Original research article

Business model stress testing: A practical approach to test the robustness of a business model

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ARTICLE INFO

ABSTRACT

Business models and business model innovation are increasingly gaining attention in practice as well as in academic literature. However, the robustness of business models (BM) is seldom tested vis-à-vis the fast and unpredictable changes in digital technologies, regulation and markets. The evaluation of the robustness of a BM raises several issues, such as how to describe the business model in a structured way, how to determine a relevant set of changes to test against, how to assess their impact on business model components, and how to use the results of the assessment to strengthen the business model. In this paper, we propose business model stress testing as a practical approach to evaluate the robustness of business model components. The method builds upon concepts from business model innovation and scenario planning. We illustrate our approach using a case example. Our approach enables testing individual business model components as well as the interrelation between components. The approach visualizes challenges and suggests ways to increase the robustness of BM. The stress testing approach is particularly useful in a stage of business model experimentation, i.e. if a company has to choose between alternative business models or still has to implement the business model. The underlying software tool is openly available for reuse and further development. The paper contributes to futures research literature by delivering the first method that allows to test the robustness of business models against future uncertainties.

1. Introduction

Businesses increasingly need to engage in business model innovation (BMI) to cope with changes in their environment (De Reuver, Bouwman, & MacInnes, 2009; George & Bock, 2011; Giesen, Riddleberger, Christner, & Bell, 2010; Morris, Schindehutte, & Allen, 2005).

Businesses redesign their business model (BM) in response to new (digital) technologies, changing regulatory conditions, evolving competitor behaviour and shifting customer demands (De Reuver et al., 2009). BMs are especially discussed in dynamic business environments like telecommunications (e.g. Ghezzi, Cortimiglia, & Frank, 2015), 3D printing (e.g. Rayna & Striukova, 2016) and robotics (e.g. Yun et al., 2016). As businesses typically face uncertainties about their future environment, business model innovation and redesign should lead to BMs that are robust to uncertainties in the environment of the firm.

Literature on designing BMs that are robust to future developments is scarce. We define BMs as 'a description of how an

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organization or network of organizations intends to create and capture value with its products and services' (Bouwman, Faber, Haaker, Kijl, & De Reuver, 2008). Literature on BM and BMI has long focused on definitions, conceptualization, ontologies, typologies and taxonomies, whether from strategic management (Zott, Amit, & Massa, 2011), information systems (Bouwman, De Vos, & Haaker, 2008; El-Sawy & Pereira, 2013) or innovation management (Chesbrough, 2010). In more recent literature, focus is shifting towards implementation and re-design of BMs and BM components (Berends, Smits, Reymen, & Podoynitsyna, 2016; Nogueira Cortimiglia, Ghezzi, & Germán Frank, 2015). Other recent publications focus on qualitative case studies on BMI processes (Wirtz, 2016) and quantitative research on how to measure the impact of BMs on business performance (Claus, 2016; Veit et al., 2014; Wirtz, 2016). Recent publications also provide approaches for combining future studies with BMI, such as combining roadmapping and BM design (e.g. Abe, Ashiki, Suzuki, Jinno, & Sakuma, 2009; De Reuver, Bouwman, & Haaker, 2013; Toro-Jarrín, Ponce-Jaramillo, & Güemes-Castorena, 2016).

Scenario planning is often used to deal with uncertainties about the future business environment in strategic planning (Schwartz, 1991; Van der Heijden, 2005). Scenario planning acknowledges that the future environment is uncertain, and helps to evaluate the robustness of a firm's strategy. Earlier studies show how scenario planning can help to tailor BMs to a specific future scenario, in specific industry sectors like mobile telecommunications (Killström et al., 2007), IPTV (Bouwman, Meng, Van der Duin, & Limonard, 2008), Internet-of-Things (Tesch, 2016) and networked media (Haaker & Van Buuren, 2005). Methods to develop scenarios as input for BM analysis have also been published (Gnatzy & Moser, 2012). However, a generic method is lacking in literature to assess the robustness of existing or new BMs against future uncertainties.

In this paper, we develop and illustrate an approach to evaluate the robustness of BM components in one or more future business environment(s). The approach, named *BM stress testing*, delivers a *heat map* that visualizes the robustness of components in the BM in a certain scenario or future development. We define robustness as the ability of a BM to remain feasible and viable in a changing business environment. Robustness is especially important in the current business environment in which the pace of change in digital technologies, regulation and markets is fast and unpredictable (Gunther McGrath, 2010). Building upon ideas from strategic planning and BM design, this paper develops our six-step BM stress testing approach. We illustrate the practical application with an illustrative case example. Spreadsheet-based tooling is used to support the process, which is available upon request from the first author.

Our approach contributes to BMI literature by developing a practical approach to analyze how BM components might be affected and are eligible for re-design in response to future uncertainties. We not only provide a practical method to evaluate BM robustness, but also provide a foundation for understanding how particular external factors impact particular BM components. Our approach and tool provide a basis for researchers to systematically evaluate the interrelation between business environment and BM. Such approach and tool is especially useful in a stage of BM experimentation (Chesbrough, 2010; McGrath, 2010).

The paper is structured as follows. The next section provides the theoretical background on BM design, BMI, testing BMs, scenario planning and BM robustness. Subsequently, we describe our stress testing method and implementation, illustrated with a case example. After that, we discuss issues, limitations and concerns when applying the method and finalize this paper with conclusions.

