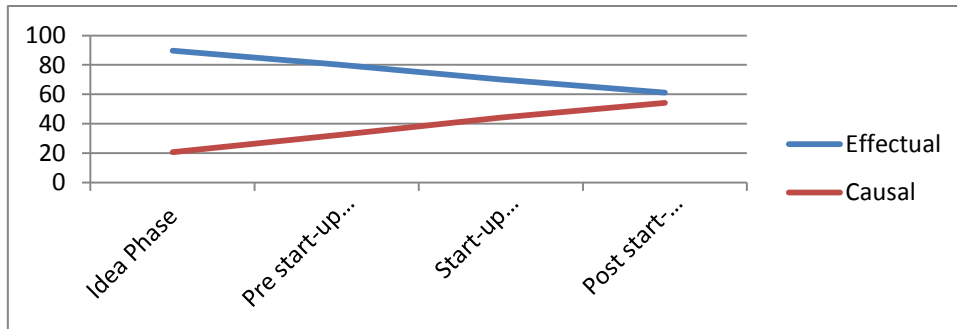
To get a good overview of the decisions entrepreneurs make it is important to collect longitudinal data containing information about all major events in the development of the sample organizations. Because there was no time in this master thesis project to do long-term data collection, an existing dataset has been used and expanded. The selected sample from the dataset consists of new ventures commercializing technology from TU/e. The selected cases also allowed for distinctions between ventures with an experienced and inexperienced entrepreneur, as well as a distinction between medium and high uncertainty during the development of the ventures. This allowed for a comparative analysis, providing insight into the influence of experience and uncertainty on the effectual or causal focus of the decision making process of the entrepreneur.

To expand the existing dataset, data has been collected from two main sources: firstly, semi-structured interviews with the lead entrepreneurs of the 6 ventures and secondly, archival data. This ensures a good overview of all major events in the development of the sample organizations and the decisions made during these events. Furthermore the combination of older and current data diminishes the bias of retrospection and controls the data for reliability and validity.

To examine the relation between the new venture life cycle and the emphasis on causal or effectual reasoning in entrepreneurial decision making, the data has been analyzed in steps. First all interviews have been analyzed in order to create for each venture an event list, concerning key decisions in the new venture creation process. All events were then coded for their phase of new venture development. The second step in the analysis was to code each event for effectual or causal reasoning. The third step in the analysis was to explore patterns in the new venture creation process, concerning effectual or causal reasoning, over time. Comparisons have also been done on the principle level to explore the patterns of causal or effectual reasoning during the new venture creation process in each principle.

Results

The data collection and analysis resulted in a wealth of data, which has all been archived in Nvivo. The overall data shows that in total 364 events have been coded, of these events 269 were coded as effectual events and 168 as causal events. The following figure illustrates the percentage of the total number of events coded per phase in the new venture life cycle for causal and for effectual reasoning.



This figure indicates that decision-making is done mainly effectual over the entire lifecycle of the ventures. However, it also shows that during the lifecycle of a new venture entrepreneurial decision making shifts from an emphasis on effectual reasoning in the beginning to an emphasis on causal reasoning when the new venture reaches maturity, supporting the general research question of this study. Furthermore the following table shows the hypotheses and whether or not they were supported by the results of this research.

Hypotheses		
Hypothesis a	<i>As a new venture progresses in its life cycle, the view of the future of the entrepreneur, will shift from creative (effectual reasoning) to predictive (causal reasoning).</i>	Partially supported
Hypothesis b	<i>As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from means oriented (effectual reasoning) to goal oriented (causal reasoning).</i>	Supported
Hypothesis c	<i>As a new venture progresses in its life cycle, the attitude towards others of the entrepreneur will shift from a partnership and co-creation orientation (effectual reasoning) to a competitive orientation (causal reasoning).</i>	Partially supported
Hypothesis d	<i>As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from limiting downside potential by setting a level of affordable loss (effectual reasoning) to focusing on upside potential by calculating the expected value of risks (causal reasoning).</i>	Partially supported
Hypothesis e	<i>As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from leveraging contingencies (effectual reasoning) to avoiding contingencies (effectual reasoning).</i>	Not supported

Conclusion

To conclude this study contributes to the literature on entrepreneurial decision making in new ventures, by identifying and filling a gap concerning the complementary fashion of effectual and causal decision making. This is done by performing a longitudinal case study in which multiple interviews, and archival data of 6 university spin-offs was gathered and analyzed. This resulted in an in depth perspective on how entrepreneurs use both effectual and causal reasoning during the lifecycle of a new venture to navigate decisions concerning the five principles of entrepreneurial decision making. This study also identifies some interesting new areas for study, like research into how to use effectual and causal reasoning in guiding future entrepreneurs through decisions in the new venture creation process.

Acknowledgements

This study was conducted in partial fulfillment of the Master of Science degree in Innovation Management at the Eindhoven University of Technology. The research is an assignment of the School of Industrial Engineering and Innovation Sciences and was conducted by conducting interviews at six university spin-offs and the Innovation Lab.

Although I have done this research project on my own, I received a lot of help from others. Therefore I would like to take the opportunity to thank several people for their effort and support. Without the university spin-offs that contributed to this study, this project would have been impossible. I can't mention names in this report, but know that you have my greatest thanks for your cooperation. I would also like to thank Bart de Jong and Robert Feelders from the TUE Innovation Lab, and Ben Hiddinga from TUE Holding for their time and help.

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A special word of thanks goes to my family: my mother Maria, my father Gerard, and my brother Stijn. I want to thank them for their love, (financial) support, and confidence in me, not only through this master thesis project, but throughout my entire life.

Joost Klessens
Eindhoven, September 2012

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1. Introduction

Entrepreneurship is the key driving force in the global economy. For example, entrepreneurs and innovators are responsible for over 95 per cent of new wealth in America, since 1980 (Swiercz and Lydon, 2002). But how do new ventures come to be? And what is the basis behind their success, or the reason for their failure?

Getting a better understanding of the way entrepreneurs make decisions and whether certain methods of decision making are more successful in certain situations than other methods is a step towards improving the field of Entrepreneurship. To this end, this paper describes a master thesis project focusing on better understanding the process of entrepreneurial decision making in new ventures, with an emphasis on the evolution of effectual and causal reasoning.

The goal of this paper is to provide a detailed description of the master thesis project, the results it provides and the implications of these results. To this end, first, an overview of the current state of the literature, concerning entrepreneurial decision making, will be provided. This is based on the literature study done in preparation for this master thesis project.

Next the research proposal is generally described. In this section the gaps in the literature are identified, resulting in a research question and several hypotheses. Furthermore an overview and explanation is given of the necessary research to prove or disprove these hypotheses.

In the third part the research method is described. This includes a case selection of the ventures analyzed in this project. Furthermore the data collection and data analysis are described. This is followed by the results of the research, and its analysis. Finally the implications of the research and its limitations are provided.

2. Theoretical Framework

Entrepreneurship is the key driving force in the global economy. For example, Swiercz and Lydon (2002, p. 380) mention a conclusion of Timmons (1999) stating that “since 1980, over 95 per cent of new wealth has been created by entrepreneurs and innovators”. This increase in entrepreneurship has had an effect on the economy in many ways. It has created new jobs, new companies, new products, and even new industries (Swiercz and Lydon, 2002). The reason for this increased level of entrepreneurial activity is not only because of the electronic age but due to a multitude of new materials, products, financial networks, joint venture possibilities, and paradigmatic changes in politics, economics and societies. “It appears a whole new remodeling of the ways in which business, communication, and government are conducted has emerged” (Fernald et al. 2005, p. 1).

But how do these new ventures come to be? And what is the basis behind their success, or the reason for their failure? Is it the new technologies that are developed, the new markets that are tapped, the new distribution channels that are used, or the (in)experienced management teams? Or is it the underlying process that drives the entrepreneurial decisions to develop certain technologies, tap certain markets, use certain distribution channels and to compose a certain management team?

2.1. Entrepreneurial Decision Making

As mentioned by Sarasvathy (2005) professionals as well as researchers have often wondered about what makes entrepreneurs entrepreneurial? One field of study concerns the process of entrepreneurial decision making in creating and managing a new venture. In this process, which can be called the new venture creation process, as in all aspects of life, the future is uncertain. Therefore entrepreneurs have to make decisions without having access to all relevant information. The way entrepreneurs handle this uncertainty or even use this uncertainty to their advantage can give valuable insight into the success or failure of new firms. This section will give a general overview of the field of entrepreneurial decision making as well as the general field of entrepreneurship.

‘There is a growing consensus among entrepreneurship scholars that entrepreneurship is a field of business which seeks to understand how opportunities to create something new (e.g., new products or services, new markets, new production processes or raw materials, new ways of organizing existing technologies) arise and are discovered or created by specific persons, who then use various means to exploit or develop them, this producing a wide range of effects’ (Shane and Venkataraman 2000, p. 218; Ucbasaran 2008, p. 221). Following this view, addressing the questions of why, when and how people identify and exploit these opportunities has become the focus of entrepreneurship research. This puts the entrepreneur center stage for recent entrepreneurship research.

As stated by Politis and Gabrielsson (2006) decision making lies at the center of the entrepreneurial process. Entrepreneurs have to make a wide variety of decisions on a daily basis, for example concerning improvements of the business idea, creating or identifying markets, solving technical problems, acquiring resources, hiring experienced employees etc. Many of these decisions can have long lasting consequences, and critical decisions taken at the early stages of the new venture creation process may have unpredictable impacts upon the entire future success and performance of the venture. Studying entrepreneurial decision making is, therefore, important for a better understanding of the process whereby individuals create and exploit new venture opportunities.

The study of the manner in which these decisions are taken by entrepreneurs has resulted in two main theories: causal reasoning and effectual reasoning, where causal reasoning assumes the existence of central artifacts, like the firm, the market, and the economy, and adopts a method of search and selection, while effectual reasoning adopts a method of transformation to create these central artifacts. The following sections will describe the literature concerning these theories.

2.2.Causal Reasoning

Causal reasoning is described as being based on the logic "To the extent that we can predict the future, we can control it." (Sarasvathy 2001, p. 251-252) According to Sarasvathy, a causal process involves decisions on the different means to reach predetermined goals. This theory assumes that the effects of using certain means can be predicted, thus being able to choose the best strategy to reach a certain goal.

This can be described by using the standard procedure in bringing a product/service to the market, as described by Sarasvathy (2001): analyze the market, research and select the target market, design marketing strategies, plan marketing programs and execute the marketing effort. In this example analyzing the market reduces the uncertainty of the future by providing knowledge about the effects of choosing a certain target market, marketing strategy, and marketing program. This effectively provides predictable aspects in an uncertain future. Another way of doing this is by strategic planning, but as explained by Mintzberg (1994) strategic planning has no use if no action is taken to set the strategy in motion, indicating the importance of the exploitation of opportunities.

According to Sarasvathy and Dew (2005), major research threads on causal processes are based on exploring all possible local and global markets and then exploiting those that are most predictable, and/or score high in terms of expected return or some version of real options logic. This causal process begins with exploration resulting in the identification, recognition or discovery of an opportunity, followed by a series of activities to exploit this opportunity. This standard set of causal tasks includes (1) developing a business plan based on (2) market research and (3) competitive analyses, followed by (4) the acquisition of resources and stakeholders for implementing the plan, and then (5) adapting to the environment as it changes over time with a view to (6) creating and sustaining a competitive advantage (Sarasvathy & Dew 2005).

March (1991) studied the use of exploration and exploitation in organizations, which as a theory is somewhat of a figurehead for causal reasoning. March studies the way organizations make a trade-off between exploring new opportunities and exploiting old certainties. The essence of exploitation in this is the refinement and improvement of existing competences, technologies, and paradigms to improve existing competitive advantages. The returns of exploitation are positive, proximate, and predictable. The essence of exploration is experimentation with new alternatives to create new competitive advantages. Exploration's returns are uncertain, distant, and often negative. As most theories in entrepreneurial decision making, March's theory of exploitation versus exploration places an emphasis on the causal reasoning of discovering opportunities and then exploiting them. (March 1991) Effectuation on the other hand focuses on using existing resources to create the opportunities.

According to Sarasvathy (2001) causal reasoning is especially useful in environments that are static, linear and independent in nature. Furthermore using causal reasoning assumes that central artifacts, like the market already exist, which means this type of reasoning can only be used to increase the market share in existing markets, and is thus less useful in tapping new markets.

To conclude the causal process generally begins with exploration resulting in the identification, recognition or discovery of an opportunity, followed by a series of activities to exploit this opportunity.

2.3. Effectual Reasoning

Effectual Reasoning is based on; "To the extent that we can control the future, we do not need to predict it." (Sarasvathy 2001, p. 251,252; 2008) As mentioned, the causal processes assume the existence of knowledge about the effects of using certain means, as well as knowledge about artifacts that might not exist yet. For example, starting a new venture usually begins with writing a business plan in which the entrepreneur tries to predict the outcome of his venture. However, at that point the actual firm does not yet exist, nor the technology, product or service in most cases. Furthermore, in the case of an innovative product there is a high likelihood that the market for this product is also nonexistent. Effectual reasoning sidesteps this problem by avoiding any assumptions about artifacts other than the entrepreneur itself and its network (sarasvathy 2001, 2008).

When using effectual reasoning in starting a new firm, instead of investing a lot of money in expensive analyses of markets and designing how to best put a product on that market, the entrepreneur starts by analyzing the resources to his/her disposal. The entrepreneur should then think creatively to create value out of his/her idea, using these resources to the best of his/her potential. Using effectuation we can therefore explain how artifacts such as firms, markets and economies are created. Because effectuation eliminates the assumption of preexisting goals, the entrepreneur is free to choose any goal (s)he deems most desirable, including the creation of previously nonexistent firms, markets or economies (Sarasvathy 2001, 2008).

In uncertain environments the traditional search and selection processes, which most MBA managers are schooled in do not suffice to explain the decision making processes of entrepreneurs (Dew et al). To fill this gap, Sarasvathy and Dew (2005) suggest a new dynamic model of stakeholder interaction, based on effectual reasoning, as depicted in figure 1. Furthermore, based on this model, Dew et al defined an entrepreneurial process using effectual transformation, which can explain the creation of markets without a conscious intent, which is not limited by a finite set of possibilities, and is intrinsically dynamic and interactive. Furthermore they present evidence that entrepreneurs using transformational processes produce more new market ideas than MBA managers schooled in search and selection processes (Dew et al).

