Using System Dynamics to Explore Reasonable Assumptions in Business Model Generation

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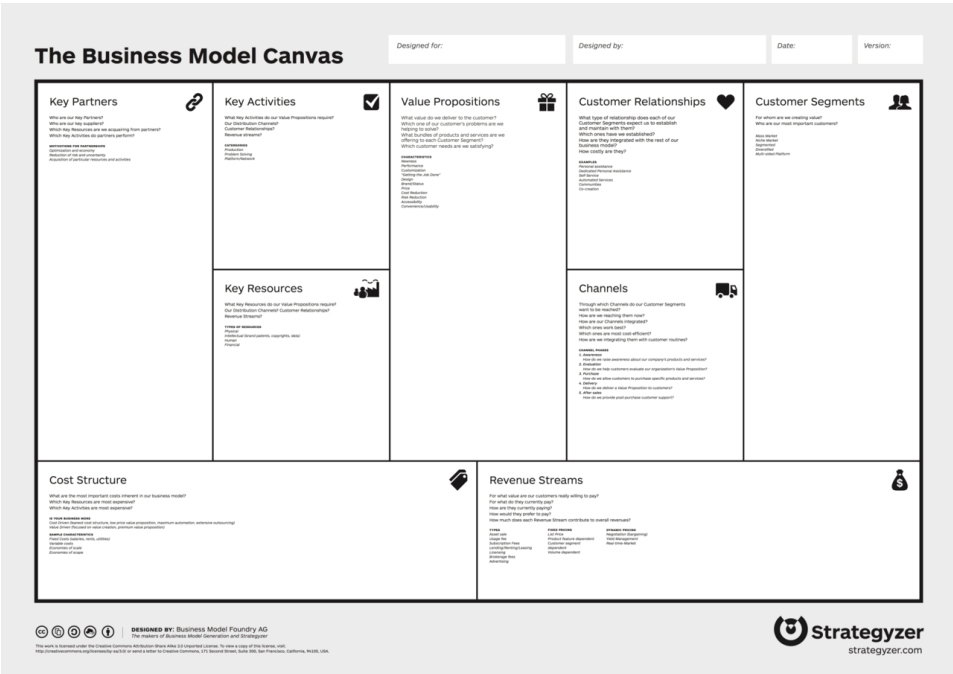
Frameworks for business models

This thesis uses system dynamics to critically examine the definitions and frameworks that govern our understanding of what a business model is and isn't as well as how one should approach generating a business model for a new business. By using simulation based modeling this study aims to contribute with insight as to how structure drives behavior, and as such bring attention to how we define the boundaries and the approaches to creating frameworks for business model generation..



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1. Introduction and problem presentation

1.1 Background for the research

When presented with the challenge of creating a new business, entrepreneurs are often asked to present their business model and, if the investors are intrigued by the business model, the entrepreneurs is asked to provide a business plan. There is an almost overwhelming amount of literature about theory surrounding business models as a basis for doing business, but the experts have not agreed on one common definition for the concept of "business model"(Al-Debei & Avison, 2010; Hedman & Kalling, 2003; Osterwalder, 2004; Verrue, 2014). This represents a challenge where the investors and the entrepreneurs may use the same word, *business model*, but may refer to different conceptual understandings as well. The one thing the literature seems to agree on however is that every business needs a business model at its base. This common truth indicate that having a good business model is essential for generating and sustaining a succesful business. Basing a business on an incomplete or insufficient understanding of what a business model is may lead to lost profits at best and a great business idea never leading to fruition at worst.

In order to meet the sustainable development we rely on the creation of jobs and sustainable technology through innovation and entrepreneurship worldwide. While innovation and entrepreneurship is happening at increasing rates, the business and trade environment in which it is supposed to happen is changing rapidly. It is prudent to ask the question of whether the methods of business model generation from the past will serve the entrepreneurs of the future who will likely operate in a market with higher volatility, higher risks and increasing pressure to shy away from business practices with negative effects. It has been argued that the business model concept can "improve the manageability of some of these effects" (Osterwalder, 2004 p. 11), which is a perspective supported by the author.