2. Theoretical background

2.1. Business model design

The terms 'BM' and 'revenue model' have become mainstream and part of everybody's language in business, and to some extent even within government and public institutions (Lindgren & Rasmussen, 2013). BM as a concept has been used to explicate how companies create and capture value from technological innovation (Chesbrough & Rosenbloom, 2002). BMs have been investigated by many scholars from various disciplines and contexts ranging from Information Systems and management to computer science and strategy (Da Silva & Trkman, 2014). This results in a wide variety of definitions (an overview is provided by Da Silva & Trkman, 2014; Zott et al., 2011).

Generally, the term 'BM' refers to a description or model that represents a firm's logic to create, distribute and capture value for its stakeholders (e.g. Bouwman, De Vos, et al., 2008; Chesbrough & Rosenbloom, 2002; Gordijn & Akkermans, 2003; Linder & Cantrell, 2000; Magetta, 2002; Ovans, 2015). We define BMs as 'a description of how an organization or network of organizations intends to create and capture value with its products and services' (Bouwman, Faber, et al., 2008). A BM can function as a boundary object that enables cooperation and communication within and between organizations (Mäkelä & Lehtonen, 2010). The BM concept offers managers a systematic, experimentation-driven approach to consider their options in uncertain, fast-moving and unpredictable environments (McGrath, 2010).

Specific ontologies and design methods have been published including Business Model Canvas (Osterwalder, 2004), the STOF model (Bouwman, Faber, et al., 2008), VISOR (El-Sawy & Pereira, 2013), BM Navigator (Gassmann, Frankenberger, & Csik, 2015) and the Business Model Cube (Lindgren & Rasmussen, 2013). While these ontologies differ in scope and focus, they share a set of common components and underlying design variables, i.e. the customer, the value proposition, the system to produce the offering, and the way revenues are generated. Designing new BMs involves balancing several design choices regarding these concepts (Bouwman, De Vos, et al., 2008; Bouwman, Faber, et al., 2008; Bouwman, Meng, et al., 2008). Our stress testing approach is agnostic to the selected ontology and can be applied on any structured BM description. In this paper we use the Business Model Canvas (BMC) as it is the most popular ontology in practice.

2.2. Business model innovation

Closely related to BM design is the notion of BM re-design or innovation. Awareness is growing that next to technological, product and process innovation especially BMI is key to business performance (Amit & Zott, 2013). BMI is about reinventing BMs to deliver value in a new way (Lindgardt, Reeves, Stalk, & Deimler, 2009). BMI has been identified as a major source for competitive advantage, economic growth and job creation (Casadesus-Masanell & Ricart, 2010; European_Union, 2014). See BMI as leading to sustainable competitive advantage.

BMI can be defined as changes in business logic that are new to the focal firm, yet not necessarily new to the world, and that result in observable changes in the practice of the firm (Bouwman, Heikkilä, Heikkilä, Leopold, & Haaker, in press). BMI typically involves changes in multiple BM components as it alters the business logic as a whole. Examples include servitization, service bundling and experimenting with new revenue models.

The process of BMI is often a learning process in which discovery through experimentation is more appropriate than conventional analytical approaches (McGrath, 2010). Chesbrough (2010) argues BMI experimentation can help overcome barriers to BM change. Case studies suggest that actual changes in a BM are preceded by prolonged phases of experimentation and failure (Sosna, Trevinyo-Rodríguez, & Velamuri, 2010). In such experimental stage, a structured approach or tool to explore how design choices affect robustness of the BM is highly relevant.

While early studies on BMI focus on large firms, small and medium-sized enterprises (SMEs) are becoming aware of the need for BMI as well (Frick & Ali, 2013). BMI is also increasingly used by public organizations to evaluate and innovate their administrative services in response to demands for cost effective e-services from citizens, companies and politicians (Ranerup, Zinner Henriksen & Hedman, 2016).

2.3. Evaluating business models: feasibility, viability and robustness

As Christensen, Bartman, and Van Bever (2016) state, it is crucial to evaluate the fit between opportunities and business models up-front in a systematic way since 'business model innovation is too important to be left to random chance and guesswork'. The success of a BM as a design or a blueprint for doing business can be linked to concepts of viability, feasibility and robustness (De Vos & Haaker, 2008). This paper focuses on robustness of a BM. We define robustness as the long-term viability and feasibility of a BM in a given future environment. Considering our definition of BMs as creating and capturing value, a viable BM provides benefits for both the customer and provider of a product or service. Viability can be operationalized through a business case that assesses the financial implications of a BM. Feasibility relates to the question if a BM can actually be implemented and deployed in practice. A BM is feasible if required resources are available, such as finance, technology, human resources or intellectual property. Also, legal, regulatory or moral barriers should not prevent implementing the BM.

Bouwman, Faber, et al. (2008) propose to use critical success factors (Rockart, 1981) to operationalize the viability and feasibility of a BM. These factors relate to the attractiveness of an offering to the proposed customer segments and to the profitability of a BM for participating stakeholders. Osterwalder and Pigneur (2010) evaluate viability through checklists with questions to assess strengths, weaknesses, opportunities and strengths of each BM component.

2.4. Scenario planning and BM robustness

For evaluating the robustness of a BM in an uncertain business environment, we build upon scenario planning, which falls in the broader tradition of futures studies. Futures studies research yields several approaches to investigate future developments such as scenario analysis, back-casting, forecasting and foresight (Bouwman & Van der Duin, 2003). Scenario planning (also referred to as scenario analysis) has a long history and can be used to improve strategic decision making and longer-term planning processes (e.g. Steiner, 1969). Future scenarios are coherent descriptions of possible future states that provide insight into the way the future may develop, based on assumptions concerning relevant developments. Scenarios provide a structured approach to describe and analyze such future states.

