Decision making for business model development: a process study of effectuation and causation in new technology-based ventures

R&D MANAGEMENT

Decision making for business model development: a process study of effectuation and causation in new technology-based ventures

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This study investigates the decision-making logics used by new ventures to develop their business models. In particular, they focussed on the logics of effectuation and causation and how their dynamics shape the development of business models over time. They found that the effectual decision-making logic was used dominantly to generate a viable value proposition for a specific customer segment. Causal logic is then used dominantly to define the other business model components in relation to the value proposition and customer segment. When a shortage of resources emerges, causal logic is replaced by an increase in effectual decision-making again. They concluded that before investing significant resources in a business model it was crucial for firms to reduce, as far as possible, technological and market uncertainty through effectual strategies to avoid high re-configuration costs later.

1. Introduction

Business model development is crucial for new technology-based ventures to create and capture value from their technologies (Chesbrough and Rosenbloom, 2002; Teece, 2010; Massa and Tucci, 2014) and received a great deal of attention (Zott et al., 2011; Schneider and Spieth, 2013; Spieth et al., 2014). Yet, technology-based ventures often experience great difficulty in defining a viable business model at the first attempt (Andries and Debackere, 2007), because of high levels of technological and market uncertainty confronting them and the unpredictability of commercialization options. In the early phases especially, they have limited knowledge and resources to deal with all these uncertainties (Bhide,

2000). Therefore, business model components are created and get revised at different moments during the development process (Dmitriev et al., 2014). Developing a business model thus is a dynamic process (Sosna et al., 2010) that involves decision-making under uncertainty.

Several approaches to decision-making under uncertainty have been described (Wiltbank et al., 2006), such as planning and visionary approaches, putting high emphasis on prediction, as well as adaptive and transformative approaches, with a low emphasis on prediction and focusing more on learning and experimentation instead. A growing number of empirical studies focuses on adaptive and transformative approaches (Wiltbank et al., 2006) such as bricolage (Baker and Nelson, 2005) and effectuation (Sarasvathy, 2001), which seem to better fit decision-making under uncertainty (Alvarez and Barney, 2005). Recent research on decision-making under conditions of uncertainty has indicated that decision-making logics can be combined (rather than one logic being used exclusively) and that emphasis in their use shifts over time (Berends et al. 2014; Nummela et al., 2014; Reymen et al. 2015), indicating dynamics in the use of decision-making logics.

So far, the relation of these decision-making logics to business model development has been largely under-explored. Chesbrough (2010) pointed at the importance of experimentation and effectuation for business model development, which was also already observed in a few empirical studies (Chandler et al., 2011; Andries et al., 2013; Sitoh et al., 2014). Yet, it is especially unclear how the dynamics in decision-making logics relate to the development of business models over time (Andries et al., 2013), and more deeply, how they relate to the development of particular business model components.

This study aims to answer the following question: '*How do the dynamics in decision-making logics relate to business model development in new, technology-based ventures?*' We approached this question by examining in detail the decision-making logics used by four new technology-based ventures in developing their business models. The study uses a process research approach (Langley, 1999) with a detailed analysis of event sequences for each venture. We use effectuation and causation (Sarasvathy, 2001) to conceptualise decision-making logics under uncertainty (Wiltbank et al., 2006), because these concepts have a process focus and get increasing attention in the entrepreneurship literature.

This study contributes to business model literature by offering unique in-depth insights into the relation between dynamics in decision-making logics over time and changes in business model components. More specifically, we found that dominant effectual decision-making logic is used initially to generate a value proposition for a specific customer segment. This often leads to letters of intent of potential customers and successfully tested prototypes, thereby lowering technological and market uncertainty. A lowered uncertainty is often followed by an increase in the use of causal logic, with a focus on defining the other business model components in relation to the crystallised value proposition and customer segment, often written down in a detailed business plan. When a shortage of resources emerges, dominant causal logic is followed by an increase in effectual dominance.

Thus, this study contributes a business model perspective to the dynamics of decision-making logics in new technology-based ventures, thereby relating the type of decision to the dominant decision-making logic used. The insights emerging from this study can guide entrepreneurs in their decision-making process during new business development.

2. Theory

Business models define how a firm creates, delivers and captures value for its stakeholders (Morris et al., 2005; Doganova and Eyquem-Renault, 2009; Osterwalder and Pigneur, 2009). In today's economic environment, business models are seen as a major source of competitive advantage (Amit and Zott, 2001; Demil et al., 2015). Business models comprise several components (Morris et al., 2005; Zott et al., 2011), a detailed set has been defined by Osterwalder and Pigneur (2009). They identified the main components value proposition, customer segment, channel and customer relationships, partner networks, revenue streams, cost structure, and key resources and activities.

2.1. Business model development process of new technology-based ventures

New technology-based ventures develop their business models under conditions of technological and market uncertainty (Andries et al., 2013), and the unpredictability of commercialization by linking technology and markets (Chesbrough and Rosenbloom, 2002), while also facing restrictions due to resource and time limits. The viability of a venture's business model is thus hard to predict in advance (Andries et al., 2013). New ventures will find it difficult to define the most appropriate model with their first attempt. Over time they are likely to alter their initial design as they acquire more information (Gruber

et al., 2008). Andries and Debackere (2007) found that new ventures that changed their business model configurations during development were more likely to succeed than those that stuck to their initial configuration.

Business model development is thus a dynamic process (Sosna et al., 2010; Demil and Lecocq, 2010). The actions and decisions taken by entrepreneurs define their eventual r business model, usually through taking into account unexpected events (Morris et al., 2005). Consequently, the development of a business model is described in terms of experimentation (Andries et al., 2013), trial-and-error learning (Chesbrough, 2010; Sosna et al., 2010) and the need for flexibility (Bock et al., 2012). Dmitriev et al. (2014) found that each business model component may furthermore receive attention at different moments during the development process. Moreover, alternative business models are often created in parallel (Casadesus-Masanell and Tarzijan, 2012).