This figure illustrates how entrepreneurs in an effectual process start with who they are, what they know and whom they know, after which (s)he creates a network of stakeholders that are committed to his/her idea. These stakeholders will all provide new means for the entrepreneur and therefore have an influence on the goal of the venture, eventually resulting in the creation of a new artifact, like a new market (Sarasvathy & Dew 2005).

The literature on effectuation suggests that effectual reasoning can be divided into principles. Ambiguity still exists on this division and the definition of these principles, but the consensus between most researchers is to divide effectual reasoning into five principles based on issues of entrepreneurial decision making: view of the future, givens, attitude toward others, predisposition toward risk, and predisposition toward contingencies (Sarasvathy and Dew, 2005; Read et al, 2008; Read et al, 2009). The underlying table describes the differences of effectual and causal reasoning divided into the five principles (Sarasvathy and Dew, 2005).

Issue	Effectual reasoning	Causal reasoning
View of the future	Creative: The future is co-created (at least in part) by willful agents that may include investors, partners, and customers who “pre-commit” to the venture.	Predictive: Causal reasoning casts the future as a continuation of the past. Accurate prediction is both necessary and useful.
Givens	Means: Goals emerge by imagining courses of action which start from available means.	Goals: Goals, even when constrained by limited means, determine sub-goals and actions.
Attitude toward others	Partnerships: Build your market together with customers, suppliers, and even prospective competitors, by sharing what you have.	Competitive analysis: Protect what you have and maximize your share of the opportunity.
Predisposition toward risk	Affordable loss: Limit downside potential and risk no more than you and your stakeholders can afford to lose.	Expected return: Pursue new opportunities based on the (risk adjusted) expected value. The focus is on the upside potential.
Predisposition toward contingencies	Leverage contingency: Surprises can be positive. Leverage unexpected events into new opportunities.	Avoid: Surprise is negative. Prediction, planning and focus enable the firm to minimize the impact of unexpected events.

Table 1: Differences of effectual and causal reasoning divided into the five principles

2.4. New Venture Life Cycles

The literature on causal and effectual reasoning hints that during the lifecycle of a new venture entrepreneurial decision making shifts from an emphasis on effectual reasoning in the beginning to an emphasis on causal reasoning when the new venture reaches maturity. To examine this relationship a better understanding of the lifecycle of new ventures is necessary.

Organizations, like products and most other systems, go through lifecycles, meaning that certain aspects of a new venture are markedly different from aspects of older (usually larger) organizations. According to Quinn and Cameron (1983) many authors suggest that changes occurring in organizations follow predictable patterns that can be characterized by developmental stages. These stages are sequential in nature, occur as a hierarchical progression, and involve a broad range of organizational activities and structures. These authors have used many different models to describe

the changing characteristics of organizations in the different stages, ranging from cognitive orientations of organization members to organizational structures and environmental relations.

Another study, claiming to be the most comprehensive reviews of stage models that has ever been published, including all of the empirical research to that date, states that: stages models and life-cycle theories of business and entrepreneurial growth, although popular among researchers and practitioners, do not accurately represent the growth and development of entrepreneurial firms (Levie & Lichtenstein, 2010). However in order to show the evolution of entrepreneurial decision making, it is necessary to be able to code events into different stages of development. Therefore a distinction has to be made between several different stages of growth in technology-based new ventures.

Most models of organizational stages of development focus more on the later organizational stages of development, and only provide one or two phases describing the early stages of new venture development (Daft, 1992; Quinn & Cameron, 1993; Kazanjian, 1988, 1990). The cases in this study are either still in these early stages of new venture development, or just passed it, and therefore these models will not be used to code the events. Instead the model of the start-up process developed by Clarysse and Moray (2004) will be used as the guideline to code events during this study. Table 2 shows this model of the new venture lifecycle.

	Idea Phase	Pre start-up Phase	Start-up Phase	Post start-up Phase
Internal Features	<ul style="list-style-type: none"> • Project team: technical researchers • Project Leader: <ul style="list-style-type: none"> -Planning -Proposal writing 	<ul style="list-style-type: none"> • New venture development team • Business plan • “Champion”: <ul style="list-style-type: none"> -motivator -puts team together -technological gatekeeper 	<ul style="list-style-type: none"> • Founding team • Open person related culture • CEO as facilitator • Champion as business manager: <ul style="list-style-type: none"> -strategic inertia -hierarchical management model -technological gatekeeper 	<ul style="list-style-type: none"> • Team structuring: <ul style="list-style-type: none"> -job descriptions -organisational flow chart -recruiting • CEO as decision maker • Champion as business developer
Main external influence	University	University	Board of directors	Market + Board of directors

Table 2: Model of the new venture lifecycle (Source: Clarysse & Moray, 2004, p.68)

3. Research Proposal

3.1. Research Question

Sarasvathy (2001) argues that March's exposition on exploration and exploitation indicates that causal reasoning and effectual reasoning need not always pull in opposite directions. Instead they can work in a complementary fashion, just as exploration and exploitation can both be used by a firm to sustain its market share over different spatial and temporal contexts.

The literature on causal and effectual reasoning hints that during the lifecycle of a new venture entrepreneurial decision making shifts from an emphasis on effectual reasoning in the beginning to an emphasis on causal reasoning when the new venture reaches maturity. However, there are few studies supporting this hypothesis, creating a gap in the current literature.

This study therefore proposes to fill this gap in the literature by examining the relation between the new venture life cycle and the emphasis on causal or effectual reasoning in entrepreneurial decision making.

Because effectual reasoning covers a broad range of entrepreneurial theories, this question can and should be divided by each effectual principle and researched separately. This results in the following hypotheses:

Hypothesis a: *As a new venture progresses in its life cycle, the view of the future of the entrepreneur, will shift from creative (effectual reasoning) to predictive (causal reasoning).*

Hypothesis b: *As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from means oriented (effectual reasoning) to goal oriented (causal reasoning).*

Hypothesis c: *As a new venture progresses in its life cycle, the attitude towards others of the entrepreneur will shift from a partnership and co-creation orientation (effectual reasoning) to a competitive orientation (causal reasoning).*

Hypothesis d: *As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from limiting downside potential by setting a level of affordable loss (effectual reasoning) to focusing on upside potential by calculating the expected value of risks (causal reasoning).*

Hypothesis e: *As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from leveraging contingencies (effectual reasoning) to avoiding contingencies (effectual reasoning).*

3.2. Research Approach

This study aims to extend the existing theory on entrepreneurial decision making by exploring the emphasis on causal or effectual reasoning in entrepreneurial decision making. This is done by adopting a process research approach (Langley, 1999) which is instrumental in focusing on the start-up processes of new ventures. To recognize the patterns in the emphasis on effectual or causal decision making, and how they develop over time, the start-up processes will be analyzed as a sequence of important decisions and will be classified as either causal or effectual.

To get a good overview of these decisions it is important to collect longitudinal data containing information about all major events in the development of the sample organizations. Because there was no time in this master thesis project to do long-term data collection, an existing dataset has been used and expanded.

The dataset that was used and expanded was collected and used in a TU/e dissertation to provide insight into how a university organization can be designed that fosters the creation and development of university spin-offs. (Van Burg, 2010). Furthermore, the dataset was used in another study which analyzes the dynamics of effectuation and causation in technology-based new ventures (Reymen et al, 2012).

The dataset contains previously collected material on the sample firms, like newspaper articles and press releases, as well as previously held interviews with the entrepreneurs. To expand this dataset all relevant publicly available material of the sample organizations has been collected and follow-up interviews have been done with the entrepreneurs. This is further explained in the next chapter and the interview guide can be found in appendix A.

To analyze the very rich text-based qualitative data NVivo has been used to help organize and analyze the non-numerical and unstructured data. This software supports classifying, sorting and arranging of the information, and examining the relationships in the data. Using NVivo all the material has been collected in one place and analyzed by using the coding scheme described in the next chapter. The scope of the master thesis project did not allow for coding and analysis of the data by different researchers. Therefore there is a risk of research bias, which diminishes the interrater reliability.

4. Research Method

4.1. Sample selection

The selected sample consists of new ventures commercializing technology from TU/e. For these spin-off companies the technology obtained from the university is the basis for the first product or service they bring to market. In this respect, their relationship with the university is essential to accomplish starting the venture effectively, both in the early stages of the venture (to receive support to start the venture, to acquire and develop the technology, and to obtain access to and use facilities) and in the subsequent stages, as well as in exploring new opportunities in the future. Studying the ventures from one single university provided a good setting because it controls for variability at the institutional, regional and national level. In the meantime, this setting enabled investigating in-depth the relationship between the new venture life cycle and the emphasis on causal or effectual reasoning in entrepreneurial decision making.

Theoretical sampling served to select 6 different ventures started by academic entrepreneurs from TU/e. Such a small sample was needed in an in-depth longitudinal study, as it allowed detailed comparison of poorly understood phenomena. As such, the aim was to understand the decision making processes in new ventures which apply to similar cases, rather than gathering a widely representative sample. The companies were selected from the database of spin-off support and technology transfer unit (TTO) at the university. In total 71 spin-offs were in this database (between 1993 and 2008) (Van Burg, 2010).

In consultation with the advisors for the master study 6 cases were selected, based on the following criteria. The existing dataset, used in this study, needed to contain at least some previously collected longitudinal data. Also to be able to collect additional data, there should be a possibility to contact the entrepreneurs, even if the firm no longer exists. And the organizations needed to be around 5 to 10 years old, to be able to observe the development of decision making over a longer time span. Overall the case selection provided sufficiently diverse cases, with new technology in diverse existing and emerging markets (biotechnology, information technology, materials, optics and mechanical devices). This ensures the conclusions not to be specific to one particular industry.

The selected cases also allowed for distinctions between ventures with an experienced and inexperienced entrepreneur, as well as a distinction between medium and high uncertainty during the development of the ventures. This allowed for a comparative analysis, providing insight into the influence of experience and uncertainty on the effectual or causal focus of the decision making process of the entrepreneur.

4.2. Case descriptions

This section provides a short case description of each selected case, as well as a table summarizing the cases, and the available data. The names and important information of all cases have been masked for confidentiality reasons.

Name of the venture	Year of founding	Industry	Experience of the entrepreneur	Uncertainty	Available data in dataset
Alpha	2004	Biotechnology	Experienced	High uncertainty	2 interviews and other documents
Delta	2004	Information Technology	Experienced	Medium uncertainty	2 interviews and other documents
Xi	2008	Materials	Experienced	High uncertainty	1 interview and other documents
Tau	2007, emerging since 2005	Materials	Inexperienced	High uncertainty	3 interviews and other documents
Rho	2007, emerging since 2006	Optics/ mechanical devices	Inexperienced	Medium uncertainty	3 interviews and other documents
Sigma	2009, emerging since 2006	Mechanical Devices	Inexperienced	Medium uncertainty	3 interviews and other documents

Table 3: Overview of the sample selection

4.2.1. Alpha

Alpha develops and markets scientifically proven, innovative medical devices. Their philosophy is that great developments in the medical world only come from real innovations. At this time this has resulted in two innovative products that are not just upgrades of current standards. With a flexible team they try to react on medical needs suggested by medical specialists and together with them they develop and market their products.

4.2.2. Delta

Delta is a company in the information technology industry, focusing on providing their clients with tools to visualize, manage and control the large amounts of data in their information systems. Based on a visualization technology developed at the university and many years of experience in BI, in various business sectors, they develop easy to use and administer products, which lead to analyses with real impact in no time.

4.2.3. Xi

Xi is a company in the materials industry, developing and marketing a unique conductive-ink technology. The conductive-ink technology enables rapid development of electrically-conductive ink for most industrially-applied printing technologies. The inks allow companies active in the new field of printed electronics to make conductive tracks on flexible and rigid substrates at high speed. Xi's ink formulations allow for good conductivity and print characteristics with low cost of use.

4.2.4. Tau

Tau was started by 3 students, wanting to commercialize a potential interesting technology of the TUE in the materials industry. Although they had good ideas, a good start, and a good amount of support from the TUE, after several years they still had trouble landing their first client. This resulted in several shifts in focus for the company until they finally had to declare bankruptcy.

Tau developed and exploited proprietary authentication and verification solutions both for document security and brand protection. They wanted to contribute to the fight against worldwide counterfeiting and other illegal activities which can damage the consumer, the government or the manufacturer in any way. It was a dynamic company which developed a new innovative way of producing optical security features, enabling consumers to personalize or uniquely identify every optical feature produced for any product or document.

4.2.5. Rho

Rho is committed to make components measurable with an ultimate accuracy. By supplying the producers of coordinate measuring machines with their probe systems, they enhance the functionality and specifications of their products. Rho believes that a strong collaboration with their customers and suppliers is a critical factor for their success. Most of their employees have a masters or doctoral degree and strive to be the best in their field of expertise. They strive to remain at the forefront of precision technology and collaborate closely with leading experts in the field of metrology.

4.2.6. Sigma

Sigma specializes in providing technology in customized production of thermo sheet applications in the construction, interior production, orthopedic, as well as small series production, prototyping and custom made applications. They have patented their technology and have a sheer competitive quality and efficiency advantage in customized thermo forming compared to other rapid manufacturing techniques.

4.3.Data Collection

To expand the existing dataset, data has been collected from two main sources: firstly, semi-structured interviews with the lead entrepreneurs of the 6 ventures and secondly, archival data. This ensures a good overview of all major events in the development of the sample organizations and the decisions made during these events. Furthermore the combination of older and current data diminishes the bias of retrospection.

To perform the interviews in a semi-structured way a general interview guide was written, which can be found in appendix A. To keep in line with the previous interviews in the dataset, the interview guide follows a similar structure. The first questions invite the interviewee to elaborate on the current status of the venture and his/her current role, as well as the most important changes since the last interview. The following questions follow the general start-up process of a university spin-off with open-ended questions about motivation, networks, contact with the university, contracts and intellectual property, support and coaching, funding and the university context in general. The questions were updated from the original interview guide to prevent duplicate data and allow for a bigger focus on entrepreneurial decision making. All in all the first part of the interview guide covers all relevant aspects of the (continued) relationship of the ventures with the university.

The rest of the interview focuses on specific aspects of the entrepreneurial decision making process that are not handled in the first part. The focus here is on the entire new venture creation process, from the idea phase until now. The interview guide provides a structured way of following this process with open-ended questions about the five principles of effectual and causal reasoning.

An interview has also been conducted with the managers of new business development of the technology transfer office (TTO) of TU/e. This interview followed the same protocol and serves to provide extra information on the 6 cases as well as extra insight into the general new venture creation process of university spin-offs.