Scenarios should be internally consistent, plausible and challenging. When using multiple scenarios, each scenario should be clearly distinguishable (Van der Heijden, 2005). Future scenarios can be developed in terms of the outcomes of scenario indicators or developments. The developments can include trends that are fairly certain, for example ageing of the population, or uncertainties for which different outcomes are plausible.

Various studies combine BMs with scenarios analysis. However, none of them provide tools or methods to test the robustness of BMs in a practical and structured way. Some studies focus on qualitative scenarios, for instance (Ballon, 2004) studied the position of telecommunications stakeholders in different future 4G scenarios. Haaker and Van Buuren (2005) used future scenarios to test the viability of managed content services, in order to identify robust service features that are viable in all chosen scenarios. In a similar fashion, Tesch (2016) used scenario planning to evaluate future BMs as part of a BMI process. In particular he developed an evaluation framework for BMI for the Internet of Things, using future scenarios based on two key uncertainties to establish a best fit for the reference model and features for each scenario. While his approach sketches a pathway from a generic initial BM to a scenario-adapted BM, it does not identify the weak and strong points of specific BMs or how to make them more robust. Killström et al. (2007) test generic BMs for introducing new mobile services in four scenarios for future business environments. The analysis reveals which design choices can be considered robust, i.e. those valid in multiple future scenarios. The robust design choices can be interpreted as guidelines for 'future proof' BM designs.

Fig. 1. Six-step approach for Business model stresstest.

Other studies apply quantitative scenarios to BMs, for example, Zoric (2011) considers a techno-business modeling approach for quantitative analysis of services and platforms. Pagani (2009) integrates planning and scenario methodology in quantitative analysis of future 3G mobile TV. Bouwman, Meng, et al. (2008) used scenario planning to discuss strategic issues for future IP-enabled television BMs.

Applying scenario planning to evaluate BMs has several merits. First, it provides insight, for instance into how BMs perform in different future environments or in the robustness of BM choices. Second, it may increase a firm's capacity to anticipate and respond to change. Existing studies are mostly strategic in nature. The robustness of a designed BMs is seldom tested vis-à-vis the fast and unpredictable changes in digital technologies, regulation and markets. A structured approach to identify robust and non-robust BM components is lacking in literature.

3. Our approach: business model stress testing

In this conceptual paper, we develop the method and explain it further with an illustrative case example. We coin the term *business model stress testing*: a systematic analysis of the robustness of BM components in different future environments. The approach reveals why certain choices in the BM create problems in a particular future environment, and inspires discussion on how to make the BM more robust. In the approach, a BM is subjected to a stress test, in which future trends and uncertainties serve as stress factors. The approach produces a heatmap with the trends and uncertainties as columns and BM components as rows. The approach is supported by Excel-based tooling, which is available upon request from the first author.

3.1. Six-step approach

Our approach contains six steps, see Fig. 1. The remainder of this section elaborates the steps.

3.1.1. Describe BM
The first step is to describe the current or desired BM in a structured way. In some cases, the BM is already described in multi-format, rich documents. In other cases, understanding of the BM is tacit, and still needs to be made explicit. In this step, the BM is articulated using a suitable Excel template for the specific BM ontology in use. Our approach and tooling can handle BM descriptions in any ontology such as BM CANVAS, STOF, VISOR or BM Cube. In case a firm has multiple BMs, one specific BM should be chosen since stress testing works best for a clearly defined value proposition.

3.1.2. Identify and select stress factors
Consistent with scenario planning, in this step we select trends, uncertainties and outcomes that will be used as stress factors. Trends and uncertainties can be derived from existing scenarios or from brainstorm sessions with involved stakeholders. Frameworks like PESTLE can be used to assure that multiple perspectives are covered.

In our experience, up to five trends and uncertainties keep the approach manageable. Stakeholders should select those trends and uncertainties that they think have the highest impact on the BM. Consistent with scenario planning, extreme outcomes should be

defined for each selected trend or uncertainty.

The validity of a BM stress test depends on the quality of the input. A BM stress test requires a structured and coherent description of the BM and a relevant and representative collection of trends and uncertainties plus outcomes. The BM needs to be sufficiently clear and complete to be suitable for a stress test. Preparing these inputs requires time, effort and some skill. Describing the BM in a clear and understandable way holds value in itself. Likewise, collecting and selecting relevant trends and uncertainties can be challenging. One approach is to collect a longlist in a brainstorm or from a PESTLE analysis and select the key developments at the start of the stress test. Doing so ensures that stress test factors are tailored to the case at hand, but does pose the risk of bias as people tend to select the factors they are already familiar with. An alternative approach is to collect trends and uncertainties from existing independent trend analyses and future studies. While collected developments are less tailored, blind spots can be avoided.

The results of the BM stress test will, at least to some extent, depend on the selection of trends and uncertainties. The choice of stress factors will influence the discussions, reasoning, heat map and analyses. Experience in several stress test sessions has shown that discussions often revolve around a limited number of issues and that these issues are discussed for more than one stress factor. Adding factors to the stress test or replacing some with other factors may still lead to the same issues being discussed.