When using the business model as the main framework for validating a business' ability to generate a profit it might serve all parties to have a common understanding of what a business model is as well as ensuring that the current modes of business model generation are appropriate in a context of frequent and drastic change. In system dynamics the term robustness is used to refer to the "ability of the business model to sustain its effectiveness over time" (Casadesus-Masanell & Ricart, 2010 p. 148). By approaching a business model as another system and examining its robustness in a similar manner one can also examine how closely it needs to be monitored or how fast it needs to be adjusted in the face of change to the environment. The robustness approach becomes an especially interesting point of research in volatile contexts. Whether or not a business thrives or even survives a situation of drastic and sudden change to its' business environment depends at large on the robustness of the business model, the management's insight into the impact of the context on the structure and how fast the business can change from one model to another. The robustness of a business model can only be examined through subjecting it to various scenarios and conditions.

The lack of a consolidated definition of a business model gives rise to questions as to what should be included and excluded from this representation of the business, and as follows what should be considered the "core" of the business, what are considered endogenous components and what are considered outside the boundaries of the business model concept. One common understanding however is that the scope of a business model created through a framework like the Business Model Canvas is limited to the processes that are within the control of the business and does not cover environmental factors (Fritscher & Pigneur, 2015). The Business Model Canvas, hereinafter BMC, serves as the closest thing to a common conceptualization we have of a business model. This is not as much due to its' in-depth analysis of a business model, but more an ode to it being the most common framework for constructing a business model (Stenn, 2017 p. 55).

The aim of using system dynamics is to gain insight into what type of behavior the assumed structure of a business model provided by a definition or a framework would produce. System Dynamics is a tool that

facilitates testing the performance or behavior of a conceptual model over time under different scenarios. System dynamics is a theoretical framework built on the premise of that behavior is generated by the structure of the system. From a system dynamics perspective the business model is at large the primary driver of the behavior, meaning the performance of the company. “System dynamics is a method to enhance learning in complex systems” according to John Sterman (Sterman, 2000 p. 4). By applying this theory to the question of model boundaries in business model generation this study may add insight to the discussion of business model robustness and what should be included and excluded. Risks, defined as “the possibility of loss or injury (to your profits) or the chance that an investment such as a stock or commodity will lose value”, are considered a variation in behavior from that the structure should normally generate, should then be considered to fall outside the boundaries of a business model. System dynamics theory provides a basis for looking at policies which endogenizes the exogenous elements that makes the system unstable. Because the BMC does not consider system feedback, the question of endogenizing risks becomes somewhat obsolete, but a system dynamics simulation model provides a basis for experimenting with the margins of inclusion and exclusion.

1.2 Research Objectives

This study aims to form part of the discussion of how a business model should be defined and understood by questioning and testing the theoretical assumptions that underpin the current dominant understandings. The main purpose for this research is to uncover the assumptions that define the scope of business models through examining the BMC and the Business Model Pattern, hereinafter BMP from a dynamic perspective. This research will explore what information might be lost in the using simple business model presentation formats such as BMC and the BMP approach. This is based on the understanding that an enterprise which is “unable to distinguish the main components of its business model, and the dynamics that lie within, it is incapable of changing and adapting the model to the environment”(Romero et al., 2015 p. 1). The first research question becomes as follows:

1. Does the structure provided by the BMC and BMP suffice in generating business performance that demonstrates the “business logic” of the company?

While the BMC tries to identify *what* is needed to create economic value, this study will apply BMP and address *how* the elements identified in a BMC can create value. With the added insight of a dynamic simulation-based model this research aims to answer the following question:

2. Which are the crucial shortcomings and contributions of the BMP and BMC frameworks in terms of demonstrating the “business logic” of the company as seen from a dynamic perspective?

Through examination of the involved dynamics, the weight attached to the different elements of the model and through examining the business under different scenarios this research aims to provide more insight into what should be regarded as the core of a business model and understanding of the extent to which the structure of the business drives behavior and when the behavior or performance of the company in turn changes the structure.

These two questions will be central in answering the final question which is

3. What are the added benefits of applying system dynamics to business model generation and how can the insights from this study contribute to build a consolidated definition of business model as a concept?

The nature of research questions 1 and 2 gives rise to question 3, and discussing what value system dynamics adds to the academic discourse on business models.