On average the interviews with the entrepreneurs took about 60-120 minutes each and the interview with the TTO manager took about 60 minutes. All interviews were done by two interviewers: the master student, and the second supervisor, except for the interview with the TTO managers, which was done by the master student. Furthermore all interviews have been recorded and fully transcribed into NVivo and analyzed concurrently.

For each of the 6 cases 4 types of archival data have been collected and analyzed. First company related documents have been collected, such as business plans, annual reports and funding proposals. Second, all relevant documents have been requested from the university technology transfer office, such as textual correspondence and contracts with the companies. Third, newspaper articles, interviews, brochures and other data found on the websites have been archived. Finally, most of the cases used in this study have one or more intellectual property rights of which the patents have been collected and archived.

4.4. Data Analysis

To examine the relation between the new venture life cycle and the emphasis on causal or effectual reasoning in entrepreneurial decision making, the data has been analyzed in four steps.

First all interviews have been analyzed in order to create for each venture an event list, concerning key decisions in the new venture creation process. These key decisions mentioned by the interviewees have been coded into NVivo. These events have to involve an intentional decision of a key player that has a significant and unique (potential) impact on the new venture creation process. To avoid including only successful events also decisions that could have had a significant effect on the new venture, but failed have been coded. The events have been coded on the organizational level, as to only include actions taken on behalf of the organization.

All events were then coded for their phase of new venture development and put in sequential order per venture. Because Tau has filed for bankruptcy before developing into the post start-up phase, this phase was used to indicate the final stage in their development starting from when they had to either sell the company or file for bankruptcy. To mitigate the recollection bias, the archival data was used to validate the events were possible. Furthermore, because the focus is only on significant events in the new venture creation process; recollection bias is further diminished, as according to Reymen et al (2012) past research shows that such events are more easily and more accurately remembered. NVivo has been used to keep track of the event list and of the connection between the events and the raw data. The final event list enables examining of the single events as well as their longitudinal implications (Langley, 1999; Reymen et al, 2012).

The second step in the analysis was to code each event for effectual or causal reasoning. To this end a coding scheme was developed that describes effectual and causal reasoning based on the five principles, described in the literature review. The main dimensions are labeled as: view of the future, givens, attitude toward others, predisposition toward risk, and predisposition toward contingencies. Effectual and causal reasoning are defined by their contrasting principles for each of these dimensions, resulting in five effectual principles: creative view of the future, means-oriented givens, partnership oriented attitude toward others, affordable loss as predisposition toward risk, and leverage contingency as predisposition toward contingencies; and five causal principles: predictive view of the future, goal-oriented givens, competitive attitude toward others, expected return as predisposition toward risk, and avoid risk as predisposition toward contingencies. Each of the principles are described by three items, which are mirrored for causal and effectual reasoning per dimension, to ensure an equivalent number of items per contrasting principle. These items were defined based on the literature review.

The coding of the events has been done by first considering the applicability of each dimension to a particular event, in which an event can belong to more than one dimension. Second, the events have been considered to fit to causal or effectual reasoning per dimension. Also effectual and causal reasoning can be mixed in each event, as it had to be possible to consider each principle separately. This means that each event could be coded to 10 principles (five effectual principles and five causal principles).

The third step in the analysis was to perform cross-case comparisons of event series using frequency graphs and tabular representations. This helped to explore patterns in the new venture creation process, concerning effectual or causal reasoning, over time. Comparisons have also been done on the principle level to explore the patterns of causal or effectual reasoning during the new venture creation process in each principle, allowing the hypotheses and research question to be answered.

The fourth step in the analysis was to analyze the effects of experience and uncertainty on the use of effectual or causal reasoning. To explore this, the results of the previous step have been divided according to the experience and uncertainty associated with the cases, and a comparison has been made between the different patterns of effectual and causal reasoning over time. This analysis could bring forth some interesting results, which can be used in future research projects.

Effectuation and Causation Coding Scheme		
Dimensions	Effectuation	Causation
<i>1. View of the future</i>	Creative: (1E) <ol style="list-style-type: none"> 1. Defining only rough visions while leaving the details open 2. Manage growth expectations and ambitions 3. Being open to “pre-commitment” and co-creation 	Predictive: (1C) <ol style="list-style-type: none"> 1. Base actions upon expectations and predictions 2. Plan development in big steps and large commitments 3. Closed off to pre-commitment and co-creation
<i>2. Givens</i>	Means-oriented: (2E) <ol style="list-style-type: none"> 1. Building on own knowledge base and own resources 2. Using infrastructure and know-how of local environment 3. Using existing network of contacts to identify and/or create opportunities 	Goal-oriented: (2C) <ol style="list-style-type: none"> 1. Defining and going after goals, by adapting means. 2. Evaluating predicted progress and adapting means based upon feedback 3. Expand network based on predefined goals
<i>3. Attitude toward others</i>	Partnerships: (3E) <ol style="list-style-type: none"> 1. Trust-based flexible agreements, alliances and commitments 2. Co-creation with stakeholders 3. Pursue opportunities together with stakeholders 4. Early collaboration with clients 	Competitive analysis: (3C) <ol style="list-style-type: none"> 1. Contract-based agreement, alliances and commitments 2. Competitive analyses and competitive positioning 3. Creating and carrying out patent strategy 4. Market research
<i>4. Predisposition toward risk</i>	Affordable loss: (4E) <ol style="list-style-type: none"> 1. Willingness to make personal sacrifices for best of venture 2. Funding by local environment 3. Invest only what can be lost 	Expected return: (4C) <ol style="list-style-type: none"> 1. Maximize personal profit 2. Funding by large stakeholders that commit as much as possible 3. Calculating and evaluating expected return
<i>5. Predisposition toward contingencies</i>	Leverage contingency: (5E) <ol style="list-style-type: none"> 1. Changing and adapting plans to accommodate unforeseen events 2. Positively reacting to and using unforeseen developments and adopt to own advantage 3. Being open to environment and adopting unforeseen feedback 	Avoid risk: (5C) <ol style="list-style-type: none"> 1. Sticking to plans, even when confronted with unforeseen events 2. Being closed off to unforeseen developments and drawing back when they occur 3. Careful interaction with environment for secrecy reasons

Table 4: Effectuation and Causation Coding Scheme

4.5.Data Reliability

A good research method gives consistent results, regardless of the person doing the research. In scientific research this concept is known as the reliability of the research. When researching the average length of a student for example, the research is reliable if it always results in the same length, no matter who performs the measurements. There are three types of reliability: interrater reliability, test-retest reliability, and internal consistency reliability (Graziano and Raulin, 2007, p. 87).

4.5.1. Interrater Reliability

Interrater reliability refers to the reliability of the observations made by the researcher. It should be controlled for whenever a research method contains a component of human judgment or rating (Graziano and Raulin, 2007, p. 87). In this research method this is the case due to the coding which has to be done by the researcher, which is in most cases a judgment call. The best way to control for this reliability would be to have a second independent researcher code the data as well. However, due to time constraints, a less time consuming control is used. The coding scheme and the coding of one of the cases were checked by another researcher, one of the supervisors, during the course of the study and before the other cases were coded.

4.5.2. Test-Retest Reliability

In performing research, the research results should remain the same when the research is performed again with a period of time in between. In scientific research this concept is known as the test-retest reliability (Graziano and Raulin, 2007, p. 87). To control for this reliability several measures were taken to improve the data. By interviewing (one of) the founders / CEOs of each of the cases the most knowledgeable informant present in a company was used. And by comparing his or her statements with the archival data, potential errors were eliminated. Also the participant was motivated to answer as accurately as possible, but also to not respond when an answer could not be recalled. And, because the focus is on the major events within the organizations, it is unlikely that they will be remembered incorrectly. Finally full confidentiality of the data was provided to motivate the participant to provide accurate information.

4.5.3. Internal Consistency Reliability

This concept is relevant when doing research containing several observations to determine the results for each case. Generally this means that the more observations are made to determine the research results, the greater the internal consistency reliability will be (Graziano and Raulin, 2007, p. 88). This research controls for this concept of reliability by using two types of data, namely archival data and interview data. The archival data was gathered by collecting company related documents, all relevant documents from the university technology transfer office, newspaper articles, interviews, brochures and other data found on the websites, and patents.

For the interview data several older interviews with each organization have been used, providing for several independent measurements over time. Second a semi-structured interview with (one of the) lead entrepreneurs of the ventures has been held, expanding the longitudinal data. Combining the different data sources will ensure a good overview of all major events in the development of the sample ventures and the decisions made during these events.

4.6.Data Validity

Another concept in scientific research is the validity of the data. This means that when performing scientific research, your research is valid when it researches what it is supposed to research. For

example a ruler is valid, when it gives the true length of an object, while it is invalid when it always gives a length of 10% less (Graziano and Raulin, 2007, p. 90). There are four types of validity, namely statistical validity, construct validity, external validity and internal validity (Graziano and Raulin, 2007, p. 181). For this research, construct, external, and internal validity are most important and are controlled for.

4.6.1. Construct Validity

Construct validity refers to the connection between the results of the research and the theory behind the research. To reduce threats to construct validity it is important that the research results support the theory behind the research, and that the theory supported by the results is the best explanation of these results (Graziano and Raulin, 2007, p. 182). In this research this threat is reduced by doing an extensive systematic literature review, on which the research has been based. This provided a solid base for the research proposal, as well as an extensive overview of the literature to explain the results.

4.6.2. External Validity

In scientific research the goal is usually to be able to generalize your results onto a bigger population. How well the research is generalizable to other, similar participants and conditions is known as external validity (Graziano and Raulin, 2007, p. 182,183). Because this research uses a relatively low sample count, due to the longitudinal aspect of the study, the external validity is not high. However to raise the external validity, the cases that were selected do differ in several aspects. Firstly, the cases come from different types of industry, providing generalizability over several industries. Also, half of the cases started with an experienced entrepreneur, and the other half didn't, providing extra insight into the relevance of that aspect. Furthermore, the cases are either in an environment of high uncertainty, or of medium uncertainty, providing insight into the relevance of that external factor. Lastly, one of the cases has gone bankrupt, controlling for influences that concern the success of the organization.

To conclude, due to the low sample count, and the fact that all cases are spin-offs from the Eindhoven University of Technology, the external validity is not high, and the generalizability of the research is limited to high tech university spin-offs. However, because of the control on industry, experience, uncertainty and success, the results are generalizable to most organizations in that area.

4.6.3. Internal Validity

Internal validity concerns the demonstration of causality. Was the variable examined, responsible for the changes in the dependent variable, or could it have been another variable which was not considered. Research is only internally valid if the independent variable is responsible for the changes in the dependent variable (Graziano and Raulin, 2007, p. 183).

In this research it is difficult to say whether the research is internally valid, as there are always a multitude of external factors that have a role in the changes within organizations. The controls that are used to provide external validity, also control for most of these factors. The fact that the cases come from different industries, controls for most external factors caused by the type of industry. Secondly, examining the relationship between the difference in experience, uncertainty and success, and the change in decision making, controls for the influence of these variables.

However, there is at least one external variable that could not be controlled for, namely the financial crisis, as it has affected all businesses, in each industry in the last years. However, because the data used was gathered over a long period of time, this will at least provide some control over this variable.

5. Results

The data collection and analysis resulted in a wealth of data, which has all been archived in Nvivo. In total 364 events have been coded, of which 39 in the Idea phase, 112 in the Pre start-up phase, 154 in the start-up phase, and 59 in the post start-up phase. The available data and number of events for each company are summarized in table 5:

Name of the venture	Number of interviews	Number of Archival Documents	Number of events	Number of references in Nvivo	Number of sources referenced
Alpha	3	53	74	268	45
Delta	3	52	55	171	29
Xi	2	21	55	151	20
Tau	4	48	72	276	36
Rho	4	30	59	184	22
Sigma	4	17	49	147	26

Table 5: Available data and coding summary

Furthermore appendices B through G show the event coding lists of all 6 ventures. This section will show the results of the research and will provide some explanations for these results, starting with the overall results of the evolution of decision making, followed by the results of the evolution of each principle. Finally the results of the influence of experience and uncertainty on the evolution of decision making will be provided.

5.1.Causal and Effectual Reasoning in the New Venture Lifecycle

The overall data shows that in total 364 events have been coded, of these events 269 were coded as effectual events and 168 as causal events. The following figure illustrates the percentage of the total number of events coded per phase in the new venture life cycle for causal and for effectual reasoning. Because events can be coded as both effectual and causal the percentages in the figures in this and following sections are meant as a way of indicating what part of the total number of events per phase was coded as either effectual or causal, and therefore they don't necessarily add up to a hundred percent.

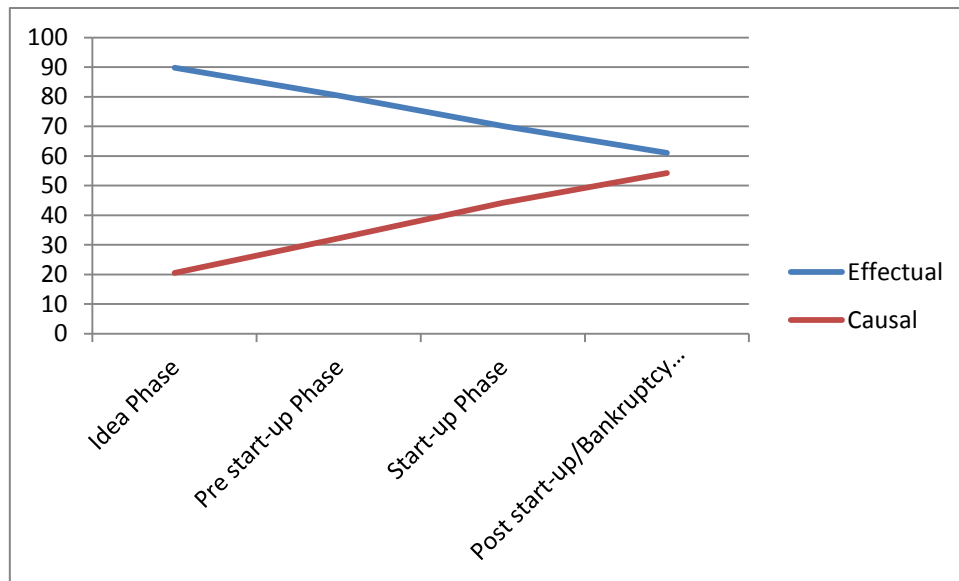


Figure 2: Percentage of effectual and causal events coded per phase in the new venture lifecycle

This figure indicates that decision-making is done mainly effectual over the entire lifecycle of the ventures. However, it also shows the evolution of the decision making logics over the lifecycle phases, as effectuation is clearly the dominant logic in the first phases, this diminishes over the course of the new venture lifecycle. In the idea phase almost all decisions have an effectual logic behind it, but going into the pre start-up phase and consequently the start-up phase this diminishes and increasingly also causal decisions are made. In the post start-up/bankruptcy phase causal and effectual decisions even start to even each other out. This indicates that during the lifecycle of a new venture entrepreneurial decision making shifts from an emphasis on effectual reasoning in the beginning to an emphasis on causal reasoning when the new venture reaches maturity, supporting the general research question of this study. This is also supported by the following Chi-square test results, which show that effectual and causal decision making vary significantly over the new venture lifecycle:

$$X^2(3, n = 413) = 12,758, p = ,0052$$

To explain this shift in the focus on decision making logic we can look at the explanation of growth in new ventures by Kazanjian (1990). According to Kazanjian (1990) the first stage of the new venture creation process is a stage in which there is no product, no market, no formalization, etc. This results in a very unpredictable future and a very dynamic and nonlinear environment. Combining this with the fact that effectuation focuses on controllable aspects of an unpredictable future (Politis and Gabrielsson, 2006) and effectuation being especially useful in dynamic and nonlinear environments (Sarasvathy, 2001), can explain why effectual decision making is dominant during the idea phase.