2.2. *Decision-making logics under uncertainty*

Approaches to decision-making under uncertainty can be classified according to their focus on prediction (Wiltbank et al., 2006). Planning and visionary approaches, like competitive analysis, real options, and scenario planning put high emphasis on prediction, whereas adaptive and transformative approaches, like emergent strategy (Mintzberg, 1994) and effectuation (Sarasvathy, 2001), put low emphasis on prediction but focus more on learning and experimentation.

Effectuation, a decision-making logic to deal with uncertainty developed in entrepreneurship literature (Sarasvathy, 2001; Wiltbank et al., 2006; Read et al., 2009), is based on choosing between the multitude of effects that could be created with a given set of means (Sarasvathy, 2001; Wiltbank et al., 2006). Uncertainty is dealt with by adopting a more flexible approach and investing only non-critical amounts of resources into opportunities, while seeking feedback early in the process through stakeholder interactions (Sarasvathy, 2001; Wiltbank et al., 2006). Central to the effectual approach is that ventures do not operate with a predefined goal (e.g. to develop a specific product or business model) but that these goals emerge out of interactions between the venture and stakeholders over time (Dew et al., 2011). This decision-making process can be regarded as an iterative search process involving experimentation and learning.

In contrast, much research assumes that in pursuing entrepreneurial opportunities entrepreneurs use rational, goal-driven behaviour. This model is referred to by Sarasvathy (2001) as the causation model (Perry et al., 2012). Causation takes a particular goal as given and then focuses on finding the right means to reach that goal (Sarasvathy, 2001). Following causal decision-making logic, firms analyse and predict what the future will look like and then plan their actions based on prediction (Wiltbank et al., 2006). Causal planning argues for improved analysis and prediction of the environment to ensure that the choice of a particular business model is correct (Wiltbank et al., 2006). However, given the often highly unpredictable and ambiguous environments in which innovative ventures operate, some research questions whether planning approaches are suitable to deal with such conditions (Fisher, 2012).

Research on dynamics in decision-making recently revealed how effectual and causal logics are combined in a venture's strategic decision-making (rather than one logic being used exclusively) and how emphasis on the use of these logics shifts over time. Effectuation is more dominant in early phases of development, whereas causation is more dominant in later stages (Berends et al., 2014; Reymen et al., 2015). The dominant decision-making logic may shift several times (Reymen et al., 2015) and both decision-making logics may co-exist according to the different degrees of uncertainty in the market and technology, or the number of decision-makers involved (Nummela et al., 2014).

The use of decision making logics for business model development got recent attention. Andries et al. (2013) found that simultaneous experimentation with a business model implied effectual behaviour while Sitoh et al. (2014) identified four decision-making configurations with unique modes of interplay between a business model and the decision-making logic used. It is still unclear, however, how dynamics in decision-making logics relate to the development of business models over time, and more specifically, how they relate to the development of particular business model components.

3. Methods

To investigate the dynamics of decision-making logics used for business model development over time in new, technology-based ventures we adopted a qualitative research approach, because that is most suited to develop new theoretical insights (Eisenhardt and Graebner, 2007). In particular, this study uses a process research approach (Langley, 1999) analysing in-depth four new technology venture development processes. Process research differs from variance research in that it investigates sequences of events or

TABLE 1. Case characteristics

Case	Industry	Events	Period covered	Number of interviews	Number of archival documents
DNACo	Life Sciences/IT	50	2009-2012	3, with founders	5 business plans, 25 press releases and presentations
MemCo	Semicon	44	2006-2012	2, with COO	2 business plans (2010 and 2013), 10 press releases and presentations, 3 videos
DataCo	Information Technology	34	2008-2012	2, with founder	2 business plans, 8 press releases and presentations, 2 videos
3DCo	Life Sciences/ Healthcare	53	2005-2012	3, with CEO	2 business plans, 18 press releases and presentations, 8 videos

activities that describe how things change over time (Van de Ven, 2007) and is appropriate to this study which aims to examine how decision-making logic relates to business model development. Research focused on the identification of events related to decision making in venture development processes over time, resulting in chronological sequences of events (Poole et al., 2000).

3.1. Case selection

Cases were selected by using purposeful sampling, searching for information-rich cases that could help extend theory (Eisenhardt and Graebner, 2007; Seawright and Gerring, 2008). Four new technology-ventures were selected on the following criteria. First, they had to be innovative ventures that developed a new technology, product or service involving high technological and market uncertainty and uncertainty about commercialisation options, increasing the likelihood that their business model configuration was under development during the firm's first years. Second, we selected cases from different industries (life sciences, semiconductor, healthcare and information technology) to allow maximum variation sampling in order to find 'important shared patterns that cut across cases and derived their significance from having emerged out of heterogeneity' (Patton, 2002). Finally, case selection was guided by initial contacts, which ensured access to collect detailed information on business model development process over several years.

3.2. Data collection

Data were collected via semi-structured interviews with founders and members of the venture management teams who had been closely involved with the business model development trajectory. Interviews were also conducted with an employee of one of the ventures and an involved consultant, in order to tap into different perspectives on the development process. In total, 12 interviews were conducted. The interviews had an average duration of one and a half hours. Eleven interviews were recorded and transcribed verbatim. During one interview where recording was not allowed, notes were taken.

To triangulate the data (Schwenk, 1985) interviews were combined with archival data such as project documentation, press releases, business plans and annual reports. The different versions of the business plans were especially useful in identifying changes over the course of the firm's development, and also acted as valuable input for follow-up interviews. An overview of the cases and data sources is given in Table 1.

3.3. Data analysis

The data were analysed at the level of the venture: how key players acted or made decisions during the venture development process, whether these actions were predominantly effectual or causal and how these actions and the decision-making logic behind them related to subsequent changes in the business model (Perry et al., 2012). Data analysis was performed in five steps.