This thesis does not intend to provide a new or improved version of the BMC or BMP, but present which dynamics that are the result of the assumptions included in the BMC. Originally this study was meant to be carried out as a group model building process with actual start ups in Uganda, but this had to be altered due to COVID-19. The final study was thus carried out with a fictitious company based on conversations with the entrepreneurs behind Mama Lizzy Ventures in Accra, Ghana. The study will thus be realistic in looking at the use of the BMC and BMP for start-ups and early stage companies that are not yet operational, and how these frameworks can help to generate an understanding of which expectations and levels of understanding that are presented by the BMC and BMP.

This thesis aims to showcase the insights gained in the process of this study. Chapter 2 will present the theoretic foundation upon which this research builds as well as the hypothesis. It will present how central concepts dicussed in this thesis are understood by the author and how they should be understood in the context of this study. Chapter 3 will demonstrate the approach and method of this study, as well as the validity of the output of this research meaning the construction of a system dynamics model along with how this model will be used to answer the questions set out in the paragraph above. Chapter 4 will provide a short presentation and rationale for the model along with a discussion of the validity of the construct. Chapter 5 will present the behavior of the first structure and analyze the relevant dynamics involved as well as summarize the findings from the simulations. Chapter 6 will present various policy options while chapter 7 will provide a short discussion on the learning outcomes of the study along with concluding remarks that address the research objectives presented in chapter 1.

2. Theoretical Framework and Hypothesis

2.1 Literature review

Understanding the concept of a business model:

The leading sources of the author's conceptual understanding of what a "business Model" is, are on "The Business Model Ontology" (Osterwalder, 2004), and "The Business Model: Recent Developments and Future Research" (Zott et al., 2011).

The central work of Osterwalder utilized in this thesis precedes Zott by seven years, and is also a topic in Zott's work. The Business Model Ontology (Osterwalder, 2004) makes an in-depth analysis of the theoretical understanding of a business model by examining and synthesizing previous works' definitions of the concept. "The Business Model: Recent Developments and Future Research" (Zott et al., 2011) highlights the lack of a consolidated definition among scholars and provides a semantic and conceptual discussion of the term "business model". Beyond the definitions provided in the table below a key take away from Zott (2011) is that many research projects touching on business models do not define the term in their work. Both these works list a number of definitions applied to the concept business model, some of which are highlighted in the table below.

Definition of business model	Source
Business models are a picture at a point in time	(Linder and Cantrell, 2000) in (Osterwalder, 2004)

Business models are “stories that explain how enterprises work. (…) How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?” Business models, as opposed to strategy do not include performance and competition	(Magretta, 2002) in Zott 2011
“The business model depicts “the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities” Based on the fact that transactions connect activities, the authors further evolved this definition to conceptualize a firm’s business model as “a system of interdependent activities that transcends the focal firm and spans its boundaries””	(Amit & Zott, 2001) in Zott 2011
“The method by which a firm builds and uses its resources to offer its customer better value and to make money in doing so”	(Afuah & Tucci, 2001) in Zott 2011
“The means by which a firm creates and sustains margins or growth”	(Euchner & Ganguly, 2014)
“How a company earns money, not describing the entire enterprise”	(Osterwalder 2004)
The business model is the architecture for the product, service and information flows, including the various actors and sources of revenue	Paul Timmers (Timmers 1998) in (Osterwalder 2004) and (Zott et. Al 2011)
The money earning logic of a business/ The business model is “the heuristic logic that connects technical potential with the realization of economic value”	(Osterwalder 2004) / (Chesbrough & Rosenbloom 2002)
“A business layer (acting as sort of glue) between business strategy and processes”	(Osterwalder 2004)
“Business models are a new unit of analysis that can be observed and compared, help defining measures and should therefore also improve and should therefor also improve decisions.”	Stähler (2002) in (Osterwalder 2004)
“A description of a complex business that enables the study of its structure, of the relationships among structural elements and of how it will respond to the real world”	Petrovic, Kittl et al. (2001) & Applegate (2001) in (Osterwalder 2004)
A simplification of the complex reality which helps to understand the fundamentals of a business or how a future business should look like	(Osterwalder 2004)
The commercial relationship between a business enterprise and the products and/or services it provides in the market.	Hawkins (2001) in (Osterwalder 2004)