The second stage of the new venture creation process is a stage in which a product prototype has been developed, a preliminary market has been selected, and preliminary financial backing has been established. However the decision-making is still centralized and fairly informal. Also new relationships with stakeholders might still be accidental and informal, resulting in a changed product, a new market and/or new financial backing. This will result in a future that is still fairly unpredictable and an environment that is still mostly dynamic and nonlinear (Kazanjian, 1990). This could explain

that in the pre start-up phase and start-up phase effectuation diminishes, in favor of causation, but remains dominant.

According to Kazanjian (1990) the final stages of the new venture creation process are of growth, medium centralization and medium formalization of decision making. Furthermore the problems are focused on obtaining a larger market share as opposed to creating new markets. During this the venture is in a constant state of change, still indicating a fairly dynamic, nonlinear environment. Finally resulting in a stage in which the major problems of the organization are to maintain growth momentum and market position, and develop a second generation product. This indicates a static linear environment in which the future is predictable and controllable. However, the development of a second generation product does bring in unpredictability for the future and makes for a more dynamic environment. This could explain the fact that, although causal decision increases a lot again in the last phase, it eventually evens out with effectual decision making, instead of surpassing it.

The distribution of events per principle over the lifecycle of a new venture, as shown in figure 3, shows another interesting result of the research, namely that in the idea phase almost all decisions focus on the view of the future and the givens, while almost no decisions focus on the attitude toward others and the predisposition toward risk. This evens out in the later phases, although decisions involving givens remain the dominant decisions made during the pre start-up phase.

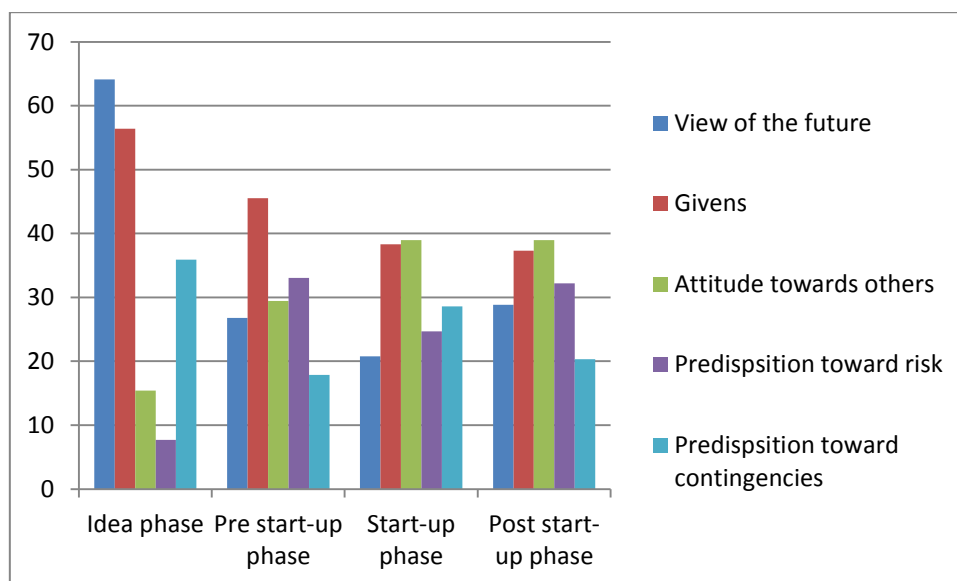


Figure 3: distribution of events per principle over the lifecycle of a new venture

The first phases of the new venture development process are phases in which the future is very unpredictable, there is no product, no market, no formalization (Kazanjian, 1990). Furthermore in these phases entrepreneurs usually start writing a business plan and forming the management team (Clarysse and Moray, 2004), which also requires a lot of thought about the future, the goals and means of the new venture. This could explain why these principles are so dominant early on. Furthermore this early in their lifecycle most entrepreneurs usually do not yet make many decisions about contingencies, big risks, or their attitude towards others, as they are focused on finishing a prototype, and have no clients, partnerships, or other contracts yet.

5.2.View of the Future in the New Venture Lifecycle

Hypothesis a: *As a new venture progresses in its life cycle, the view of the future of the entrepreneur, will shift from creative (effectual reasoning) to predictive (causal reasoning).*

To test the first hypothesis of this study, all events that involve decisions concerning the view of the future were analyzed separately. In total 104 events have been coded in view of the future, of which 73 were coded for creative view of the future and 31 for a predictive view of the future. The following figure illustrates the percentage of the number of effectual and causal events coded per phase in the new venture life cycle for this principle.

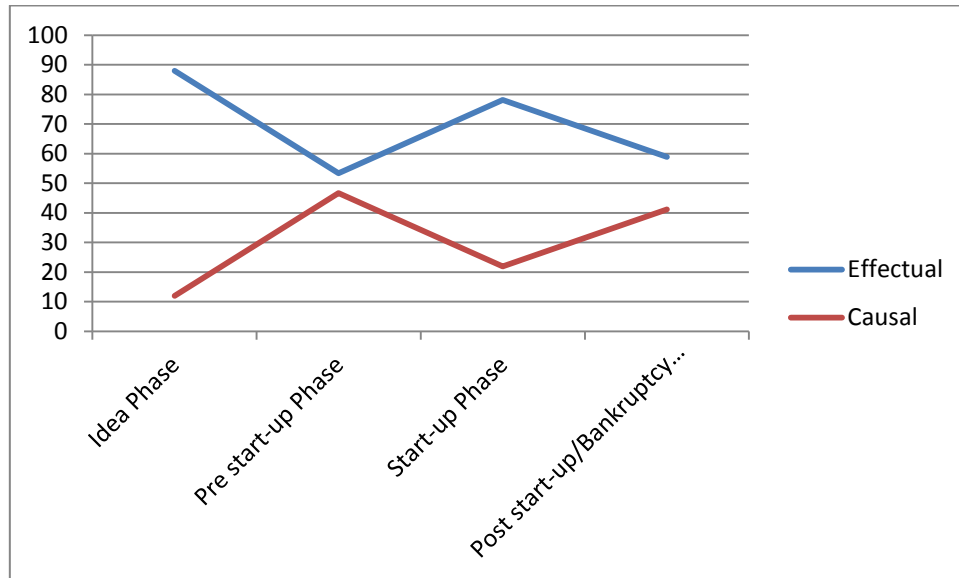


Figure 4: Percentage of effectual and causal events coded in view of the future per phase in the new venture lifecycle

This figure indicates that when it comes to the view of the future decision-making is also done mainly effectual over the entire lifecycle of the ventures. However, it also shows the evolution of the decision making logics over the lifecycle phases, which is fairly erratic. In the idea phase almost all decisions have an effectual logic behind it, but going into the pre start-up phase causal and effectual decision making concerning the view of the future almost even out. However, going into the start-up phase effectual decision making increases again over causal decision making and in the post start-up/bankruptcy phase causal and effectual decisions start to even each other out again. This indicates that although effectual and causal decision making concerning the view of the future vary significantly over the new venture lifecycle, which is supported by the Chi-square test results, the hypothesis is only **partly supported**, as effectual decision making does increase again during the start-up phase.

$$X^2(3, n = 104) = 9,877, p = ,0196$$

A possible explanation for the sudden shift toward effectual decision making concerning the view of the future during the start-up phase, could be the financial crisis of the last years. For most of the cases studied in this research the financial crisis came right in the middle of their start-up phase, and caused a highly unpredictable future and a very dynamic and nonlinear environment. As one entrepreneur mentioned about his business plans in one of the interviews:

“De eerste 4 jaar ofzo hebben we denk ik jaarlijks aangepast. Daarna zijn we daarmee gestopt. Toen was het ook crisistijd en zijn we meer op survival modus gegaan. Meer zoveel mogelijk omzet binnen halen en dat soort dingen. Dat was toen even echt nodig.”

English: *“The first 4 years we adjusted the business plans yearly i think. After that we stopped. Then it was the time of the financial crisis and we went into survival mode. Just trying to get as much turnover as possible. We really needed that then.”*

Combining this with the fact that effectuation focuses on controllable aspects of an unpredictable future (Politis and Gabrielsson, 2006) and effectuation being especially useful in dynamic and nonlinear environments (Sarasvathy, 2001), can explain why effectual decision making is dominant during this time of crisis.

5.3. Givens in the New Venture Lifecycle

Hypothesis b: *As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from means oriented (effectual reasoning) to goal oriented (causal reasoning).*

To test this hypothesis, all events that involve decisions concerning givens were analyzed separately. In total 154 events have been coded as belonging to the principle givens, of which 99 were coded for means-oriented givens and 58 for goal-oriented givens. The following figure illustrates the percentage of the number of effectual and causal events coded per phase in the new venture life cycle for this principle.

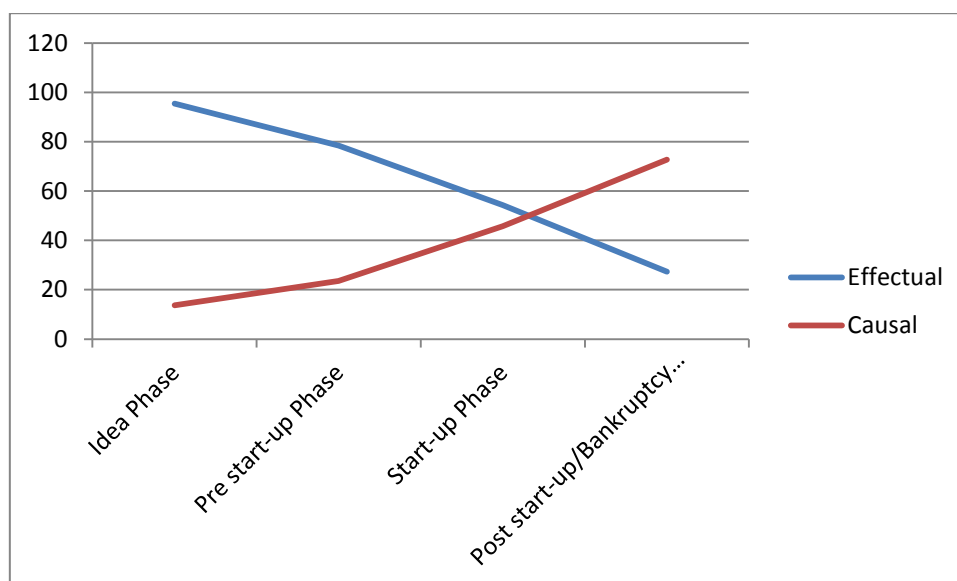


Figure 5: Percentage of effectual and causal events coded as givens per phase in the new venture lifecycle

This figure indicates that when it comes to the principle of givens the decisions made by the entrepreneur did shift from effectual in the beginning of the lifecycle to causal at the end of the lifecycle. In the idea phase almost all decisions have an effectual logic behind it, but going into the pre start-up phase this diminishes and increasingly also causal decisions are made. In the start-up phase causal and effectual decision making evens out, with causal decision making becoming the dominant logic concerning decisions about givens in the post start-up phase. This results **support** the hypothesis concerning givens in the new venture lifecycle and it is also supported by the following

Chi-square test results, which show that effectual and causal decision making vary significantly over the new venture lifecycle:

$$X^2(3, n = 157) = 24,511, p = ,0000$$

5.4. Attitude Toward Others in the New Venture Lifecycle

Hypothesis c: *As a new venture progresses in its life cycle, the attitude towards others of the entrepreneur will shift from a partnership and co-creation orientation (effectual reasoning) to a competitive orientation (causal reasoning).*

To test this hypothesis, all events that involve decisions concerning the entrepreneurs' attitude toward others were analyzed separately. In total 122 events have been coded as belonging to the principle attitude toward others, of which 79 were coded for partnership-based attitude toward others and 44 for competitive attitude toward others. The following figure illustrates the percentage of the number of effectual and causal events coded per phase in the new venture life cycle for this principle.