The first step was to identify the relevant events in the new venture development trajectory: actions or decisions by key players, for example, hiring employees, collaborating with partners, creating and executing project plans or introducing products on the market. For each event the date it occurred, a description of it and the data source(s) were recorded in an events file. Actions were taken to minimise potential retrospective biases (Schwenk, 1985). Following Perry et al. (2012) the cases were mostly of recent date. Next, we triangulated the documentation using both interviews and archival documents (Yin, 2009) while event lists were verified by the interviewees to

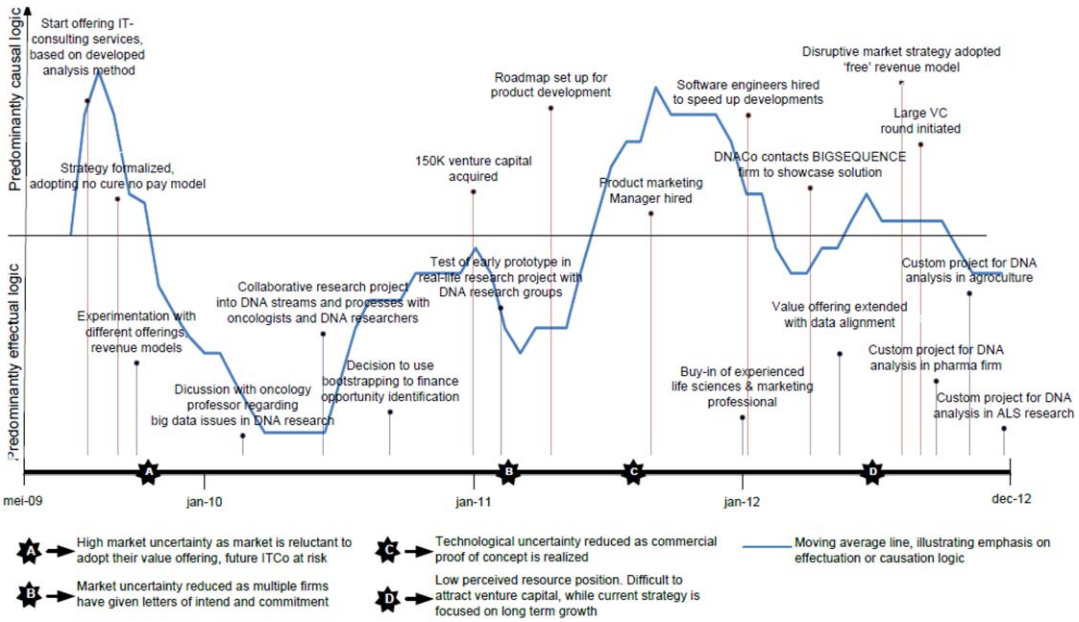

Figure 1. Timeline DNACo. [Colour figure can be viewed at wileyonlinelibrary.com]

increase their validity. This resulted in event lists for each the four cases (DNACo: 50 events, MemCo: 44, DataCo: 34, 3DCo: 53). These were mapped on a timeline as in Figures 1–4.

The second step was to code the event lists along effectuation and causation dimensions. The coding scheme was based on that of Reymen et al. (2015) which offers empirical indicators for each of the dimensions of effectuation and causation, namely basis for taking action, attitude toward unexpected events, attitude toward outsiders, and view on risk and resources. Events can have both effectual and causal codes (e.g. causal basis for taking action and effectual view of risks and resources) as ventures may combine both approaches (Perry et al., 2012).

In the third step, inspired by the approach in Reymen et al. (2015), we determined patterns of causation and effectuation over time by calculating the moving averages of the use of both logics. When an event was coded with one or more codes for the effectuation dimensions, it was marked as 1 for the effectuation category. When an event had no coding for an

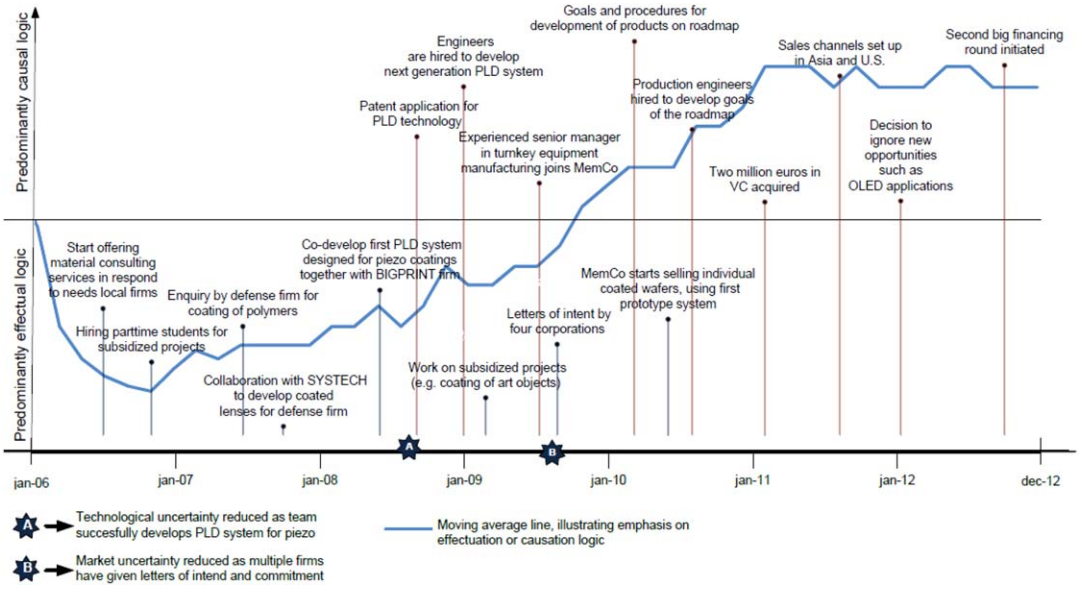

Figure 2. Timeline MemCo. [Colour figure can be viewed at wileyonlinelibrary.com]