3.1.3. Map BM to stress factors

In the actual stress test, the stress factors (i.e. selected trends, uncertainties and outcomes from Step 2) are confronted with the components of the BM (as described in Step 1). In this intermediate step, we first explore which stress factors and BM components are causally related. In some cases, there is a straightforward causality. For example, there is an obvious causality if a BM component involves 'using personal data of customers' and a selected stress factor is about 'regulation for using personal customer data'. In other cases, the causal relationship is less straightforward. In our example about using personal data of customers, a selected stress factor 'privacy-enhancing technologies' may impact the BM component, but in which way exactly may be subject to debate. This step provides a first mapping of which stress factors have an impact on which BM components. Only these combinations have to be included in the actual stress test in step 4.

3.1.4. Heat Map

This step is about assessing how the stress factors affect the BM components. A '*Heat Map*' is produced in the form of a matrix with BM components positioned vertically and outcomes on uncertainties positioned horizontally. In the heat map a coloring scheme is used to indicate the impact of a specific stress factor on a BM component:

– Red: The outcome on the stress factor makes a BM component no longer feasible. In this case, the stress factor becomes a potential showstopper for the BM.
– Orange: The outcome on the stress factor makes a BM component no longer viable. In this case, the stress factor requires revisiting choices regarding the BM component.
– Green: The outcome on the stress factor affects the feasibility or viability of the BM component, but not in a negative way. When colored green, the stress factor may even positively influence the feasibility or viability of choices regarding the BM component.
– Grey: The outcome on the stress factor does not affect the BM component in any way, as concluded at the end of step 3.

Besides coloring the cells in the Heat map, also the reason why an impact warrants a particular color should be motivated. This is particularly important as input for the last step of our approach, in which recommendations are formulated.

Assessing the impact of stress factors on the BM components is challenging. Determining impact and selecting colors is not an exact science, as it results from intersubjectivity between stress test participants. Participants sometimes disagree about impacts being positive or negative. By discussing the underlying reasoning, hidden assumptions become clear, which partially resolves differences of opinion. Still, the validity and reliability of the stress test results largely depends on the knowledgeability of participants, the clarity of the BM and the selection of scenarios.

3.1.5. Analyse results

The Heat Map visualizes which BM components are not robust. Analysis contains two sub-steps.

5a. Sub-view analysis. Sub-views on the Heat Map help to structure the analysis, zoom in on problem areas of the BM, and unravel reasons why parts of the BM appear more robust than others. For example, a sub-view can accumulate a BM component over all stress factor outcomes, which indicates the overall robustness of that specific BM component. Alternatively, a sub-view can accumulate a stress factor outcome over all BM components to show which stress factor has the largest positive or negative impact.

5b. Pattern analysis. The heat map can reveal patterns of colorings that point to:

– Preferred outcomes on stress factors: A specific outcome shows to be consistently favorable or unfavorable for multiple BM components. Such insight is useful if stakeholders can enact the stress factors, e.g. by lobbying for certain regulation.
– Potential inconsistencies between BM choices: Choices on one or more BM components are favoured by one uncertainty outcome, while another uncertainty outcome favours other components. As a result, whatever outcome materializes in the future, the combined BM components are not feasible.
– BM choices that are not feasible in any future environment: A BM component is not feasible in either of two extreme outcomes on a stress factor. Such 'double-red' outcome indicates a serious issue in the BM that needs to be analyzed and remedied (e.g. with root-cause-analysis).

– Patterns can be used in combination with sub-views to assess a BM's robustness.

3.1.6. Formulate improvements and actions

After analyzing the robustness and vulnerabilities of the BM, the next step is to define actionable conclusions. Recommendations are typically made on how to improve weak BM components or improve consistency across BM components. A well-described reasoning behind the choice for a specific coloring is an important input to this final step. This helps especially in directing the initial stages of BM design, or when revising BMs.

Our BM stress test approach so far assumes a one-way impact from the environment on the business. However, in reality, businesses often attempt to enact their environment. For instance, companies can lobby against strict regulation if they regulation is not in their interest. The results of a BM stress test can help to inform businesses on what future scenarios are desirable, and should thus be subject of enactment.

The stress test takes into account the impact of a given trend, uncertainty or scenario but not the likelihood of such development. As an additional step after conducting a stress test one could look at the best and worst case scenario by assessing whether the best (or worst) case is a realistic scenario. If the future is more likely to unfold according to the worst-case scenario one may need to re-examine the BM.

3.2. How to apply the method

A BM stress test can be done in a facilitated session with a group of people that are familiar with the BM. Adding an external domain expert helps to avoid tunnel vision and biased conclusions. A facilitator guides the session, chairs discussions, records impacts and pushes for results. Next to the facilitator, an observer can register findings, next to video-taping and the use of spreadsheets. The final steps of analysis and recommendations are not trivial to execute, but can result in surprising insights. Discussions on how to interpret the results are a relevant source of information for drawing conclusions.

Next to the stress test procedure is useful to consider who is carrying out the stress test, who is supplying the input about stress factors, and who is going to use the information to modify the business in response. As mentioned we can see three types of involved stakeholders. First the team and manager of the team that is responsible for the business or business idea to be tested. They provide a clear description of the business model to be tested. Second, input for stress factors can come from independent domain or industry experts, typically in cooperation with the case owners. Third, the stress test facilitator(s) is knowledgeable about the stress test approach and can help with describing the business model and selecting the stress test factors. The facilitator's role is specially to guide the creation of the heat map and interpret results. It is the team or manager who is going to use the results to modify the business in response.

4. Illustration with a case example

In this section, we illustrate our approach with a case example. The case example is fictional yet based on various research projects done by the authors in the insurance industry.