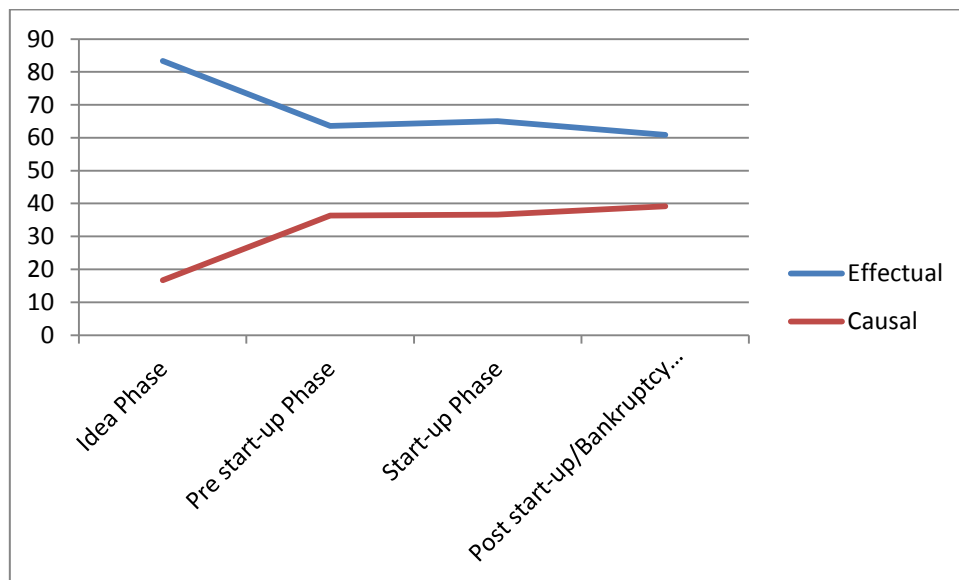


Figure 6: Percentage of effectual and causal events coded as attitude toward others per phase in the new venture lifecycle

This figure indicates that when it comes to the principle of attitude toward others, the decisions made by the entrepreneur are made mainly effectual over the entire lifecycle of the ventures. However, it also shows the evolution of the decision making logics over the lifecycle phases, as effectuation is clearly the dominant logic in the idea phase, this diminishes significantly when going into the pre start-up phase, after which it stays mostly the same over the course of the start-up phase. In the post start-up phase effectual decision making diminishes a little further, while causal decision making slightly increases. Although causal decision making logic when it comes to entrepreneurs' attitude toward others never becomes dominant over the effectual logic, these results do show that effectual and causal decision making vary significantly over the new venture lifecycle, **partly supporting** the hypothesis. This is also supported by the Chi-square test results:

$$X^2(3, n = 157) = 24,511, p = ,0000$$

5.5.Predisposition Toward Risk in the New Venture Lifecycle

Hypothesis d: As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from limiting downside potential by setting a level of affordable loss (effectual reasoning) to focusing on upside potential by calculating the expected value of risks (causal reasoning).

To test this hypothesis, all events that involve decisions concerning the entrepreneurs' predisposition toward risk were analyzed separately. In total 97 events have been coded as belonging to the principle predisposition toward risk, of which 72 were coded for affordable loss and 25 for expected return. The following figure illustrates the percentage of the number of effectual and causal events coded per phase in the new venture life cycle for this principle.

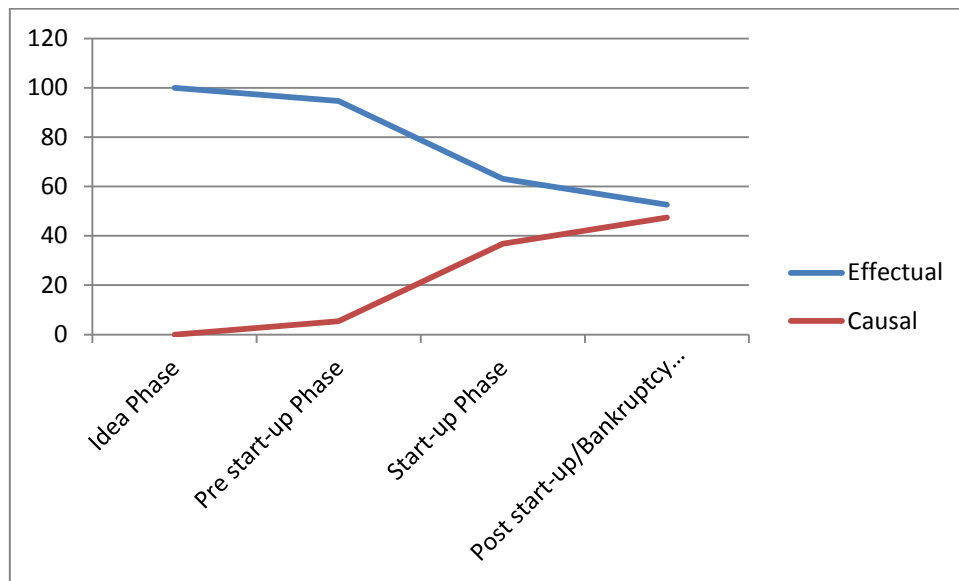


Figure 7: Percentage of effectual and causal events coded as predisposition toward risk per phase in the new venture lifecycle

This figure indicates that when it comes to the principle of predisposition toward risk, the decisions made by the entrepreneur are made mainly effectual over the entire lifecycle of the ventures. However, it also shows the evolution of the decision making logics over the lifecycle phases, as effectuation is clearly the dominant logic in the idea phase, this diminishes slightly when going into the pre start-up phase. During the start-up phase effectual logic in decision making diminishes dramatically, while causal logic increases dramatically, evening out in the post start-up phase. Although causal decision making logic when it comes to entrepreneurs' predisposition toward risk never becomes dominant over the effectual logic, these results do show that effectual and causal decision making vary significantly over the new venture lifecycle, **partly supporting** the hypothesis. This is also supported by the Chi-square test results:

$$X^2(3, n = 97) = 16,130, p = ,0011$$

5.6.Predisposition Toward Contingencies in the New Venture Lifecycle

Hypothesis e: As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from leveraging contingencies (effectual reasoning) to avoiding contingencies (effectual reasoning).

To test this hypothesis, all events that involve decisions concerning the entrepreneurs' predisposition toward contingencies were analyzed separately. In total 90 events have been coded as belonging to the principle predisposition toward contingencies, of which 70 were coded for leverage contingency and 20 for avoid risk. The following figure illustrates the percentage of the number of effectual and causal events coded per phase in the new venture life cycle for this principle.

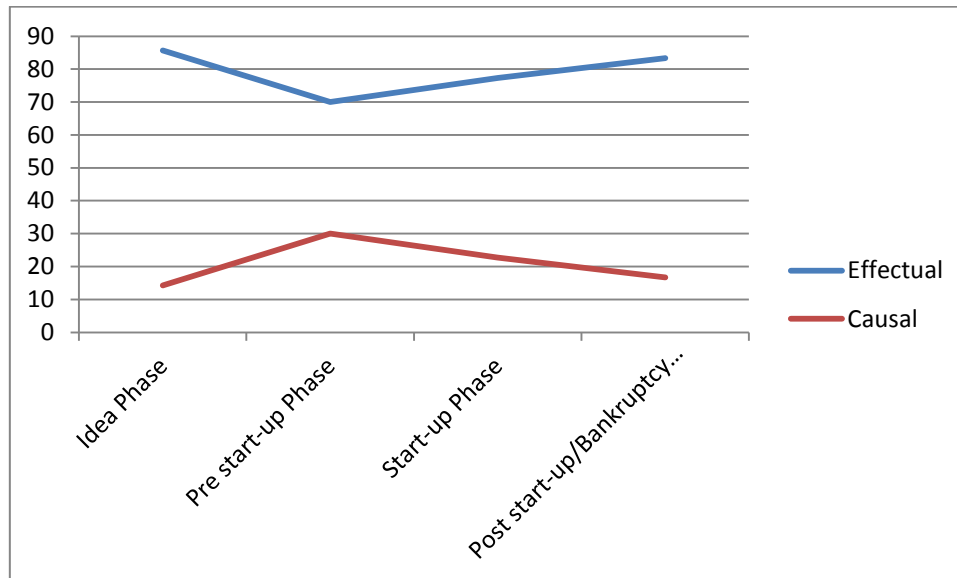


Figure 8: Percentage of effectual and causal events coded as predisposition toward contingencies per phase in the new venture lifecycle

This figure indicates that when it comes to the entrepreneurs' predisposition toward contingencies, their decisions are also made mainly effectual over the entire lifecycle of the ventures. Furthermore, in contrast to other principles, effectual logic remains the dominant logic over all lifecycle phases. Although effectual logic does diminish during the pre start-up phase, it increases again during the start-up phase, and increases even more going into the post start-up phase. This indicates that for decisions concerning the entrepreneurs' disposition toward contingencies there is no shift in the dominant logic, meaning that the hypothesis is **not supported**. This is also supported by the results of the Chi-square test, which are not significant:

$$X^2(3, n = 90) = 1,431, p = ,6983$$

A possible explanation for the fact that the predisposition of the entrepreneurs toward contingencies remains predominantly effectual could be the financial crisis again. As explained in section 4.2 the financial crisis made the future highly unpredictable and the environment increasingly dynamic, therefore the entrepreneurs had to change and adapt their plans to accommodate these events, as well as react positively to unforeseen developments and adopt them for their own benefit. One other explanation could be that all the cases studied in this research are university spin-offs that usually start out having to rely on the university, automatically opening them up to their environment.

5.7. Entrepreneurial Decision Making Under Uncertainty

To explore the effects of uncertainty on the evolution of decision making, the events were divided between the cases operating under high uncertainty and the cases operating under medium uncertainty. In total 201 events have been coded within the cases that operate under high

uncertainty, of which 142 were coded for effectuation and 83 for causation. Furthermore 163 events have been coded within the cases that operate under medium uncertainty, of which 127 were coded for effectuation and 61 for causation. The following two figures show the comparison between the levels of uncertainty within the evolution of effectual and causal decision making over the phases of the new venture life cycle.

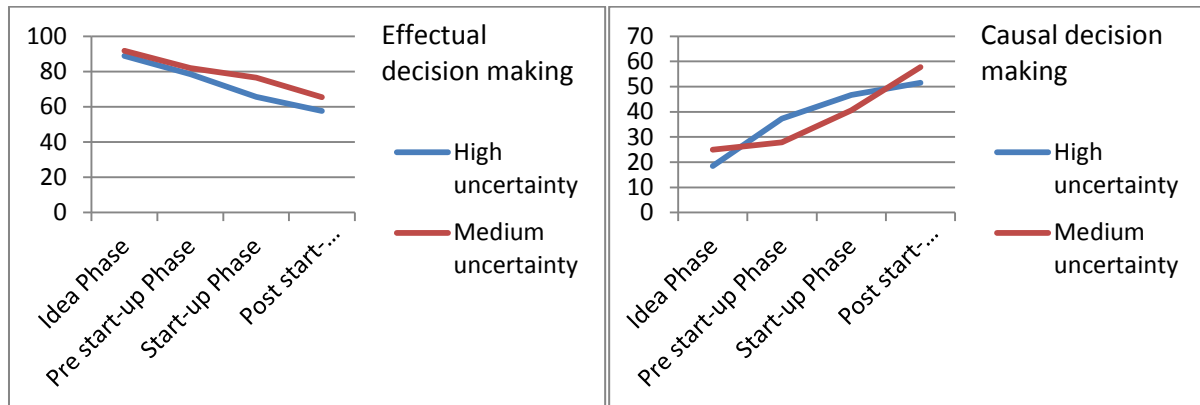


Figure 9: comparison between the levels of uncertainty within the evolution of effectual and causal decision-making over the new venture life cycle.

This figure indicates that, when it comes to the logics of decision making, the levels of uncertainty in which the entrepreneurs operates have no significant influence. A reason for this could be the fact that all cases were university spin-offs, which gives them access to a lot of support and guidance in building a new venture, possibly negating the effect of uncertainty on the development of the new venture. The support from the TUE was also mentioned positively in the interviews, for example the following quote:

“Ik denk zonder de mensen die zich toen, en nu ook nog wel een beetje, en dan dus niet alleen het IL maar ook de faculteit. Hoe die zich voor de spin-offs hebben ingezet. Ik zou niet zeggen dat we er dan niet geweest waren, maar wel anders en dan had ons hele pad er ook anders uitgezien denk ik. Dus ik vind het moeilijk om uiteindelijk te zeggen van, we zijn nu hier gekomen, of we dan daar zouden zijn, of hier dat weet ik niet, maar ik zie dat wel als positief.”

English: *“I think that without the people that supported spin-offs, not just Innovation Lab, but also the department. I don’t want to say that we wouldn’t have been here right now, but at least different and our path would have been very different as well I think. So it is hard for me to say we are here because of them, or otherwise we would’ve been there, I don’t know, but I do regard that as positive.”*

Furthermore, it is interesting to note how the entrepreneurs that operate in high uncertainty, appear to prefer causal logic in the last phase of the lifecycle. It might be interesting to investigate if this trend continues when the new ventures mature and progress into the later stages of organizational development.

5.8. Effects of Experience on Entrepreneurial Decision Making

To explore the effects of entrepreneurial experience on the evolution of decision making, the events were divided between the cases starting with an experienced entrepreneur in their management team and the cases without such an entrepreneur. In total 184 events have been coded within the

cases that started with an experienced entrepreneur within the management team, of which 138 were coded for effectuation and 70 for causation. Furthermore 180 events have been coded within the cases that started without an experienced entrepreneur within the management team, of which 131 were coded for effectuation and 74 for causation. The following two figures show the comparison between the levels of experience within the evolution of effectual and causal decision making over the phases of the new venture life cycle.

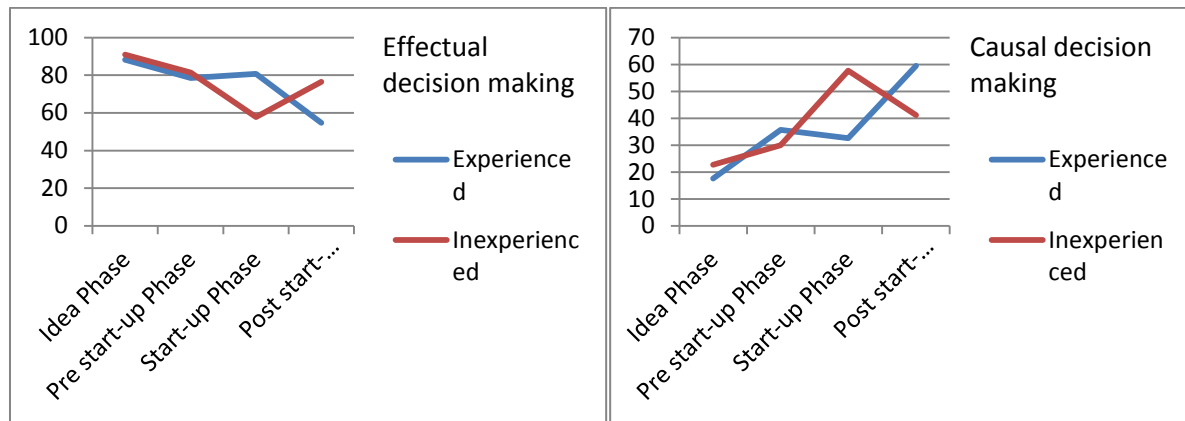


Figure 10: comparison between the levels of experience within the evolution of effectual and causal decision making over the new venture life cycle.