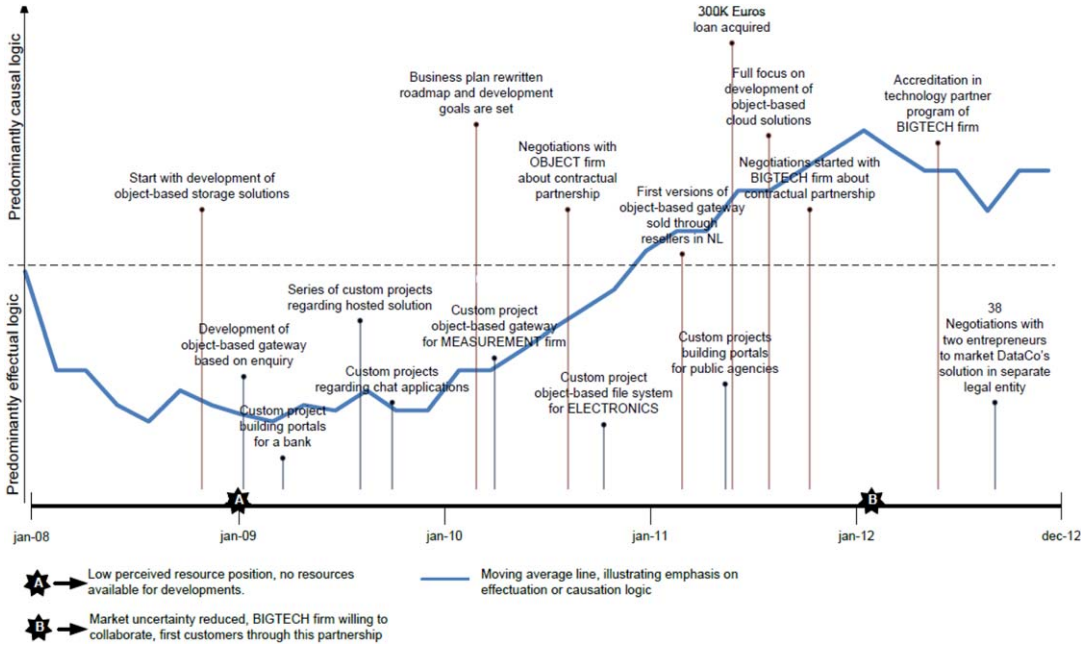

Figure 3. Timeline DataCo. [Colour figure can be viewed at wileyonlinelibrary.com]

effectuation dimension it was marked with a 0. The same was done for the causation dimensions and categories. The total moving average was calculated by subtracting the effectual moving average from the causal moving average for the ten most recent events (see Figures 1–4).

The fourth step was to code events for changes in business models for the components distinguished by Osterwalder and Pigneur (2009): value proposition, customer segment, channel and customer relationship, partner network, revenue streams, cost structure, key resources and key activities. We used their framework

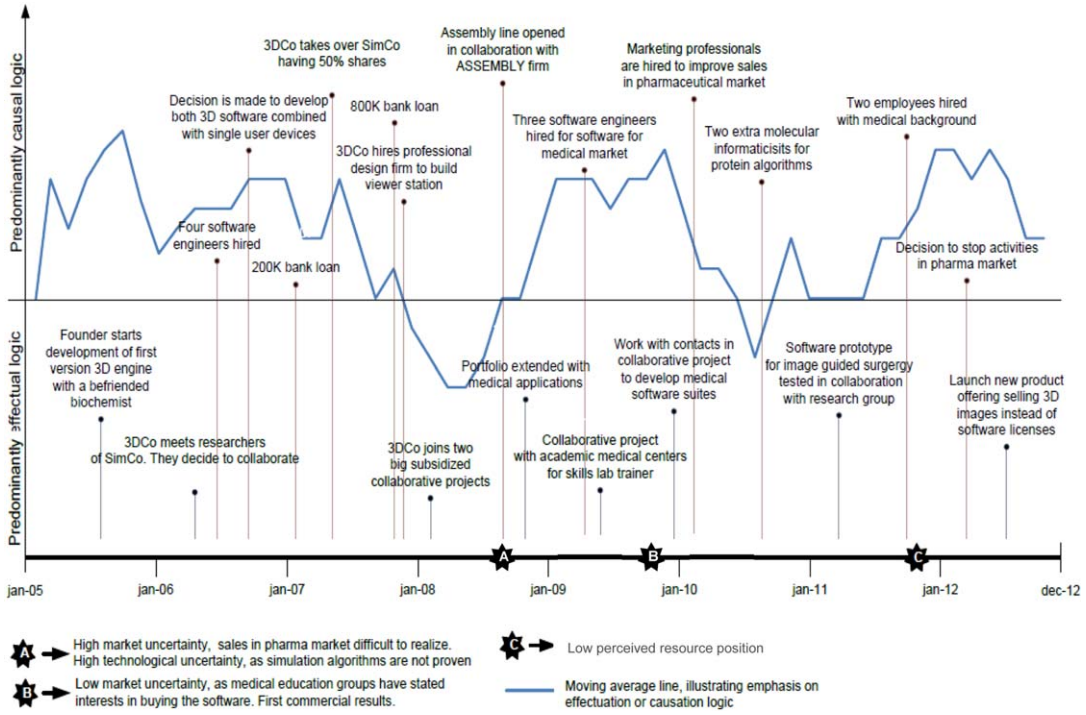

Figure 4. Timeline 3DCo. [Colour figure can be viewed at wileyonlinelibrary.com]

for coding, since it is detailed, can be easily linked to frameworks (e.g. Morris et al., 2005), and was used in prior studies of business model dynamics (e.g. Dmitriev et al., 2014). Along with component changes, we also coded major business model changes, such as abandoning a business model or experimenting with different business models in parallel. As most ventures are unlikely to have stable, up-and-running business models, changes in them were coded either when the change was actually implemented or when it was conceived.