4.1. Case introduction

The case example focuses on a typical insurance intermediary. An insurance intermediary is a broker or agent that represents consumers in insurance transactions. Insurance intermediaries have contracts with multiple insurance companies so they can advise the consumer on the most suitable insurance products (Investorwords, 2016). Intermediaries offer advice, information and other services in combination with the solicitation, negotiation and sale of insurance (brookers, 2016).

Bastiaansen is a fictional insurance intermediary in the Netherlands that brokers a broad range of damage and life insurances from a large number of insurance companies. Its service portfolio consists of (1) personalized advice about insurances based on consumer needs and context, (2) handling of applications and administration of insurance products with insurance companies that the intermediary is contracted with, and (3) support consumers by handling insurance claims. We model Bastiaansen on the basis of several projects and case studies that we did on BMs of insurance companies and insurance intermediaries in The Netherlands (Bouwman, Faber, & Van der Spek, 2005; Bouwman, Ter Doest, & Van der Duin, 2009; Derikx, De Reuver, & Kroesen, 2016).

4.2. Case context

Intermediaries in the insurance industry are facing regulatory, technological and market-related uncertainties and challenges that can make existing BMs vulnerable and prone to disruption (Shaw & Eckenrode, 2016). For instance, regulation is forcing intermediaries to be more transparent on their pricing model, while new digital channels and car safety (registration) systems might impact their BM as well. To better understand what are vulnerable components of Bastiaansen's BM, we perform a BM stress test.

Step 1: Describe the BM

We use the Business Model Canvas to describe the BM of Bastiaansen. The customers of Bastiaansen are mostly families, some with children. Typically, they have 1–5 insurance policies ranging from relatively simple car, travel and liability insurances, to property
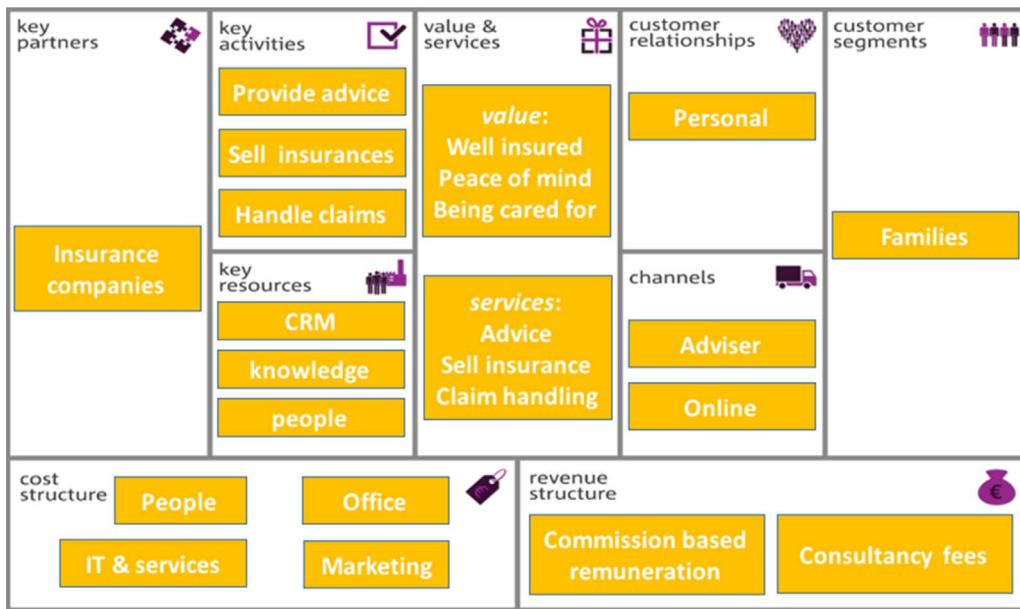
Fig. 2. Business model for Bastiaansen Insurance Intermediary.

insurance and more complex income and life insurances. Bastiaansen's value proposition is about being well-insured, peace of mind and being cared for when something happens that results in a claim. The actual services of Bastiaansen consist of personal advice, selling, handling and administration of insurance policies and claim support. The personal customer relationship is key for an intermediary like Bastiaansen. Regular face-to-face contact at the office or customer premises is key for Bastiaansen although digital channels become increasingly important. The main revenue model is a commission-based remuneration system, which implies that insurance companies pay a fee when Bastiaansen sells one of their policies as a secondary revenue source, customers can pay a consultancy fee for advice based on an hourly rate.

The key activities include providing advice, sell insurances and handle claims. The key resources include customer relationship management systems, insurance knowledge and human resources. The costs are mainly associated with personnel (80% of total), infrastructure including IT & services and office, and marketing. Key partners are the insurance companies. The BM of Bastiaansen is summarized in the BM Canvas in Fig. 2.

Step 2: Identify and select stress factors

In this step we first collect the relevant trends and uncertainties. These are derived from publications about developments and trends in the insurance industry as well as discussions with actual insurance intermediaries. For this case example, we select four uncertainties that have the highest impact for the intermediary BM, from legal, technological, societal and political perspective.