This figure indicates that, when it comes to the logics of decision making, the inclusion of an experienced entrepreneur has no significant influence on the earlier phases of the lifecycle. A reason for this could be the fact that all cases were university spin-offs, which gives them access to a lot of support and guidance in building a new venture, possibly negating the effect of experienced entrepreneurs in the other ventures. The support from the TUE was also mentioned positively in the interviews, for example the following quote:

“Een business developer van het Innovation Lab heeft wel heel veel gesteund... Want als de TU achter je staat en de mensen zeggen: hier staan we achter, hier geloven we in, dan kom je toch wat makkelijker door zo’n selectieronde heen. Wat dat betreft hebben we eigenlijk heel veel steun gehad van de TU.”

English: *“A business developer from the Innovation Lab supported us a lot.. Because if the TU is behind you and the people are saying: We are behind this, we believe in this, then it is easier to get through a selection for a grant. We got a lot of support from the TU in that regard.”*

It is interesting to note, however how the cases with an experienced entrepreneur focus more on effectual logic during the start-up phase, in comparison to their counterparts with no experienced help. A reason for this might be that the start-up phase is the phase in which the business actually gets started, so most experienced entrepreneurs might have only stepped up in this phase, as the earlier phases are mostly concerned with developing a prototype and formalizing the management team (Clarysse and Moray, 2004), which is usually done by the students in a university spin-off.

*“Is de ervaren ondernemer hier fulltime mee bezig?
Nee, niet fulltime hiermee bezig. Tot halverwege vorig jaar heeft hij nog een project afgemaakt. Er was een mogelijkheid hier een gedeelte mee op te starten. We willen graag software ontwikkelen en verkopen. Hiervoor moet je heel veel van te voren ontwikkelen. Daarin zit zo’n jaar of twee*

ontwikkelen zodat je er echt verder mee kan en kan gaan verkopen.”

English: *“Is de experienced entrepreneur working on this fulltime?*

No, not fulltime. Until about halfway last year he finished a project. We had the opportunity to start this partially already. We wanted to develop and sell software. For that you gave to develop a lot beforehand. There is about a year or two development time beforehand, before you can actually continue with it and can sell it.”

Another explanation for the difference in decision making logic during the start-up phase could be that it was a reaction on the financial crisis. The experience of the entrepreneurs might have allowed them to react earlier and easier to the unpredictable future and dynamic environment the new ventures had to deal with during the financial crisis.

Furthermore it is interesting to note how the cases with an experienced entrepreneur, appear to prefer causal logic in the last phase of the lifecycle. It might be interesting to investigate if this trend continues when the new ventures mature and progress into the later stages of organizational development.

6. Discussion and Conclusions

This study contributes to the literature on entrepreneurial decision making in new ventures, by identifying the way decision making logic evolves during the new venture lifecycle. It explores and analyzes the current body of research on effectual and causal decision making, identifying a gap in the literature in how the two logics can work in a complementary fashion. This gap is explored by a longitudinal case study offering a perspective on how entrepreneurs use both effectual and causal reasoning during the lifecycle of a new venture. Furthermore this study explores the effects of uncertainty and entrepreneurial expertise on the evolution of decision making. This study has several theoretical and practical implications.

6.1. Discussion

As argued by Sarasvathy (2001) March's exposition on exploration and exploitation indicates that causal reasoning and effectual reasoning need not always pull in opposite directions. Instead they can work in a complementary fashion. This study provides a unique insight in the way effectual and causal reasoning are working together in the lifecycle of a new venture. The findings suggest that during the lifecycle of a new venture entrepreneurial decision making shifts from an emphasis on effectual reasoning in the beginning to an emphasis on causal reasoning when the new venture reaches maturity. These results support the suggestions of Dew, Read, Sarasvathy and Wiltbank (2011) that these two methods work concurrently or iteratively within a new venture. It supports the argument of Sarasvathy (2001) that causal and effectual reasoning need not always pull in opposite directions. Furthermore it supports the findings of Reymen et al. (2012) suggesting effectual and causal processes may be at work simultaneously over the course of a new venture lifecycle.

To explore the evolution of decision making logics over time a longitudinal case study was done including 6 university spin-offs from the Eindhoven University of Technology. Multiple interviews were collected from them over the course of their venture lifecycle, which were coded and supported by archival data. The results were also coded for the five principles based on issues of

entrepreneurial decision making: view of the future, givens, attitude toward others, predisposition toward risk, and predisposition toward contingencies (Sarasvathy and Dew, 2005; Read et al, 2008; Read et al, 2009). This allowed for five hypotheses to be answered, as shown in table 6.

Hypothesis a was only partially supported as the results did show that effectual and causal decision making concerning the view of the future vary significantly over the new venture lifecycle and causal reasoning does increases during the new venture lifecycle, effectual reasoning remains the dominant logic.

Hypotheses		
Hypothesis a	<i>As a new venture progresses in its life cycle, the view of the future of the entrepreneur, will shift from creative (effectual reasoning) to predictive (causal reasoning).</i>	Partially supported
Hypothesis b	<i>As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from means oriented (effectual reasoning) to goal oriented (causal reasoning).</i>	Supported
Hypothesis c	<i>As a new venture progresses in its life cycle, the attitude towards others of the entrepreneur will shift from a partnership and co-creation orientation (effectual reasoning) to a competitive orientation (causal reasoning).</i>	Partially supported
Hypothesis d	<i>As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from limiting downside potential by setting a level of affordable loss (effectual reasoning) to focusing on upside potential by calculating the expected value of risks (causal reasoning).</i>	Partially supported
Hypothesis e	<i>As a new venture progresses in its life cycle, the decisions made by the entrepreneur, will shift from leveraging contingencies (effectual reasoning) to avoiding contingencies (effectual reasoning).</i>	Not supported

Table 6: Hypotheses

Hypothesis b was supported as the results showed that effectual and causal decision making concerning givens vary significantly over the new venture lifecycle and these decisions clearly shift from predominantly effectual in the early phases to predominantly causal in the later stages of the new venture lifecycle.

Hypothesis c was only partially supported because although causal decision making logic when it comes to entrepreneurs' attitude toward others never becomes dominant over the effectual logic, the results do show that effectual and causal decision making vary significantly over the new venture lifecycle and that causal reasoning increases significantly.

Hypothesis d is also partially supported, because again the results show that effectual and causal decision making when it comes to the entrepreneurs' predisposition toward risk vary significantly over the new venture lifecycle. However, causal decision making logic never becomes dominant over the effectual logic.

Finally hypothesis e is not supported, because the results showed no shift in the dominant logic for decisions concerning the entrepreneurs' disposition toward contingencies. However it does provide an interesting insight, as for this principle, the effectual logic remained dominant throughout the new venture lifecycle. This indicates that either entrepreneurs are always predisposed to leveraging

contingencies, or an external factor influenced the results. As all ventures are spin-offs from the university, and they all had some trouble with the financial crisis it could be that one of these factors prevented the shift in decision making logic from effectual to causal.

When exploring the effects of environmental uncertainty on the evolution of entrepreneurial decision making logic no significant results were found. Both entrepreneurs with ventures in medium and highly uncertain environments made their decisions based on the same logic. This opposes the findings of Reymen et al. (2012) that entrepreneurs adapt decision making logic according to the perceived environmental uncertainty.

Furthermore the research shows that, when it comes to the logics of decision making, the inclusion of an experienced entrepreneur has no significant influence on the earlier phases of the lifecycle. However a significant variation is found during the start-up phase, where an experienced entrepreneur steers its team toward a more effectual logic of decision making.

A reason for these last results might be the fact that all cases were university spin-offs, which gives them access to a lot of support and guidance in building a new venture, possibly negating the effect of perceived uncertainty and the experienced entrepreneurs in the ventures.

Finally, it is interesting to note how experienced entrepreneurs and entrepreneurs that operate in high uncertainty, appear to prefer causal logic in the last phase of the lifecycle. It might be interesting to investigate if this trend continues when the new ventures mature and progresses into the later stages of organizational development.

6.2. Practical Implications and Limitations

This study has several practical implications, starting with the gap it fills in the literature and the educational value of filling this gap both for entrepreneurs and entrepreneurial education. This study shows that two opposing theories of entrepreneurial decision making can be and are complementary, and that they can shift focus over the lifecycle of a new venture. Furthermore it provides a more in depth analysis of the evolution of effectual and causal reasoning providing by also analyzing the shift in the five principles based on issues of entrepreneurial decision making: view of the future, givens, attitude toward others, predisposition toward risk, and predisposition toward contingencies. This allows future entrepreneurs to use this information and carefully consider and select which type of reasoning suits them best in different situations and on different points in their new venture lifecycle.

However, the research is not complete and could benefit from further research and perhaps the development of a framework, which could guide future entrepreneurs through certain problems in the new venture creation process. It is now clear that effectual and causal reasoning can work in a complementary fashion and that entrepreneurs have the ability to shift between these two logics. Research needs to be done into whether using either effectual or causal reasoning in certain decisions and on certain points of the new venture lifecycle might be significantly more beneficial than using the other.

This research has a few limitations. First due to the low sample count, and the fact that all cases are spin-offs from the Eindhoven University of Technology, the external validity is not high, and the generalizability of the research is limited to high tech university spin-offs. However, because of the

control on industry, experience, uncertainty and success, the results are generalizable to most organizations in that area. This does invite future research, focusing on new ventures from other origins.

A second limitation is the focus on retrospective data, which can cause problems with test-retest reliability, however because the focus is on the major events within the organizations, it is unlikely that they will be remembered incorrectly. Although, the field of research would benefit from a real time study in which the entrepreneurs and their ventures are more directly followed and analyzed.

There is also an external variable that could not be controlled for, namely the financial crisis, as it has affected all businesses, in each industry in the last years. Although the data was gathered over a long period of time to try and control for this variable, some of the results of this study warrant a closer look into the financial crisis and its consequences on entrepreneurial decision making.

6.3.Conclusion

To conclude this study contributes to the literature on entrepreneurial decision making in new ventures, by identifying and filling a gap concerning the complementary fashion of effectual and causal decision making. This is done by performing a longitudinal case study gathering and analyzing multiple interviews, and archival data of 6 university spin-offs. This has resulted in an in depth perspective on the five principles based on issues of entrepreneurial decision making (view of the future, givens, attitude toward others, predisposition toward risk, and predisposition toward contingencies) and how entrepreneurs use both effectual and causal reasoning during the lifecycle of a new venture to navigate decisions concerning these five principles. Furthermore this study identifies some interesting new areas for study, like research into how to use effectual and causal reasoning in guiding future entrepreneurs through decisions in the new venture creation process.

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Appendix A: General Interview Guide

Interview scheme university spin offs and entrepreneurial decision making

Date & Time:	Location:
Interviewee:	Interviewer:

Introduction

This research is done to gain insight into the changes in entrepreneurial decision making during the course of the new venture creation process. This will allow us to better understand this process and the role of entrepreneurial decisions therein. This interview will also be used to expand the knowledge base on university spin-off creation.

1. Background

- a) Please tell us about <company name> and the most important changes since the last interview?
- Could you describe the processes surrounding these changes?
(cause/reaction/result/satisfaction)
- b) Did your position in the company change since the last interview?

2. Spin-off general

During the previous interviews you were questioned about the relationship between your company and TU/e Innovation Lab (IL). In the past years Innovation Lab's leadership and direction changed.

- a) Did this change have an effect on the relationship between <company name> and the TU/e?
- Has there been a change in the support received from TU/e?
 - Has there been a change in the structures and policies at IL concerning spin-offs?
(scouting/eligibility/revenues and share distribution/IP agreements)
 - Can you elaborate on the current support provided by TU/e to <company name>?
(facilities/financing/advice and coaching/network)
- b) How has the support from TU/e contributed to the development of <company name>?
- c) How were the policies and possibilities for support communicated to you as the entrepreneur?
- d) What has been the influence of the university context on the creation of <company name> and its success?
- e) In retrospect, have there been cases in which you would have liked to act differently, with regard to the cooperation with TU/e?

3. Planning and givens

- a) Was the development of <company name> planned in detail or was it a rough idea which later took shape?
- What has been the role of your business plan throughout the creation process?
 - Has your business plan been altered during this process?

- What was the reason for these changes?
 - *If no (or outdated) business plan available ask for recent version.*
- b) Could you describe how your management team got formed?
- What has been your process of human resource acquisition? Has this changed over time?
- c) Have there been cases in which availability or lack of certain means, forced or coerced you to change your plans for the future of the company?
- d) Have there been cases in which significant effort was required to acquire means needed to pursue your plans for the future of the company?
- e) In retrospect, has the development of <company name> been like your plans/expectations?
- Has this resulted in a shift in how you will manage your expectations and ambitions for this and potential new venture(s) in the future?

4. *Financing*

- a) How has <company name> been financed?
(Public funding/business angels/venture capitalists/other investors)
- Please elaborate on the process of the funding?
(motivation/relationship/returns and paybacks/satisfaction)
 - Being a TU/e spin-off; does TU/e have a say in the financing of the company?
- b) Could you describe the major investments done by the company?
(motivation/risk/result/satisfaction)
- c) Have there been cases in which you put the best of the company before personal profit?

5. *Intellectual Property (IP)*

- a) What is the current status of the IP used by <company name>?
(creator/ownership/agreement/usefulness)
- b) Could you elaborate on the process of IP negotiations between the company and IL?
(motivation/tensions/outcome)
- c) In retrospect, have there been cases in which you would have liked to act differently, with regard to acquiring and (potentially) losing intellectual property?

6. *Networks and collaboration*

- a) Could you describe the activities you have pursued in expanding your business network?

(Personal network/network meetings/social media/pitching/etc)
- b) Could you describe the collaborations that have had the biggest effect (also negative) on the company? (alliances/joint ventures/financing/suppliers/etc)

- Please elaborate on the circumstances surrounding this collaboration?
(relationship/motivation/contract-based vs. trust-based/problems/results/satisfaction)
- c) Have there been cases in which <company name> has collaborated with clients?
- Please describe this collaboration? (motivation/result/satisfaction)
- d) In retrospect, would you have liked to act differently, with regard to building your network and collaborations?