A final step was to analyse for patterns in the trajectories. For analysis purposes, we summarised business model changes in a limited number of episodes consisting of a series of related events, marked by changes in dominance of effectuation and causation and/or critical events. The critical events were determined by coding the data for changes in market and technology uncertainty, resource position and stakeholder interaction, because Reymen et al. (2015) identified these as explanation for dynamics in the use of effectuation and causation. The most important changes are indicated by an asterisk in the timelines in Figures 1–4.

4. Results

Based on an analysis and comparison of the four business model development trajectories, Figures 1–4 show two main overall patterns in dynamics of dominant decision-making logics. In three cases, effectual logic dominated early business model development. The fourth case (3DCo) shows a completely different pattern with an alternation of mixed episodes and causal episodes.

4.1. Patterns in decision-making logic

The main pattern in the business model development trajectories of DNACo, MemCo and DataCo can be described as *early effectual dominance*. These ventures based their actions mainly on the availability of means (e.g. knowledge, skills, financial resources). They appeared able to identify and test the critical assumptions underlying novel value propositions for particular customer segments through effectual cycles of stakeholder interactions, and receive early commitment, possibly made explicit through letters of intent, in order to learn about specific customer needs before setting major goals. When technological and market uncertainties were reduced these ventures switched their emphasis to causal decision-making logic, aligning their actions to fit a specific business model.

MemCo, for example, went through a pattern of effectual decision-making during its early new venture development (see Figure 2). At first it based its actions on means, using a service-oriented business model to offer material science services to local firms. This enabled MemCo to learn about market needs whilst also generating cash flow, and identify new value propositions and market segments. '*Our business model? Well actually, we didn't have one. We acted opportunistically and responded to enquiries that came along. Most of the facilities were already available to us*'. MemCo initially offered multiple services and products and used different revenue models. Its later collaboration on the development of a system for applying polymer coatings led to its being asked to work with BIGPRINT firm to develop a technology for coating silicon wafers. Together, the two firms successfully developed a prototype that caught the interest of the big players. To keep costs at a minimum, they worked on projects subsidised by the Dutch government, using student labour.

At MemCo, causal decision-making became more dominant once tests of prototypes were successful and letters of intent by potential customers were received. At that moment (critical event B), technological and market uncertainty were reduced. The value proposition crystallised as being focused on equipment manufacturer as opposed to acting as advisory service provider. MemCo's development became increasingly goal-driven with the signing of a letter of intent by several technology corporations at the end of 2009. MemCo then wrote a business plan, acquired venture capital and invested substantially in developing equipment in line with their objectives. As the founder recalled: '*2010 was the year we decided who we wanted to be. We hired more people, acquired investment and cancelled all other opportunities. The cash burning rate increased rapidly, but we needed that investment to keep momentum and focus*'. Mid 2012 MemCo signed its first contract for the sale of production equipment.

DataCo also demonstrates early effectual processes (see Figure 3). DataCo's founder originally planned to develop and market a cloud-based virtual drive solution, but a client project uncovered a radically different need which diverted DataCo from its initial business plan. Since the solution was developed specifically for a client, the firm was able both to cover development costs and obtain valuable feedback. During the period of opportunity identification DataCo kept its scope wide, working on a range of projects and experimenting with different revenue mechanisms. For one of their solutions (object-based gateway), they were able to start already sales end 2010. Then in mid-2011, a bank loan enabled the firm to

develop its cloud-based software solution further. Using a strategic licensing business model in partnership with a leading cloud solutions software company, the founder focused on software development and in June 2012, finally achieved his goal. Also DNACo showed early effectual dominance, and even returned to effectual decision-making logic due to a shortage of resources, which is explained below.

Our fourth case, 3DCo, showed a *causal start with an alternation of causal dominance and mix of causation and effectuation*. This pattern differs significantly from the other three cases (see Figure 4). After coming across opportunities for 3D technology in healthcare, the founders of 3DCo began to develop solutions with a biochemist colleague. Despite their lack of pharmaceutical knowledge they came up with the idea of developing 3D visualization stations, whose use by large pharmaceutical companies could potentially yield enormous revenues. In order to develop the necessary software and hardware, 3DCo hired professional software engineers, acquired a protein algorithm venture and attracted large amounts of venture capital. Between January and December 2007 when results began to show promise, the founders were able to negotiate a series of bank loans, used to develop their first 3D engine. In its preliminary business plan, the firm decided to adopt a product business model, selling 3D viewer stations with software to pharmaceutical firms. As one of the founders observed: '*We always believed strongly that if we could combine protein algorithms with 3D visualization it would significantly increase the researcher's understanding of why these proteins do or do not bind with each other*'.

Although the venture had not generated cash flow or found any customers, the founders thus continued with technical development, resulting in the launch of a first assembly line in mid-2008. Over the next few years, although their exploratory work in 3D technology attracted much attention, the founders failed to find a pharmaceutical firm willing to invest in their product. '*It's difficult to get into contact with these pharma giants. You've got to come with something really impressive before you knock on their door. So we just took a leap of faith and hoped that these algorithms would eventually work out*'. Thus despite high market and technological uncertainty 3DCo stuck to its initial plan, continuing to invest resources in development and hiring experienced marketing professionals to deal with sales. In mid-2009, in the course of a government-funded project on protein visualization, one of its project partners asked 3DCo if their 3D technology could also be used to visualise human anatomy. With pharma sales still failing to develop, the firm's focus gradually shifted to the medical sector and in particular, medical education and image-guided surgery where they had contacts and ultimately also scored a first customer by the end of 2009. By 2011 the value proposition had changed toward producing simple 3D software suites, with hardware becoming just an option. In January 2012, all pharma-related activities were cancelled as 3DCo focused on sales in image-guided surgery.