- *Ban on commission based remuneration*. The revenue model of commission based remuneration for intermediaries can create conflicts of interest. Intermediaries' advice for customers may not be impartial as their revenues depend on what insurance products they sell. For this reason, as well as other potential conflicts of interest, in some countries commission based remuneration has been banned for certain products, particularly more complex products. Given this trend, we select as extreme outcomes 'ban on commissions for complex insurance products only' vs. 'ban on commissions for all insurance products'.
- *Availability and adoption of cognitive systems*. Adoption of new (digital) technology will have a large impact on the insurance industry, for example with regard to interaction with customers and working practices of intermediaries. Cognitive systems, such as IBM's Watson, use natural language processing and machine learning to enable people and machines to interact more naturally. These systems will learn and interact to provide expert assistance to customers, effectively emulating human helpdesk expertise. As outcomes we select the current 'human helpdesks prevailing' vs. 'conversational agents prevailing'.
- *Interest in do-it-yourself (DIY) insurance*. New and especially young customers may be less inclined to buy insurance policies through intermediaries. Instead customers may want to compare insurance products themselves and rely more on self-service or so-called direct writers for insurance products. As outcomes we select 'intermediary channel is stable' vs. 'intermediary channel is declining'.
- *Scope of generic care duty*. Another potential source of conflict of interest relates to short-term profit maximization and long-term customer satisfaction. When intermediaries collect their commission (or consultancy fee) especially at the beginning of the lifetime of an insurance product, then any care for the customer later on may be considered as a cost. Because of this, several countries are considering to introduce a generic care duty, which forces providers of insurance products to care for their customers over the full runtime of the product. As outcomes we select 'care duty is limited' vs. 'care duty is strict'.

Table 1
Summary of selected uncertainties and outcomes.

Perspective	Uncertainty	Outcome 1	Outcome 2
Legal	*Ban on commission based remuneration*	Ban on commissions for complex insurance products only	Ban on commissions for all insurance products
Technology	*Availability and adoption of cognitive systems*	Human helpdesk	Cognitive conversational agent
Society	*Interest in DIY insurance*	Limited interest	Growing interest
Political	*Scope of generic care duty*	Care duty is limited	Care duty is strict

Table 1 summarizes the selected uncertainties and their outcomes.

Step 3: Map BM to stress factors

In this section, we map the BM components to the uncertainties.

First, we consider *ban on commission-based remuneration*. This uncertainty is directly related to the BM components 'revenue structure' and 'key partners'. Commission based remuneration is a key part of the revenue structure and paid for by the insurance companies as key partners. Less obvious is how dependent the firm is on this type of remuneration, for which type of insurance products it is paid and whether there are alternative revenue models. Depending on how these issues are solved, there may be an impact on other BM components such as choices for 'customers' and 'value proposition', 'cost structure'. The uncertainty *availability and adoption of cognitive systems* directly relates to 'key resources'. Advice and help in the current BM is provided by humans. It is also obvious that conversational agents make communication via internet more personal and faster. Issues concern to what extent and at what point in time cognitive systems can take over tasks from humans, and how this impacts the 'cost structure', 'key activities' and 'customer relationship'. The uncertainty about the *interest in DIY insurance* directly impacts the 'value proposition', 'customer segments' and 'channels'. Intermediaries currently work with advisors to help customers with their insurances. Issues exist with regard to a multichannel strategy, i.e. the extent to which intermediaries can blend personal and online channels in relation to customer needs and preferences. Finally, we consider *scope of generic care duty*. This uncertainty is directly related to the BM components 'customer relationship', 'value proposition' and 'key activities'. These causal relationships are obvious since care is a core aspect of the value proposition, embedded in the 'customer relationship' and a part of the 'key activity' advice. A less obvious issue is what 'key resources' are needed for the level of care that is required.

Step 4: Create Heat Map

In this step we create the Heat Map. It visualizes the impact of outcomes of uncertainties on the BM components. Before showing the complete Heat Map in matrix form, we provide a few examples to show the coloring process and underlying reasoning.

As argued in Step 3, a *ban on commission-based remuneration* will impact the revenue structure. If the ban is imposed on all insurance products, this is a potential showstopper, hence the coloring with red. When cognitive or conversational agents are available for helpdesk tasks, then obviously this requires rethinking and shifting key activities. This is beforehand neither good nor bad but it does require attention, hence the coloring with orange. Finally, if we assume that regulation about customer care is strict, then a strong customer relationship will be essential, hence the coloring with green as this fits well with the personal relationship assumed in the BM. In Table 2, a few additional examples are presented.

Next, we provide the complete Heat Map with all impacts of the selected stress factors on the BM components (Fig. 3).

A Heat Map is the end result of this step. The headings of the rows reflect the BM components of the BM canvas (Step 1). The top row shows the selected uncertainties and their outcomes (Step 2). The coloring follows the indicated scheme, with argumentation provided in Table 2.

Step 5: Analyse results

Step 5a: Sub-view analysis: BM components

Sub-views on the rows in the Heat Map provide an idea of the robustness of the individual BM components. Fig. 4 shows that BM component 'Revenue structure' shows several red cells, suggesting that multiple realistic future developments that make the current revenue model based on commissions unfeasible. This is a clear indication that intermediaries like Bastiaansen should consider alternative revenue models.

Other components, like 'Key activities', show no red but several orange cells. Orange cells imply that the insurance intermediary should consider changing activities in accordance with evolving developments. In this sense, the sub-view creates awareness about which developments to monitor that lead to changes in BM components. For example, monitoring and anticipating the obligations with regard to care duty can inform changes in key activities to cope with such obligations.

Step 5a: Sub-view analysis: Stress factors

Next, we create sub-views for some of outcomes on the stress factors, see Fig. 5. Outcomes *Ban on commission for all insurance products* and a *Interest in DIY insurance* produce several red and orange cells. Apparently, with these outcomes, the BM can hardly sustain. Outcomes *Human helpdesks prevailing* and *Limited interest in DIY insurance*, show a lot of green cells. The current BM is more

Table 2
Impact of uncertainty outcomes on selected BM components (partial stress test result).