7. Opportunities, unforeseen developments and risk

- a) Could you describe some of the most interesting opportunities you have come across?
- Please elaborate on the process surrounding the success or failure of these opportunities?
(time period/reaction/result and influence/satisfaction)
- b) Could you describe some of the most unexpected developments you have come across?
- Please elaborate on the process of dealing with these developments?
(time period/reaction/result and influence/satisfaction)
- c) Could you describe some past activities of <company name> involving a high level of risk?
- Please describe the process of dealing with these risks?
(time period/reaction/result/satisfaction)

Appendix B: Alpha Event Coding

Alpha Event	1E	1C	2E	2C	3E	3C	4E	4C	5E	5C	New Venture Development Phase
Acquiring technology from TUE	No	No	Yes	No	Yes	No	No	No	No	No	Idea Phase
AIO develops technology	No	No	No	No	Yes	No	No	No	No	No	Idea Phase
Getting assistance from Jos Keurentjes	No	No	Yes	No	No	No	No	No	No	No	Idea Phase
Getting interested in entrepreneurship	Yes	No	No	No	No	No	No	No	No	No	Idea Phase
Getting work experience at Unilever	No	Yes	No	No	No	No	No	No	No	No	Idea Phase
Starting the enterprise	Yes	No	Yes	No	No	No	No	No	No	No	Idea Phase
Considering moving to High Tech campus	Yes	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Cooperation with academic hospital Maastricht	Yes	No	No	Yes	Yes	No	No	No	No	No	Pre start-up Phase
Cooperation with TUE	No	No	Yes	No	Yes	No	No	No	No	No	Pre start-up Phase
Creating the first business plan	No	Yes	No	No	No	No	No	No	Yes	No	Pre start-up Phase
Creating the first product development plan	No	Yes	No	No	No	No	No	No	No	No	Pre start-up Phase
Deciding not to go for early stage financing	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Deciding to develop a product instead of doing research	No	No	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Developing and testing first polypulse prototype	No	Yes	No	No	No	No	No	No	No	No	Pre start-up Phase
Filing first patent	No	No	No	No	No	Yes	No	No	No	No	Pre start-up Phase
Filing new patents on polypulse technology	No	No	No	No	No	Yes	No	No	No	No	Pre start-up Phase
Getting first stage grant from Biopartner	No	No	No	No	Yes	No	Yes	No	No	No	Pre start-up Phase
Getting housing (financing) from TUE	No	No	No	No	Yes	No	Yes	No	No	No	Pre start-up Phase
Going to network meetings via TUE	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Improving communication skills	No	No	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Starting BV	No	Yes	Yes	No	No	No	No	No	No	No	Pre start-up Phase

Acquiring desired competences and improving team	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Acquiring technology	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Actively acquiring new projects	Yes	No	Yes	No	No	Yes	No	No	Yes	No	Start-up Phase
Being open for new opportunities	No	No	No	No	Yes	No	No	Yes	Yes	No	Start-up Phase
Changing from business plans to business cases	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Changing the role of Jos Keurentjes	No	No	Yes	No	Yes	No	No	No	No	No	Start-up Phase
Choosing potential partner for focus on cancer-pain medication	No	No	No	No	Yes	Yes	No	No	No	No	Start-up Phase
Considering project for a nose spray	Yes	No	Yes	No	No	Yes	No	Yes	Yes	No	Start-up Phase
Considering project for dissolvable odor dispensers	Yes	No	No	No	No	Yes	No	Yes	Yes	No	Start-up Phase
Considering project for dissolvable pills	Yes	No	No	No	No	No	No	Yes	Yes	No	Start-up Phase
Cooperation with distributors	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Cooperation with TU Delft	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Deciding not to go for investors	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase
Deciding on technology for spin-off	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Deciding to continue with BV despite disappointing results from product	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase
Deciding to develop the new product	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Doing market research for the product	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Finding suitable accountants	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Further development of the product	No	No	No	No	No	No	No	No	No	Yes	Start-up Phase
Getting 2 medical professionals as stakeholders	No	No	No	Yes	Yes	No	No	No	No	No	Start-up Phase
Getting a loan from	No	No	No	No	No	No	Yes	No	No	No	Start-up

the bank											Phase
Getting IS grant from SenterNovem	No	No	Yes	No	Yes	No	Yes	No	No	No	Start-up Phase
Getting money guarantee from IL for IS grant	No	No	No	No	Yes	No	Yes	No	No	No	Start-up Phase
Getting tax deduction on research	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase
Hiring first employees	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Hiring promovendi Wouter	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Increasing team size	No	Yes	No	Yes	No	No	No	No	No	No	Start-up Phase
Initial hiring strategy	No	Yes	No	Yes	No	No	No	No	No	No	Start-up Phase
Initial plans for the future	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Marketing through medical expos	No	No	Yes	No	Yes	No	No	No	No	No	Start-up Phase
Marketing through medical professionals	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Preparing for animal testing	No	No	No	Yes	No	No	No	No	No	Yes	Start-up Phase
Starting spin-off and holding Group	No	Yes	No	Yes	No	No	No	No	Yes	No	Start-up Phase
Working together with clients	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Deciding on a lean team	Yes	No	No	No	No	No	Yes	No	Yes	No	Post start-up Phase
Deciding on future financing	No	No	No	No	No	No	No	Yes	No	No	Post start-up Phase
Deciding on future polypulse	No	Yes	No	Yes	No	No	No	No	No	No	Post start-up Phase
Deciding on investments	No	No	No	No	No	No	No	Yes	No	No	Post start-up Phase
Deciding to let patents go	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase
Decreasing team size	Yes	No	No	No	No	No	Yes	No	No	No	Post start-up Phase
Developing the second product	No	No	No	No	No	No	No	Yes	No	No	Post start-up Phase
Filing new patents for spin-off	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase
Filing new patents on technology	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase
Filing patents for carbonite	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase
Financing BV with income from spin-off	No	No	No	No	No	No	Yes	No	No	No	Post start-up Phase
Finding distributors for the second	No	No	No	Yes	No	No	No	No	No	No	Post start-up Phase

product												
Focusing on big markets for the second product	No	Yes	No	Yes	No	No	No	No	Yes	No	Post start-up Phase	
Further development water softening technology	No	No	No	Yes	No	No	No	No	No	Yes	Post start-up Phase	
Getting FDE approval for America	Yes	No	No	Yes	Yes	No	No	No	No	No	Post start-up Phase	
Getting financed by grants	No	No	No	No	No	No	Yes	No	No	No	Post start-up Phase	
Getting grant from SenterNovem for research project spin-off	No	No	No	No	Yes	No	Yes	No	No	No	Post start-up Phase	
Later hiring strategy	No	No	No	Yes	No	No	No	No	No	No	Post start-up Phase	
Moving to Catalyst	No	No	Yes	No	No	No	No	No	No	No	Post start-up Phase	

Appendix C: Delta Event Coding

Delta Event	1E	1C	2E	2C	3E	3C	4E	4C	5E	5C	New Venture Development Phase
Early entrepreneurship experience Erik-Jan	No	No	Yes	No	No	No	No	No	No	No	Idea Phase
Erik-Jan gets interested in the visualisation tool	No	No	No	Yes	Yes	No	No	No	No	No	Idea Phase
Roel gets involved as an intern	No	No	Yes	No	No	No	No	No	Yes	No	Idea Phase
Early business plan	No	Yes	No	No	No	No	No	No	Yes	No	Pre start-up Phase
Early involvement of Erik-Jan	No	No	Yes	No	Yes	No	No	No	No	No	Pre start-up Phase
Filing European Community Design	No	No	No	No	No	Yes	No	No	No	No	Pre start-up Phase
Financing from Erik-Jan personally	No	No	Yes	No	No	No	Yes	No	No	No	Pre start-up Phase
BV gets founded	No	Yes	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Negotiations with TUE about technology	No	No	No	No	Yes	No	No	No	Yes	No	Pre start-up Phase
Roel does workshop at TUE	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Roel gets involved as stakeholder	Yes	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Support from Jack	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Support from TUE IL in housing and facilities	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Client - Ahold	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Competitive positioning 2010	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Cooperation with Fontys	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Deciding to go international	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Early business development support from TUE	No	No	No	No	No	No	No	Yes	No	Yes	Start-up Phase
Early commercial support from TUE IL	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Early hiring strategy	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Early risks	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase
Early sales strategy	No	No	No	Yes	Yes	No	No	No	No	No	Start-up Phase
Financing from	No	No	Yes	No	No	No	Yes	No	No	No	Start-up Phase

outside sources												
First contact with Gartner	No	No	No	No	No	Yes	No	No	No	Yes	Start-up Phase	
Formalizing communication	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase	
Getting first clients	No	No	Yes	No	Yes	No	No	No	No	No	Start-up Phase	
Growth strategy 2009	Yes	No	No	No	No	No	No	No	No	No	Start-up Phase	
Growth strategy 2010	Yes	No	No	No	No	No	No	No	No	No	Start-up Phase	
ICT Kennis Congres	No	No	Yes	No	No	No	No	No	Yes	No	Start-up Phase	
Little contact with other businesses in building	No	No	No	Yes	No	No	No	No	No	Yes	Start-up Phase	
Looking into innovation vouchers	No	No	No	No	No	No	No	No	No	Yes	Start-up Phase	
Marketing through expo's	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase	
Meet&Match	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase	
Opportunity with Deutsche Bank	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase	
Partnership Philips	No	No	No	No	Yes	No	No	No	Yes	No	Start-up Phase	
Partnership with PALGA	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase	
Partnership with Pinesoft	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase	
Partnership with Simac	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase	
Roel finishes his study at BV	No	No	Yes	No	No	No	Yes	No	No	No	Start-up Phase	
Strategy change due to economic crisis	Yes	No	No	No	No	No	No	Yes	Yes	No	Start-up Phase	
WBSO tax deduction	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase	
Financing strategy 2010	No	No	No	No	No	No	No	Yes	No	No	Post start-up Phase	
Future business strategy	No	Yes	No	Yes	No	Yes	No	No	Yes	No	Post start-up Phase	
Future Financing strategy	Yes	No	No	No	No	No	Yes	No	No	No	Post start-up Phase	
Later hiring strategy	Yes	No	Yes	No	No	No	No	No	No	No	Post start-up Phase	
Later involvement TUE	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase	
Later risks	No	No	No	Yes	No	No	No	No	No	Yes	Post start-up Phase	
Marketing strategy 2010	No	No	No	Yes	Yes	No	No	No	No	No	Post start-up Phase	
Marketing through specific expo's	No	No	No	Yes	No	No	No	No	No	No	Post start-up Phase	
Other partnerships	No	No	No	No	Yes	No	No	No	No	No	Post start-up Phase	
Patent strategy	No	No	No	No	Yes	No	No	No	No	No	Post start-up Phase	

Product strategy 2010	No	Yes	No	No	Yes	No	No	Yes	No	No	Post start-up Phase
Roel does MBI	No	No	Yes	No	No	No	No	No	No	No	Post start-up Phase
Specializing products for special markets	Yes	No	Yes	No	Yes	No	No	No	Yes	No	Post start-up Phase
Vendor strategy 2010	No	No	No	Yes	No	Yes	No	No	No	No	Post start-up Phase

Appendix D: Xi Event Coding

Xi Event	1E	1C	2 ^E	2C	3E	3C	4E	4C	5E	5C	New Venture Development Phase
Getting interested in entrepreneurship	Yes	No	No	No	No	No	No	No	Yes	No	Idea Phase
Joost does traineeship at Philips research	Yes	No	No	No	No	No	No	No	No	No	Idea Phase
Ko and Joost decline CTE-project	No	Yes	No	No	No	No	No	No	No	Yes	Idea Phase
Ko and Joost get the idea for venture	Yes	No	Yes	No	No	No	No	No	Yes	No	Idea Phase
Ko is involved in Maxum project	Yes	No	No	No	No	No	No	No	No	No	Idea Phase
Ko starts as AIO	Yes	No	No	No	No	No	No	No	No	No	Idea Phase
Phd research into semiconductors	Yes	No	No	No	No	No	No	No	Yes	No	Idea Phase
Delaying publicizing the research	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Early focus on inkjet technology	No	Yes	No	No	No	No	No	No	Yes	No	Pre start-up Phase
Early planning	Yes	No	No	No	No	No	No	No	No	No	Pre start-up Phase
Early support from TUE	No	No	Yes	No	Yes	No	No	No	No	No	Pre start-up Phase
Filing first patent	No	No	Yes	No	No	Yes	No	No	No	No	Pre start-up Phase
Incubator3+ grant	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Joost starts working fulltime for Neodec	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Ko starts working 1 day a week for BV	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Negaotiations with TUE about technology	No	No	No	No	No	Yes	No	No	No	No	Pre start-up Phase
Participate in STW and ELAD workshops	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Plans for initial production	Yes	No	Yes	No	Yes	No	No	No	Yes	No	Pre start-up Phase
Rabobank innovation credit	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Rob gets involved in BV	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Starting BV	No	No	No	No	Yes	No	Yes	No	No	No	Pre start-up Phase
Students working on technology	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
STW-grant phase 1	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase

TOP-regeling	No	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Building up own network	No	No	Yes	No	No	No	No	No	No	No	No	Start-up Phase
Change in focus away from inkjet technology	No	No	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Charrol and Rien take over Rob's duties	No	No	Yes	No	No	No	No	No	No	Yes	No	Start-up Phase
Client in Germany using technology for intelligent packaging	No	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Cooperation with DuPont	Yes	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Cooperation with Fontys	No	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Cooperation with multinational in Germany	Yes	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Deciding to stay at the faculty and not move to Catalyst	No	No	Yes	No	No	Yes	No	No	No	No	No	Start-up Phase
Filing new patents	No	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Financing from Rob's personal network	No	No	Yes	No	No	No	Yes	No	No	No	No	Start-up Phase
First batch of ink sold to multinational in Germany	No	No	No	No	Yes	No	No	No	Yes	No	No	Start-up Phase
Fontys grant	No	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
IPC grant	No	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Ko leaves BV	No	No	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Marketing through printed electronics expo	No	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Other grants	No	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Partnership with Holst centre	Yes	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Peter gets involved as Rob's compagnon	No	No	Yes	No	Yes	No	No	No	No	No	No	Start-up Phase
STW-grant phase 2	No	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Support from TUE in buying a silkscreen printer	No	No	Yes	No	Yes	No	No	No	No	No	No	Start-up Phase
Using Rob's personal contacts to improve network	No	No	Yes	No	No	No	No	No	No	No	No	Start-up Phase
CenterNovem innovation credit	No	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase
Client in France producing flexible	No	No	No	No	Yes	No	No	No	No	No	No	Post start-up Phase

solar panels											
Client in Germany using technology in unforeseen way	No	No	No	No	Yes	No	No	No	No	No	Post start-up Phase
Later cooperation with TUE	No	No	No	No	Yes	No	No	No	No	No	Post start-up Phase
Looking for financing to grow	No	No	No	Yes	No	No	No	Yes	No	No	Post start-up Phase
Looking into selling BV	No	No	No	No	No	No	No	Yes	No	No	Post start-up Phase
Research into new ways to use technology	No	No	No	No	No	No	No	No	Yes	No	Post start-up Phase
Strategy for the future	No	No	No	Yes	No	No	No	No	Yes	No	Post start-up Phase
Writing first business plan in 2011	No	Yes	No	No	No	No	No	Yes	No	No	Post start-up Phase
Bringing in a third inventor	Yes	No	Yes	No	No	No	No	No	Yes	No	Idea Phase