The method of doing business by which a company can sustain itself	Rappa (2001) in (Osterwalder 2004)
Business Models "Consist of four interlocking elements, that, taken together, create and deliver value". (Value prop, profit formula, key resources and key processes)	(Johsnon, Christensen & Kagermann, 2008) in Zott 2011
"A business model articulates the logic, the data and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value"	(Casadesus-Masanell & Ricart, 2010), (Teece, 2010) in Zott 2011
"Business models (BMs) are simplified representations of the aspects—and the interactions between these aspects—that an organization considers when creating, delivering, capturing, and exchanging value"	(Khodaei & Ortt, 2019)
"The business model is conceptually placed between a firm's input resources and market outcomes, and it "embodies nothing less than the organizational and financial 'architecture' of the business"	(Teece, 2010).

Table 1

The majority of the definitions presented by Osterwalder describe a business model as a structural tool, while quite a few define it by its goal which is profit revenue>costs. While the majority of the definitions presented by Zott also refer to the business model as a structural tool, some of the definitions also put significant emphasis on the processes of the business, a perspective that is absent from the definitions presented in Osterwalder. The definitions provided by Zott also diverge from the ones presented by Osterwalder in that they focus less on the business model as a tool to reach a goal, and more on the conceptual understanding of a business model.

Both Osterwalder and Zott also attempt to narrow down the conceptual understanding of a business model through exclusion. A business model:

- Does not involve "a linear mechanism for value creation from suppliers to the firm to its customers"(Zott et al., 2011 p. 1031)
- Is not a product market strategy (Zott et al., 2011 p. 1032)
- "Cannot be reduced to issues that concern the internal organization of firms".(Zott et al., 2011 p. 1032)
- Does not aim at describing an entire enterprise(Osterwalder, 2004 p. 9)
- Does not aim at "modeling and explaining business model success"(Osterwalder, 2004 p. 9)
- Is not a strategy instrument (Osterwalder, 2004 p. 0)

In light of the purpose of this study, the research will consider a business model a tool which aims at showcasing and validating the assumptions of value creation that the business is built on. This study will not discuss in depth how the definition of business model has evolved over time, but some key points are worth noting. A focal point of this study is that in the later years a major part of the critique of the BMC and traditional approaches to business model generation have not been dynamic enough and that the over simplification of the business model drives a need for more complementary (extra) work (Türko, 2016 p. 57). Similarly Euchner and Gangulay (2014) have challenged Osterwalder and Pigneur's definition of business model through exploring business model innovation and comparing strong business models to ordinary business models. Their deliberations on competitive advantage and economic leverage are key reflections that serve as central points of discussion at the intersection of dynamic and conceptual analysis of business models. In line with the research objective of this thesis they also explore the margins of a business model, inter alia, through exploring the role of risk management in business model generation and innovation.

Understanding business model frameworks:

"Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" (2010) has since been translated to 29 languages and sold over a million copies[1]. This book provides in depth guidance on how to understand and apply the canvas as a tool for business model generation. In terms of this thesis this book provides the basis for applying the BMC and understanding the multiple levels of interpretation of the concepts presented in the canvas.

Romero, Sánchez and Villalobos present a more dynamic framework ontology for presenting a business model in their conference paper "Weaving Business Model Patterns: Understanding Business Models"(Romero, María Camila, Sanchez, Mario, Villalobos, 2016) from the 18th international conference on Enterprise Information Systems, also published in their self-published in their collection of selected papers from the conference. This paper also elaborates on how the various components that would naturally be included in a Business Model Pattern structure should be represented in terms of variables in a dynamic simulation-based model. This is the paper that has provided a point of departure for understanding the dynamics in the BMC.

Understanding business model dynamics:

Sterman, John: "Business Dynamics: Systems Thinking and Modeling for a Complex World" (2000) is one of the most comprehensive works on system dynamics and provides in depth examinations of approaches to modeling complex systems and how to conceptualize real life elements to variables such as stocks, flows and converters, as well as how to identify and quantify cause and effect relationships.