Compared with the other three firms, 3DCo took a significantly different approach to business development, predominantly using causal logic. The founders chose a business model and allocated resources to realizing it, despite the early lack of commitment from relevant stakeholders inevitably giving rise to much uncertainty about the viability of the value proposition.

4.2. Business model components linked to decision-making logics

Looking more in depth at changes in business model components, we found over all cases that in seven episodes with *dominant effectual decision-making logic*, the following business model components were mainly changed: the *value* proposition (7 times in 7 episodes with mainly effectual dominance), the *customer segment* (7/7), sometimes in combination with defining a revenue stream (3/7), partner network (2/7), cost structure (2/7) or key resources and activities (1/7). Effectual decision making thus mainly fits developing the value proposition and customer segment, in iterative cycles focusing on early stakeholder involvement.

Experimenting with the value proposition and market segment using effectual decision-making logic, may lead to commitment of potential customers and successfully tested prototypes, thereby lowering market and technological uncertainty. For example, in the DNACo case (see Figure 1), when the DNACo team was confronted with an opportunity to come up with a solution for DNA analysis. Instead of setting development goals and beginning software development, the team first discussed their theoretical solution with the relevant stakeholders in their existing network and postponed any significant resource allocation (by using bootstrapping, subsidies and grants). Once the founders realised their ideas matched the scientists' needs, they collaborated closely with oncologists from academic research centres on a DNA data streams project. This allowed DNACo to understand quickly the specific data transfer and analysis issues involved. Between March and May 2011, since their theoretical solutions seemed to fit a clear market need, they were able to get commitment via letters of intent from the research institutions, later their first

customers. An unexpected opportunity was thus transformed into a new value proposition for a new customer segment, with a first commercial contract signed at the end of 2012.

In all cases, a *lowered market and technological uncertainty was often followed by an increase in the use of causal logic*. This can be seen in the three cases with an early effectual dominance, but also in 3DCo at critical event B. 3DCo attracted in an effectual way a first customer through their informal network of partners, which was used to refine their product. Based on this stakeholder feedback, 3DCo ultimately changes, using causal decision-making logic, their value offering and starts rewriting their business plan.

In the six episodes with dominant causal decision-making logic, focus was always on the revenue stream (6/6), and very often on cost structure (5/6), key resources and activities (5/6), and often also on the value proposition (4/6), customer segment (4/6), partner networks (4/6), and channel and customer relationships (3/6). The value proposition and customer segment were crystallised by that moment and thereby defined goals to be reached. All business model components are defined in relation to the value proposition and customer segment, using causal decision making. In all four cases, a detailed business plan was written up in order to reach that goal, thereby predicting what the future will look like. For example in 2011 DNACo, once assured that their solution satisfied a 'job needing to be done', the founders focused on setting goals to exploit the opportunity and developing strategies for revenue mechanisms and sales channels, in order to maximise value creation and capture. Based on their market analysis and the business model they envisaged they then searched for partners and acquired the necessary resources (product marketing manager and two software engineers) to implement their business plan.

The episodes with a dominant causal decision-making logic are sometimes followed by an *increase in effectual dominance when a shortage of resources emerges*. This is apparent in the DNACo case, where at critical event D (low perceived resource position) a dominance of effectual logic arises after a period of increased use of causal logic. Since it was difficult to attract venture capital with a long term growth strategy, they shifted their focus to 'low hanging fruit' via custom projects outside their initial scope (e.g. in the agro and pharma businesses) in order to obtain cash and credibility. Effectual decision-making logic became again dominant as they responded to serendipitous encounters as they appeared. The same pattern is visible in the 3DCo case, where a low perceived resource position occurs at the start of T3 and T7 (critical event C), which is followed by the use of more effectual logic.

5. Discussion

This article makes a unique contribution to *business model literature* by giving in-depth insights into the relation between dynamics in dominance of decision-making logic and changes in business model components over time. All of our four cases used both effectual and causal approaches to make business model development decisions but in a differentiated way. We find that a value proposition for a specific customer segment is generated using effectual decision-making logic by going through cycles of stakeholder interactions. These interactions often lead to commitments of potential customers, thereby reducing market uncertainty. Also prototypes get tested, reducing technological uncertainty. At that moment, the use of causal logic increases. The value proposition and customer segment gets crystallised and the other business model components are defined in relation to these, often written down in a detailed business plan. When a shortage of resources emerges, dominant causal logic is followed by an increase in use of effectuation.

These findings add to the *literature on trial-and-error learning in business model development* (e.g. Sosna et al., 2010) *and experimentation* (Andries et al., 2013) by specifying the business model components developed primarily through learning and experimental approaches, and by showing that over time, decision-making logic shifts to more goal-oriented approaches. We did this by taking a perspective on business model development at the component level similar to that of Dmitriev et al. (2014), and linking it to the dynamics of decision-making logics. These goal-oriented approaches often start with writing a business plan, once uncertainties for the ventures are lowered. They thereby considered the whole business model, which then served as a cognitive instrument for venture managers to further develop all other business model components in relation to the crystallised value proposition and customer segment (cf. Baden-Fuller and Mangematin, 2013; Baden-Fuller and Haefliger, 2013).

The findings also add to the *design and implementation of business models*. The studied cases involved both the design and implementation of business models, indicated by the moment when a first product was sold to a paying customer. All business model development trajectories showed that effectual as well as causal decision-making logics are necessary to design the business model far enough to get first sales. In other words, the full exploration of the business model

involved both effectual and causal decision-making logics. Yet, the closer the new ventures got to implementation, the more the process shifted toward exploitation, the more causal decision-making became dominant.