Outcome	BM component	Impact & Coloring
Ban on commissions for all insurance products	Revenue structure	Current revenue model no longer possible; new models required
	Customer segments	Customers don't accept explicit payment for intermediation services as commission based is model perceived as 'free'.
	Partnerships	Partnership with insurance companies needs to be reconsidered
Cognitive system helpdesk	Key activities	Implies a shift in activities from humans to systems
	Key resources	Requires attention to build and needs (big) data as input
	Cost structure	Initial costs are high but in the longer term save costs as labour is reduced
DIY insurance interest is growing	Value proposition	If especially young people turn to self service and direct writers, the current proposition is not sustainable
DIY insurance interest is growing	Channel	strengthening online channels and self service in multichannel strategy
Care duty is strict	Customer relationship	Customer relationship will become essential when care duty is strict

robust in these future scenarios.

The sub-view shows the weak and vulnerable parts and their causes. An actionable outcome could be to anticipate the uncertainties, for instance experimenting with self-service for simple insurance products to anticipate increased customer demand for DIY insurance. Another outcome could be to enact those outcomes on the stress factors that favour the BM. While an individual intermediary like Bastiaansen will not be able to enact the regulatory environment, the combined force of the intermediary channel may try to lobby with regulators and politicians.

An alternative to creating sub-views is to map one outcome of a stress factor directly on the Business Model Canvas representation, see Fig. 6. In the example of Fig. 6, the left part shows that a ban on commission negatively affects several BM component. Contrary, the right part shows that a limited interest in DIY insurance fits well with most current BM components.

Step 5b: Patterns analysis

The heat map in Fig. 3 shows a double red coloring. Specifically, both outcomes on the uncertainty *Ban on commission* are showstoppers for BM component 'revenue model'. This double-red pattern shows that the BM needs to be revised whatever future
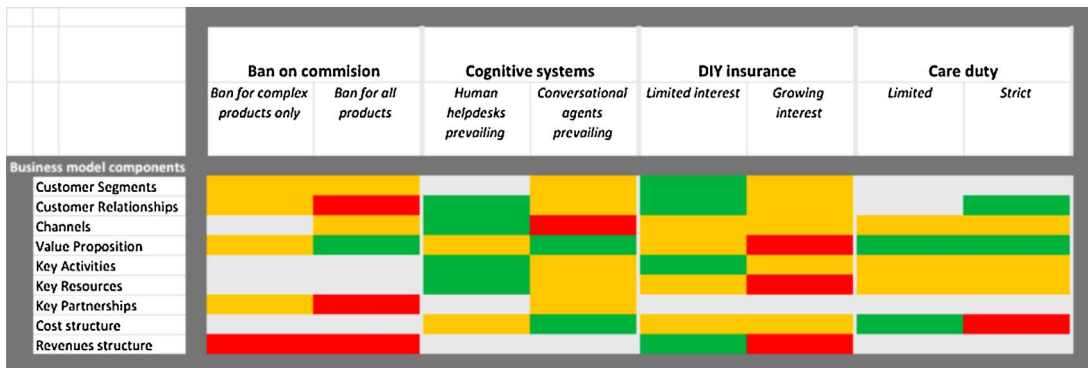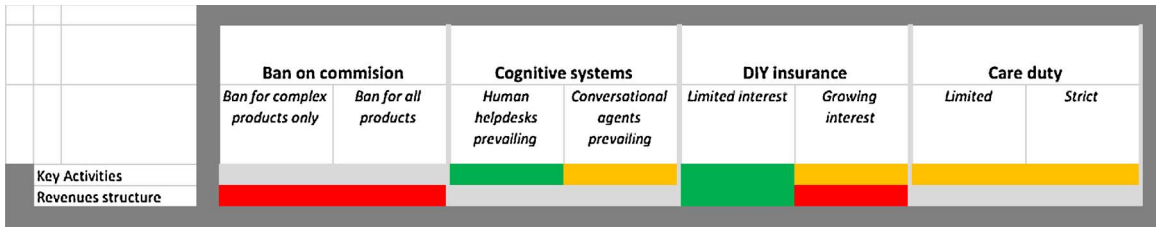

Fig. 3. Stress test Heat Map for Bastiaansen.

Fig. 4. Stress test Heat Map for Bastiaansen (fragment).

scenario unfolds, i.e. intermediaries like Bastiaansen should look for alternative revenue models.

In a similar fashion, Fig. 3 shows a double green coloring. Both outcomes on *Care duty* are favorable for BM component 'Value proposition'. Customer care is a core component of the value proposition of Bastiaansen and therefore the BM is robust under any outcome on the stress factor.

Step 6: Formulate improvements and actions

The analysis in Step 5 show that the revenue model based on commissions is under threat. Other models like pay-per-hour for advice or subscription models for longer term support or pay per event are required. Bastiaansen needs to establish the viability of such models by redefining its pricing model and proofing it with customers.

A core value that intermediaries like Bastiaansen can provide is 'care for the financial wellbeing of the customer'. Bastiaansen could exploit this more and develop a subscription model to sustain a long-term, pro-active and deep relationship with its customers. Care does not necessarily imply face-to-face contact. Given technological developments and 24/7 demands from customers, intermediaries may experiment with self-service to strengthen the customer relationship. Careful experimentation with self-service can reveal the potential to improve customer satisfaction while at the same time show the potential for cost reduction.