Appendix E: Tau Event Coding

Tau Event	1E	1C	2 ^E	2C	3E	3C	4E	4C	5E	5C	New Venture Development Phase
Brainstorming and deciding on a plan	Yes	No	No	No	No	No	No	No	No	No	Idea Phase
Change to different production technique	No	No	No	No	No	No	No	No	Yes	No	Idea Phase
Deciding on suitable technology	Yes	No	Yes	No	No	No	No	No	No	No	Idea Phase
Looking for others to form team	No	Yes	No	No	No	No	No	No	No	No	Idea Phase
Nico gets interested in entrepreneurship	Yes	No	No	No	No	No	Yes	No	No	No	Idea Phase
Nico gets involved	Yes	No	Yes	Yes	No	No	No	No	No	No	Idea Phase
Receiving support from Bart Kranz	Yes	No	Yes	No	No	No	No	No	No	No	Idea Phase
Receiving support From Kees Bastiaans	Yes	No	Yes	No	No	No	No	No	No	No	Idea Phase
Robert gets interested in entrepreneurship	Yes	No	No	No	No	No	Yes	No	No	No	Idea Phase
Robert starts working on it	Yes	No	No	No	No	No	No	No	No	No	Idea Phase
Searching for technologies	Yes	No	Yes	No	Yes	No	No	No	Yes	No	Idea Phase
Thijs gets involved	Yes	No	Yes	No	No	No	No	No	No	No	Idea Phase
Using laboratory at TUE	No	No	Yes	No	Yes	No	No	No	No	No	Idea Phase
Asking for support from IL about financing	No	No	Yes	No	Yes	No	No	No	No	No	Pre start-up Phase
Brainstorming over Business Plan	Yes	No	No	No	No	No	No	Yes	No	No	Pre start-up Phase
Contact with DSM	Yes	No	No	No	No	No	No	No	No	No	Pre start-up Phase
Contact with potential partners	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Draft of Business Plan	No	Yes	Yes	No	No	No	No	No	No	Yes	Pre start-up Phase
Filing 1st patent	No	No	Yes	Yes	No	Yes	No	No	No	Yes	Pre start-up Phase
Focus on Pharmaceutical industry	No	Yes	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Keeping technology secret	No	No	No	No	No	No	No	No	No	Yes	Pre start-up Phase
Nico does the CTE program	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Participating in new venture	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase

Participation by TUE	No	No	Yes	No	Yes	No	No	No	No	No	Pre start-up Phase
Receiving support from Bert Jan Lommerts	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Receiving support from father	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Receiving support from network	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Setting up the holding and 3 BV's	No	Yes	No	No	No	No	No	No	No	No	Pre start-up Phase
Studying to support business	No	No	Yes	No	No	No	Yes	No	Yes	No	Pre start-up Phase
Trying to expand team	No	No	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Using TOP-lening	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Winning young entrepreneurship award	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Acquiring new personnel	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Adjustment in product towards 4 levels of security	No	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Change focus to high value products	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Change focus to low value products	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Collaboration with customers	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Contra expertise report	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Creating new leads	No	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Doing research	No	Yes	No	No	No	No	No	No	No	No	Start-up Phase
Filing new patents	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Financing by banks	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
First round of financing with technostars, gaviland and ABN	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
From large team to lean and mean	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Getting contacts in the security branche	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Hiring Mariette	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Hiring Pitt Teunissen	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase

Hiring student assistants	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Joining branche organisation	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Market research	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Negotiating with stakeholders	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Negotiations with ACEA Pharma	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Nico, Thijs and Robert start MBI	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Ordering and building the machine	No	No	No	Yes	No	No	No	No	No	Yes	Start-up Phase
Ordering base machine from ITI	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Orientation towards other business models	Yes	No	No	No	No	No	No	No	No	No	Start-up Phase
Partnership with OCE	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Positioning and brand-recognition towards major players in security branche	No	Yes	No	No	No	No	No	No	No	No	Start-up Phase
Problem with getting the first customer	No	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Project to deliver security labels to microsoft	No	Yes	No	No	Yes	No	No	No	Yes	No	Start-up Phase
Pushing for projects	Yes	No	No	Yes	No	No	No	No	No	Yes	Start-up Phase
Second round of financing by de BOM	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
Staying at the TUE	No	No	No	No	No	No	No	No	No	Yes	Start-up Phase
STW grant fase 1	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
STW grant fase 2	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
Various subsidies like OP-Zuid, PIP innovatie, etc	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
Partnership with DPI	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Investments stop	No	No	No	No	No	No	Yes	No	No	No	Bankruptcy Phase
Trying for new investors	No	No	No	No	Yes	No	No	No	No	No	Bankruptcy Phase
Bankruptcy	No	No	No	No	No	No	Yes	No	No	No	Bankruptcy Phase
Negotiating about	No	No	No	No	Yes	No	No	No	No	No	Bankruptcy Phase

selling the company
Trying to sell company and technology

Yes No No No No No No No Yes No Bankruptcy Phase

Appendix F: Rho Event Coding

Rho Event	1E	1C	2 ^E	2C	3E	3C	4E	4C	5E	5C	New Venture Development Phase
Edwin gets interested in entrepreneurship	No	No	Yes	No	No	No	No	No	Yes	No	Idea Phase
Ernst does CTE	Yes	No	Yes	No	No	No	No	No	Yes	No	Idea Phase
Ernst gets interested in entrepreneurship	No	No	Yes	No	No	No	No	No	Yes	No	Idea Phase
Ernst meets Edwin through CTE	Yes	No	Yes	Yes	No	No	No	No	Yes	No	Idea Phase
Acquiring first clients	No	No	No	Yes	No	No	No	No	Yes	No	Pre start-up Phase
Client - Carl-Zeiss	No	No	No	No	Yes	No	No	No	Yes	No	Pre start-up Phase
Cooperation GTD	No	No	No	No	Yes	No	No	No	No	No	Pre start-up Phase
Delaying study and PHD for business	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Developing the first product	Yes	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Early Business Model	No	No	No	Yes	Yes	No	No	No	No	No	Pre start-up Phase
Early business plan	Yes	No	No	No	No	No	No	No	Yes	No	Pre start-up Phase
Early contact with university in england	Yes	No	No	No	Yes	No	No	No	No	No	Pre start-up Phase
Early development of new products	No	Yes	No	No	No	No	No	No	Yes	No	Pre start-up Phase
Early financing plans	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Early negotiations with TUE	No	No	Yes	No	No	Yes	No	No	No	No	Pre start-up Phase
Early personal financing	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Early support from experienced entrepreneur	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Early support from TUE	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Edwin does PHD at BV	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Financing by zevende kaderprogramma	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Getting housing and facilities at the TUE	No	No	Yes	No	No	No	Yes	No	No	No	Pre start-up Phase
Incubator 3+ grant	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Looking for support about exclusivity	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
New Venture grant	No	No	No	No	No	No	Yes	No	No	No	Pre start-up

											Phase
Outsourcing production	No	No	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Potential launching customer	No	No	No	No	Yes	No	No	No	Yes	No	Pre start-up Phase
Starting with self employment	Yes	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Start-up of BV	No	Yes	No	No	No	Yes	No	No	No	No	Pre start-up Phase
STW Fase 1	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
STW Fase 2	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Support from Edwin's promoter	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Using Edwin's contacts to expand network	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Attracting new clients	No	No	No	Yes	No	No	No	No	Yes	No	Start-up Phase
Cooperation with NTS	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Cooperation with SIOS	No	No	No	No	Yes	No	No	No	Yes	No	Start-up Phase
Credit crisis	No	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Deciding to stay housed at TUE	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Developing trinano	Yes	No	No	No	No	No	Yes	No	Yes	No	Start-up Phase
Distribution strategy	No	No	No	Yes	Yes	No	No	No	No	No	Start-up Phase
Early collaboration with clients	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Early contact with clients	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Early hiring strategy	No	No	No	Yes	No	No	Yes	No	No	No	Start-up Phase
Employing students for research	No	No	Yes	No	No	No	Yes	No	No	No	Start-up Phase
Going to an expo in France	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Going to scientific conventions	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Looking into credit from ABN	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase
OP-zuid	No	No	No	No	Yes	No	Yes	No	No	No	Start-up Phase
Other cooperations	Yes	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Other grants	No	No	No	No	No	No	Yes	No	No	No	Start-up Phase
Patent strategy	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Paying for advisor	No	No	No	Yes	No	No	No	No	Yes	No	Start-up Phase
PLanning development of measuring machine	No	Yes	No	No	No	No	No	No	No	No	Start-up Phase
Unforeseen cash shortage	Yes	No	No	No	No	No	Yes	No	Yes	No	Start-up Phase

Changing strategy	Yes	No	No	No	No	No	No	No	Yes	No	Post start-up Phase
Custom developments	No	No	No	Yes	Yes	No	No	No	Yes	No	Post start-up Phase
Later business strategy	Yes	No	No	No	No	No	No	No	Yes	No	Post start-up Phase
Later financing strategy	No	No	No	No	No	No	Yes	No	No	No	Post start-up Phase
Later hiring strategy	No	No	Yes	No	No	No	No	No	No	No	Post start-up Phase
Reaching industrial clients	No	No	No	Yes	No	No	No	No	No	No	Post start-up Phase

Appendix G: Sigma Event Coding

Sigma Event	1E	1C	2 ^E	2C	3E	3C	4E	4C	5E	5C	New Venture Development Phase
Doing course how to sell technology	No	No	Yes	No	No	No	No	No	No	No	Idea Phase
Early support from Gerard Verschuren	No	No	Yes	No	No	No	No	No	No	No	Idea Phase
First patent	No	No	No	No	No	Yes	No	No	No	No	Idea Phase
Getting interested in entrepreneurship	No	No	Yes	No	No	No	No	No	Yes	No	Idea Phase
Starting with self employment	Yes	No	No	No	No	No	Yes	No	No	No	Idea Phase
Deciding not to get STW grant	No	No	No	No	No	Yes	No	No	No	Yes	Pre start-up Phase
Developing first prototype during PHD	No	No	No	No	Yes	No	No	No	No	No	Pre start-up Phase
Developing new product from prototype	Yes	No	No	No	Yes	No	No	No	No	No	Pre start-up Phase
Doing consultancy work	No	No	Yes	No	No	No	Yes	No	Yes	No	Pre start-up Phase
Doing MBI	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Early business strategy	Yes	No	No	No	No	No	No	No	Yes	No	Pre start-up Phase
Early contact with TUE	No	No	Yes	No	No	No	No	No	No	Yes	Pre start-up Phase
Early cooperation with supplier	Yes	No	No	No	Yes	No	Yes	No	No	No	Pre start-up Phase
Early patent strategy	No	No	No	No	No	Yes	No	No	No	No	Pre start-up Phase
Expanding support network	No	No	No	Yes	No	No	No	No	No	No	Pre start-up Phase
First assignment	Yes	No	No	No	No	No	No	No	Yes	No	Pre start-up Phase
First client	No	No	No	No	Yes	No	No	No	No	No	Pre start-up Phase
Grant - Slim bouwen	Yes	No	No	No	Yes	No	Yes	No	No	No	Pre start-up Phase
Housing at TUE	No	No	Yes	No	No	No	No	No	No	No	Pre start-up Phase
Incubator 3+	No	No	Yes	No	No	No	Yes	No	No	No	Pre start-up Phase
Negotiations with TUE	No	No	No	No	No	Yes	No	Yes	No	No	Pre start-up Phase
Other grants	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Personal financing	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Reaching first clients	No	Yes	No	Yes	No	No	No	No	No	No	Pre start-up Phase
Requesting EU grant	No	No	Yes	No	No	No	Yes	No	No	No	Pre start-up Phase

											Phase
Starting up the holding and BV	No	No	No	No	No	Yes	No	No	No	No	Pre start-up Phase
TOP-regeling	No	No	No	No	No	No	Yes	No	No	No	Pre start-up Phase
Writing business plan	No	Yes	No	No	No	No	No	No	No	Yes	Pre start-up Phase
Change in attitude towards others	No	No	No	No	No	Yes	No	No	No	No	Start-up Phase
Changes in support network	No	No	No	Yes	No	Yes	No	No	No	No	Start-up Phase
Cooperation with DuPont	No	No	No	No	Yes	No	No	No	No	No	Start-up Phase
Filing second patent	Yes	No	No	No	No	Yes	No	No	Yes	No	Start-up Phase
Financing strategy	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
Hiring first employee	No	No	No	Yes	No	No	No	No	No	No	Start-up Phase
Joining Vizzion	No	No	No	Yes	Yes	No	No	No	No	No	Start-up Phase
Later support from TUE	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Orthopedic project	Yes	No	No	No	No	No	No	No	Yes	No	Start-up Phase
Problems with machine for DuPont	No	No	No	No	No	No	Yes	No	No	Yes	Start-up Phase
Second client	No	No	No	No	No	Yes	No	No	Yes	No	Start-up Phase
STW grant	No	No	No	No	No	No	No	Yes	No	No	Start-up Phase
Support from TUE	No	No	Yes	No	No	No	No	No	No	No	Start-up Phase
Theo gets stake in company	No	No	Yes	No	Yes	No	No	No	No	No	Start-up Phase
Winning Herman Wijffels Innovation award	No	No	No	Yes	No	No	Yes	No	No	No	Start-up Phase
Cooperation with Ballast Nedam	No	No	No	No	No	Yes	No	No	No	No	Post start-up Phase
Future financing strategy	No	Yes	No	No	No	No	No	Yes	No	No	Post start-up Phase
Later business strategy	No	Yes	No	No	Yes	No	No	No	No	No	Post start-up Phase
Later cooperation with supplier	Yes	No	No	No	No	No	No	No	No	No	Post start-up Phase
Letting first employee go	No	No	No	Yes	No	No	No	No	No	No	Post start-up Phase
New partner in company	No	No	Yes	No	No	Yes	No	No	No	No	Post start-up Phase