We also offer insights into the *central role played by the value proposition* in business model development. Earlier literature has suggested that business model innovation should start with the development of the value proposition (Johnson et al., 2008; Cortimiglia et al, 2015). Whilst our findings support its key role, they do not imply that the value proposition must be defined first. Effectual approaches may initially be more concerned with other business model components in order to find a viable value proposition in an emergent way. However, in our study the crystallization of a value proposition for a customer segment appeared to be the turning point after which other business model components could be conceived. While the fourth case, 3DCo, showed a different pattern in the use of effectuation and causation logic, it confirmed the central role of the value proposition. Defining their value proposition right from the start enabled the 3DCo founders to take a causal approach early on. Interestingly, their approach shifted to effectuation once their initial proposition appeared to fail. An alternative value proposition was found using an effectual approach, thereby corroborating the link between effectuation and the emergence of a viable value proposition.

To the *effectuation literature* we offer empirical evidence confirming the suggestion that effectual logic is especially useful in the early phases of new venture development, while a causal planning becomes increasingly important as the venture grows (Sarasvathy, 2001; Read and Sarasvathy, 2005; Wiltbank et al., 2006). This also confirms the work of Reymen et al. (2015) and Nummela et al. (2014) on the dynamics of decision-making logics. We further add a *business model perspective* to the dynamics of decision-making logic in new technology-based ventures. We find that dominance in the use of effectual decision-making logic is used to uncover a value proposition that matches a certain market need, that is, market segment, whereas dominance in the use of causal decision-making logic is applied in order to define and develop all business model components. We add to the findings of Sitoh et al. (2014) by offering a more detailed insight into the development of specific business model components, and the use of effectual and causal logic over time. Based on the work of Reymen et al. (2015) we find that market and technological uncertainty, together with resource position, do indeed explain changes in the dominance of effectual and causal decision-making logics. Market and technological uncertainty conditions indicate a shift of focus from value proposition and market segments to other business model components, while a limited resource position indicate a shift in the opposite direction.

Our study is limited by the specific sample chosen, namely four new technology-based ventures in the Netherlands. The specific institutional setting may have coloured our findings, and more variety might be found with a larger set of cases. Studying a larger set of venture development processes is therefore needed to test our findings. Further research could also focus on the factors that determine why a certain pattern occurs. We found only two of the three conditions discussed in Reymen et al. (2015), missing stakeholder interactions. Changes in management team members, or the search for external funding as indicated by Nummela et al. (2014) could also be taken into account as important triggers in future research. Furthermore, future research is needed to investigate performance implications. Studying the links between the performance of the new technology-based ventures, their initial dominant decision-making logic, their vision of business model development (i.e. to strive immediately for the 'holy grail' or focus on 'low hanging fruit'), and organizational capabilities needed for business model innovation (Mezger, 2014) could give entrepreneurs a stronger indication of what decisions to take and when in business model development.

The insights in this study could serve to support entrepreneurs in their decision-making process during new business model development. More specifically, the study demonstrates that the crystallization of a value proposition for a customer segment appeared to be the key turning point after which other business model components could be conceived. It seems crucial for firms to diminish technological and market uncertainty as much as possible before investing significant resources, in order to reduce potentially high re-configuration costs. The early stages of new business model development are best suited to experiment with and learn from stakeholder interactions, in order to find the proper value proposition and market segment. Once uncertainty has been diminished, our findings suggest that also a focus on the other components of the business model is recommended.

References

Alvarez, S.A. and Barney, J.B. (2005) How do entrepreneurs organize firms under conditions of uncertainty?. *Journal of Management*, **31**, 776–793.

Amit, R. and Zott, C. (2001) Value creation in e-business. *Strategic Management Journal*, **22**, 493–520.

Andries, P. and Debackere, K. (2007) Adaptation and performance in new businesses: understanding the moderating effects of independence and industry. *Small Business Economics*, **29**, 81–99.

Andries, P., Debackere, K., and van Looy, B. (2013) Simultaneous experimentation as a learning strategy: business model development under uncertainty. *Strategic Entrepreneurship Journal*, **7**, 288.

Baden-Fuller, C. and Haefliger, S. (2013) Business models and technological innovation. *Long Range Planning*, **46**, 419–426.

Baden-Fuller, C. and Mangematin, V. (2013) Business models: a challenging agenda. *Strategic Organization*, **11**, 418–427.

Baker, T. and Nelson, R.E. (2005) Creating something from nothing: resource construction through entrepreneurial bricolage. *Administrative Science Quarterly*, **50**, 329–366.

Berends, H., Jelinek, M., Reymen, I.M.M.J., and Stultiens, R.G.L. (2014) Product innovation processes in small firms: combining entrepreneurial effectuation and managerial causation. *Journal of Product Innovation Management*, **31**, 616–635.

Bhide, A. (2000) *The Origin and Evolution of New Businesses*. Oxford: Oxford University Press.

Bock, A.J., Opsahl, T., George, G., and Gann, D.M. (2012) The effects of culture and structure on strategic flexibility during business model innovation. *Journal of Management Studies*, **49**, 279–305.

Casadesus-Masanell, R. and Tarzijan, J. (2012) When one business model isn't enough LAN Airlines flourishes by running three distinctly different operations at the same time. *Harvard Business Review*, **90**, 132–136.

Chandler, G.N., DeTienne, D.R., McKelvie, A., and Mumford, T.V. (2011) Causation and effectuation processes: a validation study. *Journal of Business Venturing*, **26**, 375–390.

Chesbrough, H. (2010) Business model innovation: opportunities and barriers. *Long Range Planning*, **43**, 354.

Chesbrough, H. and Rosenbloom, R.S. (2002) The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, **11**, 529–555.

Cortimiglia, M.N., Ghezzi, A., and Frank, A.G. (2015) Business model innovation and strategy making nexus: evidence from a cross-industry mixed-methods study. *R&D Management*, **46**, 414–432.