5. Discussion

5.1. Contribution to literature

Our BM stress testing approach is the first structured method that combines scenario planning and BM design. Rohrbeck and Schwarz (2013) found empirical support that strategic forecasting activities contribute to firms' capacity to interpret and respond to change. BM stress testing helps to identify vulnerabilities in a BM, and leads to more informed decisions in BM innovation and redesign.

Stress testing is strategy school agnostic. As a tool it can be used in every possible strategy approach (Mintzberg, 2005). However, its agile character it fits strategy experimentation and learning approaches. Hence our approach is not focused on creating scenarios per se, but on integrating concepts from scenario planning into an agile process of strategy experimentation for BMI.

We build upon concepts of scenario planning as future scenarios are input to our approach. Our approach assumes that scenarios are available with different outcomes that are relevant to the BM. As such, our approach is agnostic of the particular scenario planning approach that is being used, considering these are amply available in future studies literature. Our approach goes beyond
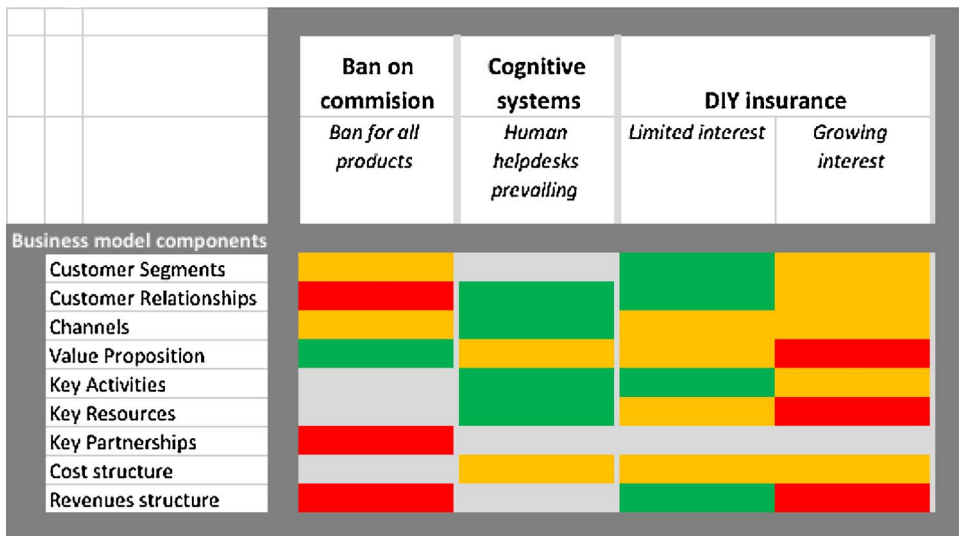

Fig. 5. Stress test Heat Map for Bastiaansen (sub-view).

Fig. 6. Ban on commission for all products (left) and DIY insurance limited interest (right).

the mere anticipation of scenarios relevant for the BM, as it makes explicit how to adapt the BM to achieve robustness.

Our approach contributes to BMI literature. Cortimiglia, Ghezzi, and Frank (2016) observe a gap in BMI literature between strategic thinking and implementation. The importance of thought experiments in a process of BM experimentation is stressed by existing literature (Chesbrough, 2010; McGrath, 2010; Sosna et al., 2010). Our BM stress testing approach can be used in an early phase of strategy formulation, in order to evaluate what strategic options lead to feasible and viable business models in the future. As such, our approach bridges the gap between strategy and implementation, and facilitates the learning process during BM experimentation.

We also contribute to BM literature by providing practical tooling, as called for by Bouwman et al. (2012) and Osterwalder and Pigneur (2010). BM stress testing can be combined with other BM approaches, such as BM roadmapping (De Reuver et al., 2013). Based on a stress test a robust to-be BM can be defined. In case BM components are found to be vulnerable, alternative roadmaps can be developed.

The BM stress test is qualitative in nature. A further development would be to add quantitative assumptions to future developments and to use these to quantify the impacts on BM robustness and future viability (Zoric, 2011).

Practitioners can benefit from our approach by developing more robust BMs that can deal with multiple future scenarios. By applying stress-testing robustness of current or desired BMs becomes clear, before investing in the actual implementation (Christensen et al., 2016). Therefore, we especially advise applying our approach in the early stages of BMI, for instance after formulating an initial idea.

6. Conclusions

We have presented BM stress testing as a structured and practical approach to test the robustness of components of a BM in different future scenarios. The method was illustrated with a case example about an insurance intermediary. Our approach visualizes challenges and suggests ways to increase the robustness of the BM. The heat map resulting from the analysis highlights strengths and weaknesses of the BM and provides a way to communicate the robustness of the BM.

Strength of the method is its general applicability. BM stress testing can be used in different domains and contexts in which BMs are discussed and innovated. The approach is ontology-agnostic and our support tools can be easily adjusted to express results in alternative BM ontologies. A prerequisite for useful results from a BM stress test is quality input in the form of a clear and structured description of the BM and a set of relevant trends and uncertainties to test against. The BM description and the set of trends and uncertainties are valuable results in their own right. Conclusions about the robustness of a BM based on the heat map are structured and supported by the reasoning behind the analysis.

Our approach contributes to an enhanced capacity to perceive change and to interpret and respond to change and to an enhanced capacity for organizational learning. The stress testing approach is particularly useful if a company still has to select from alternative BMs or still has to implement the BM.

Acknowledgements

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