"Simulating the BMC Using System Dynamics" by Romero, Sanchez and Villalobos (2015) examines how system dynamics can enrich the understanding of the business beyond what the BMCc an convey. This article also goes into a detailed discussion on the nature of the different elements in the BMC and the rationale behind the representation of the various parts as auxiliary variables, stocks and flows.

"Business Model Robustness: A System Dynamics Approach" by Abdelkafi and Tauscher (2015) which explores how ignoring the dynamics contained in a feedback model is a prominent cause of lack of success for a business.

"Business Model Pattern Execution: A System Dynamics Application" by Romero, Sanchez and Villalobos (2017) presents business model pattern execution as a more dynamic approach to creating a business model as compared to the business model canvas. This project has utilized the business model pattern execution method as the framework for conceptualizing a dynamic simulation model of a generic business model.

"Capturing Dynamics in Business Model Frameworks" by Khodaei and Ortt (2019) argues why the static frameworks for business model generation and analysis are insufficient in creating lasting understanding of the company's performance over time, and how a dynamic framework can provide added insight and reduce time spent. It also addresses the model boundaries of the business model concept, and their main criticism of the BMC are also tied to questions of model boundaries. The authors also present a framework for assessing the completeness of a business model, meaning "internal company aspects and external environmental aspects" presented in the table below.

Criteria	Degrees in Which Criteria can be Met
1) Completeness	A. Complete in internal company variables B. Complete in external company variables C. Complete in business model variables
2) Interrelationships	A. No interrelationships distinguished B. Relationships assumed but not specified C. Relationships specified
3) Interrelationships over time	A. No interrelationships over time distinguished B. Relationships over time assumed but not specified C. Relationships over time specified
4) Framework changes	A. No framework changes specified B. Framework changes assumed but not specified C. Framework changes specified

Table 2

I am not the first and hardly the last to look at the BMC from a system dynamics perspective and the identification of appropriate system dynamics approaches to understanding the concepts contained in the BMC and the BMP takes into account the works of Romero, Sánchez and Villalobos (2011, 2015 and 2017) that relates to simulating the BMC and Business Model Patterns using system dynamics. Although this working group has laid foundations for exploring how these structures can be explored using system dynamics, this study goes further in addressing issues such as unit consistency, model cohesion and diverts from their conceptual presentation of the elements of the BMC founded on principles of system dynamics. The simulation model of Editorial de los Alpes' BMC (Romero et al., 2015) does not contain any extra variables not explicitly provided in the static Business Model Canvas, except for the flows regulating the stocks. While the model can be simulated, it does not auto-generate any behavior and it has not established the causal relationships between all the sectors. The model that forms the basis for this study differs from any of the models mentioned or showcased in the mentioned literature. The rationale behind the divergent modeling is documented in the tables below.

Table 3

Canvas Element	Key Partner	Key Resources	Key Activities	Value Proposition
Romero, Sánchez & Villalobos	Converter	Converter	Stock	Converter
This study	Converter	Stocks	Flows	Stocks
Rationale	A variable is instantaneous rather than cumulative that marks the presence of a partnership, in a similar manner to a switch.	The key resources accumulate over time as the company develops, with the acquisition of new resources and scrapping of old ones with the delays those processes entail. These do not represent an instantaneous relationship and can be identified by the snapshot test (Sterman, 2000).	The key activities are continuous processes which could be accumulated, but in this model it is not the processes in themselves that "make the business logic", but they are means to an end. Both key activities in this enterprise regulate the most central key resource, the products for sale. The validity of representing Key Activities as flows vs stocks will be elaborated in chapter 5.	The strength of the value prop vis-à-vis the customer segment is the central determinant of competitive advantage as well as the attractiveness vis-à-vis the end customer. In order to capture the state of the system it is therefor necessary to be able to examine the accumulation and depreciation of the value props. These can also be identified using the snapshot test.

Table 4

Canvas Element	Customer Relationships	Channels	Customer Segments
Romero, Sánchez & Villalobos	Stocks	Stocks	Converter
This study	Stocks	Converters	Converter
Rationale	Customer relationships in this model are represented by the amount of customers in that given relationship level.	Channels in this model are defined as existing or not existing. The effect of the channel is disaggregated, and any change in the variable is instantaneous.	A decision rule, meaning exogenous input, that has a set constant value.