Demil, B. and Lecocq, X. (2010) Business model evolution: in search of dynamic consistency. *Long Range Planning*, **43**, 227–246.

Demil, B., Lecocq, X., Ricart, J.E., and Zott, C. (2015) Introduction to the SEJ special issue on business models: business models within the domain of strategic entrepreneurship. *Strategic Entrepreneurship Journal*, **9**, 1–11.

Dew, N., Read, S., Sarasvathy, S.D., and Wiltbank, R. (2011) On the entrepreneurial genesis of new markets: effectual transformations versus causal search. *Journal of Evolutionary Economics*, **21**, 231–253.

Dmitriev, V., Simmons, G., Truong, Y., Palmer, M., and Schneckenberg, D. (2014) An exploration of business model development in the commercialization of technology innovations. *R&D Management*, **44**, 306.

Doganova, L. and Eyquem-Renault, M. (2009) What do business models do? Innovation devices in technology entrepreneurship. *Research Policy*, **38**, 1559–1570.

Eisenhardt, K.M. and Graebner, M. (2007) Theory building from cases: opportunities and challenges. *Academy of Management Review*, **50**, 25–32.

Fisher, G. (2012) Effectuation, causation, and bricolage: a behavioral comparison of emerging theories in entrepreneurship research. *Entrepreneurship Theory and Practice*, **36**, 1019–1051.

Gruber, M., MacMillan, I.C., and Thompson, J.D. (2008) Look before you leap: market opportunity identification in emerging technology firms. *Management Science*, **54**, 1652–1665.

Johnson, M.W., Christensen, C.M., and Kagermann, H. (2008) Reinventing your business model. *Harvard Business Review*, **86**, 50–59.

Langley, A. (1999) Strategies for theorizing from process data. *Academy of Management Review*, **24**, 691–710.

Massa, L. and Tucci, C.L. (2014) Business model innovation. In: Dodgson, M., Gann, D.M., Phillips, N. (eds.). *The Oxford Handbook of Innovation Management*. Oxford: Oxford University Press. pp. 420–441.

Mezger, F. (2014) Toward a capability-based conceptualization of business model innovation: insights from an explorative study. *R&D Management*, **44**, 429–449.

Mintzberg, H. (1994) *The Rise and Fall of Strategic Planning: Reconceiving Roles for Planning, Plans, Planners*. New York: Free Press.

Morris, M., Schindehutte, M., and Allen, J. (2005) The entrepreneur's business model: toward a unified perspective. *Journal of Business Research*, **58**, 726–735.

Nummela, N., Saarenketo, S., Jokela, P., and Loane, S. (2014) Strategic decision-making of a born global: a comparative study from three small open economies. *Management International Review*, **54**, 527–550.

Osterwalder, A. and Pigneur, Y. (2009) *Business Model Generation*. Hoboken, NJ: Wiley.

Patton, M.Q. (2002) *Qualitative Research and Evaluation Methods*, 3rd edn. Thousand Oaks: Sage.

Perry, J.T., Chandler, G.N., and Markova, G. (2012) Entrepreneurial effectuation: a review and suggestions for future research. *Entrepreneurship Theory and Practice*, **36**, 837–861.

Poole, M.S., Van de Ven, A.H., Dooley, K., and Holmes, M.E. (2000) *Organizational Change and Innovation Processes: Theory and Methods for Research*. Oxford: Oxford University Press.

Read, S. and Sarasvathy, S.D. (2005) Knowing what to do and doing what you know: effectuation as a form of entrepreneurial expertise. *Journal of Private Equity*, **9**, 45–62.

Read, S., Song, M., and Smit, W. (2009) A meta-analytic review of effectuation and venture performance. *Journal of Business Venturing*, **24**, 573–587.

Reymen, I.M.M.J., Andries, P., Berends, H., Mauer, R., Stephan, U., and van Burg, J.C. (2015) Understanding dynamics of strategic decision-making in venture creation: a process study of effectuation and causation. *Strategic Entrepreneurship Journal*, **9**, 351–379.

Sarasvathy, S.D. (2001) Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Academy of Management Review*, **15**, 243–263.

Seawright, J. and Gerring, J. (2008) Case selection techniques in case study research: a menu of qualitative and quantitative options. *Political Research Quarterly*, **61**, 294–308.

Schneider, S. and Spieth, P. (2013) Business model innovation: toward an integrated future research agenda. *International Journal of Innovation Management*, **17**, 34.

Schwenk, C.R. (1985) The use of participant recollection in the modeling of organizational decision processes. *Academy of Management Review*, **10**, 496–503.

Sitoh, M.K., Pan, S.L., and Yu, C.Y. (2014) Business models and tactics in new product creation: the interplay of effectuation and causation processes. *IEEE Transactions on Engineering Management*, **61**, 213.

Sosna, M., Trevinyo-Rodríguez, R.N., and Velamuri, S.R. (2010) Business model innovation through trial-and-error learning: the naturhouse case. *Long Range Planning*, **43**, 383.

Spieth, P., Schneckenberg, D., and Ricart, J.E. (2014) Business model innovation–state of the art and future challenges for the field. *R&D Management*, **44**, 237–247.

Teece, D.J. (2010) Business models, business strategy and innovation. *Long Range Planning*, **43**, 172–194.

Van de Ven, A.H. (2007) *Engaged Scholarship: A Guide for Organizational and Social Research*. Oxford: Oxford University Press.

Wiltbank, R., Dew, N., Read, S., and Sarasvathy, S.D. (2006) What to do next? The case for non-predictive strategy. *Strategic Management Journal*, **27**, 981–998.

Yin, R.K. (2009) *Case Study Research: Design and Methods*, 4th edn. Thousand Oaks, CA: Sage.

Zott, C., Amit, R., and Massa, L. (2011) The business model: recent developments and future research. *Journal of Management*, **37**, 1019–1042.

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