Table 5

Canvas Element	Cost structures	Revenue Streams
Romero, Sánchez & Villalobos	Converters	Converters
This study	Converters + flow	Stock + flow
Rationale	The converters represent the fixed unit prices, the total costs for the different cost segments and it is all summarized in the Cost Rate flow.	The revenue streams are represented by the Revenue Rate which is a result of the Sales Rate and the Price.

The above paragraphs demonstrates academia's commitment to exploring the theoretical understanding of what a business model is. The reality is however that most entrepreneurs do not interact thoroughly with the produced research and the most widely used tool to understand and approach business models is the BMC. This study wishes to explore the sufficiency of the BMC in the process of business model generation.

Estimating Parameters:

Design as a value prop is discussed and presented in (Bansah et al., 2015). The understanding and estimation of solar panels is taken from the Bloomberg report (ResponsAbility et al., 2019), the Energy Commission's report on the energy supply and demand outlook for Ghana (Energy Commission, 2018), the role of solar panels in managing power fluctuations (Scott et al., 2014) and (Blimpo & Cosgrove-Davies, 2019). The effect, functioning and price of operating and using diesel generators have been deduced from (Quansah et al., 2017), (Braimah & Amponsah, 2012), (Oseni & Pollitt, n.d.), (Ramachandran et al., 2019), (Nyanzu & Adarkwah, 2016), (Forkuoh & Li, 2015), (Scott et al., 2014) which also gives an in depth analysis of the effects of power fluctuations on SME's in Ghana and Africa.

2.2 Business Model Generation Frameworks

This study will base it's understanding of business model generation on the BMC. Due to the lack of dynamic insight in the BMC the BMP will be used as a complementary tool to capture the necessary dynamics contained in the business model of the case company.

The Business Model Canvas:

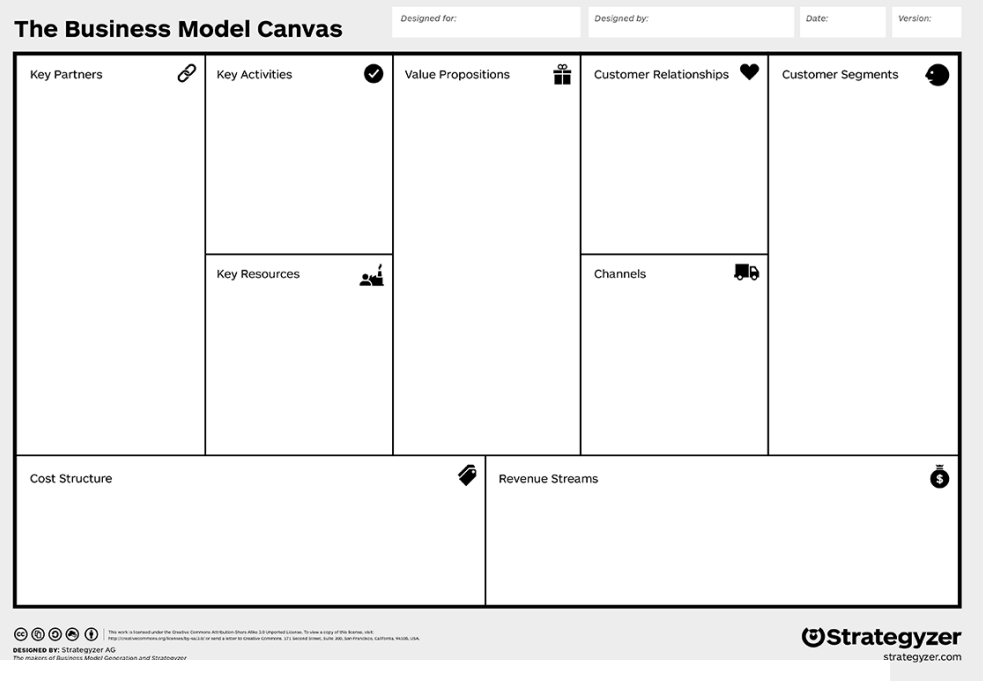


Figure 1

A BMC is a visual format meant to capture and communicate the core tenets of a business model, "the money making logic of a business"(Osterwalder, 2004 p. 7), which makes up the skeleton of the business which will be subject to pressure and influence from external (Osterwalder, 2004 p. 18). This approach to business model generation attempts to break down the business in smaller parts in order to identify what is needed in order to create value, what value should be created and who wants it, what it costs and what will be brought back to the firm typically through sales. It does not however give any indications as to the sizes of any of these components or how they are interconnected.

The nine sectors of the BMC are meant to represent the nine core building blocks of a business. The building blocks containing the resources of the company are most commonly associated with costs and are placed to the left of the canvas. The building blocks that elaborate on the generation of value are most commonly associated with revenue and are placed to the right in the canvas. This placement is intentional so as to give an indication of the relationship between the building blocks. Example: Key partners facilitate key activities or key resources which strengthens the value prop, which means the company has more to display in their chosen channels so they can improve the relationships to their customer segments and as such increase their revenue stream.

The BMC is supposed to present the most central components of the business, and should help entrepreneurs and companies to "understand the current business model and decide whether it needs to be tweaked or replaced" as a response to a changing environment (Türko, 2016 p. 57). Each of the variables in the canvas can be presented only by label or with an explanation or remark, however as this is not supposed to be a strategy document it should contain current information. In light of the research objectives of this thesis Euchner and Ganguly's critique of the BMC provides a good point of departure for dynamic analysis. "The canvas may be useful in representing a business model, but it misses the key dynamic elements of working businessmodels, it does not represent coherence (or the relationship among elements); it does not represent the competitive position (which is off the canvas); and it does not quantify the economic leverage points" (Euchner & Ganguly, 2014 p. 35). Pigneur promoted a similar critique of the BMC in 2015, claiming that the "usage itself of the model seems very basic and is limited to static analysis of one business model at a given time"(Fritscher & Pigneur, 2015 p. 86).

Although Osterwalder and Pigneur elaborate on business model archetypes in their book "Business Model Generation" (2010), there is no inherent choice of archetype or focus area in the canvas. There is for example no instruction or facilitation to expand the "Cost Streams" building blocks in the event that the

whole business is centered around minimizing costs, this type of classification of the business can be assumed excluded from the business model ontology although Osterwalder himself considers it a relevant aspect of business model generation.

The format of the BMC is intended to assist the user in identifying and placing the central components of the business model, however the rigid framework can also make it difficult to place elements that may be central to the running of the company, but do not easily fit into one of the assigned squares. Although Osterwalder himself recommend business model simulation and testing as a means of learning, one of the main critiques is how the format is a challenge to understanding the dynamics involved in the business model(Osterwalder, 2004 p. 22). This format makes it quite impossible to contextualize the business model in any significant way, for example by referring to equity/debt balance or to indicate the relative quantity or quality of the different components which makes it difficult to make a BMC the basis of a system dynamics model.

Business Model Pattern:

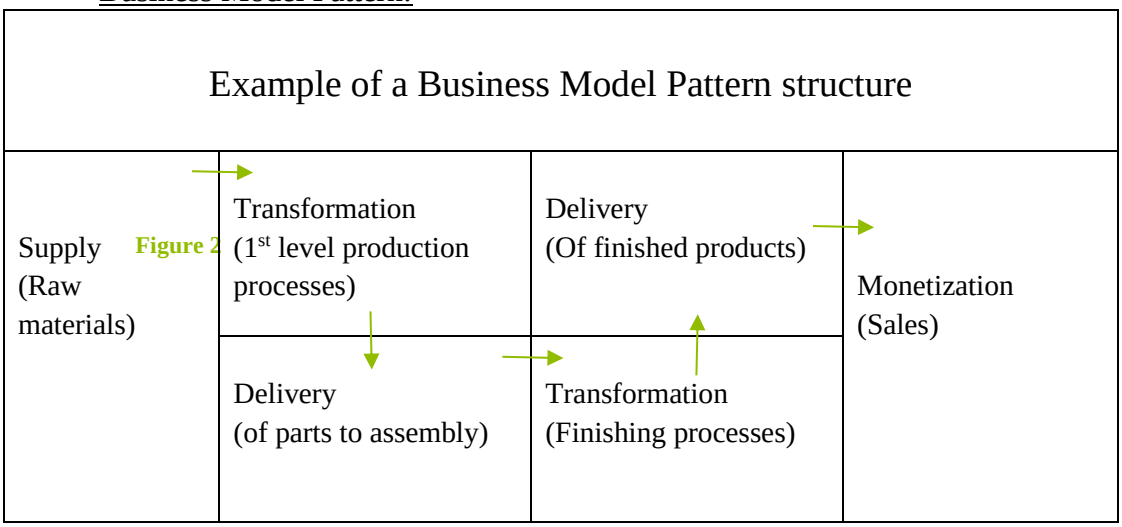


Figure 2

The Business Model Pattern approach is based in part on a critique of that the BMC put too much emphasis on the structural dimension of the business model, claiming that it can only provide a partial understanding of the business (Romero, María Camila, Sanchez, Mario, Villalobos, 2016). The Business Model Pattern approach assumes that businesses too are complex systems of interconnected variables and components that depend on feedback which influences their behavior over time, similarly to the understanding that "There are many interrelationships between the different components of the business model" (Khodaei & Ortt, 2019 p. 4). The framework of the Business Model Pattern helps understanding the behavior of the company and the added insight makes it easier to predict possible consequences of any alterations.

Unlike the BMC the BMP does not deal with elements in the structure, but with the flow of the value creation process. The method aims at breaking the business down to its core processes and place these in one out of four zones: Supply, Transformation, Delivery and Monetization. There could be more than one supply zone, and more than one delivery zone, depending on the nature of the company. In spite of having a more dynamic approach to business model generation than the Business Model Canvas, this framework does not imply any contents and as such provides merely a framework for mapping already identified components of a business, without classification.

The BMP and BMC are complementary approaches, while the BMC can help identifying elements and implies an exhaustive list of elements and as such also the boundaries for the model the BMP contextualizes the elements in the light of the value creation process.

3. Hypothesis

3.1 Case study

MILLY DRESSHOUSE Ventures Ltd

<table>
<tr>
<td rowspan="2">Key Partners:

Household Mechanics Ltd.</td>
<td>Key Activities:

Manufacturing clothes

Selling clothes</td>
<td rowspan="2">Value Prop:

Affordability

Design</td>
<td>Customer Relationships:

Aware Customer Segment

Casual Visitors

Recurrent Visitors</td>
<td rowspan="2">Customer Segments:

Women in Accra from the middle class between the age of 25 and 35</td>
</tr>
<tr>
<td>Key Resources:
Fabrics

Staff

Machines</td>
<td>Channels:

Targeted Advertisement Campaigns

Outlets</td>
</tr>
<tr>
<td colspan="2">Cost Structures:
Fabrics
Staff
Machines
Electricity
Alternative electricity
Fabric costs</td>
<td colspan="3">Revenue Streams

Sales</td>
</tr>
</table>

Figure 3

The business model generation tools below intend to present the company studied, while the documentation in the model elaborates on the process and background for quantification of the various elements in a dynamic context

This BMC should represent a generic business model for a small holder dress maker in Ghana called MILLY DRESSHOUSE Ventures. Below you can find the same business presented using the Business Model Patterns. Note that due to the format of the canvas, it is not clear that this business requires electricity in order to create value. The BMP below provides for a little more liberty in terms of defining the relevant input.

Supply:	**Transformation:**
(Fabrics + Staff + Sowing Machines) ⟶	[**Supply**] + ((Production*Electricity) + Design) = Finished Garments

Monetization:	**Delivery:**
Price * Sales - (Staff costs+ Machine maintenance costs + Machine acquisition costs + Electricity costs + Alternative energy costs + Fabric costs)	Targeted Adverts + Outlet + Potential Customers

Figure 4

3.2 Structural Assumption

With regards to research objective 1

The business model generation frameworks presented above are largely based on assumptions and do not take into consideration the dynamics provided by feedback loops in the system. The actual validity of a business model in a real and practical context depends on the *decision rules* of the company management. If the business model is invalidated by the circumstances it has to be adapted in order for the business to generate a profit in its real life environment. This means that the less comprehensive and inclusive a business model is of its environment, the more often it needs to be adapted by decisions of the company management, which is shaped by their level of information and insight about the system.

A business model presented as an open loop sequence of events is presented in the figure below.

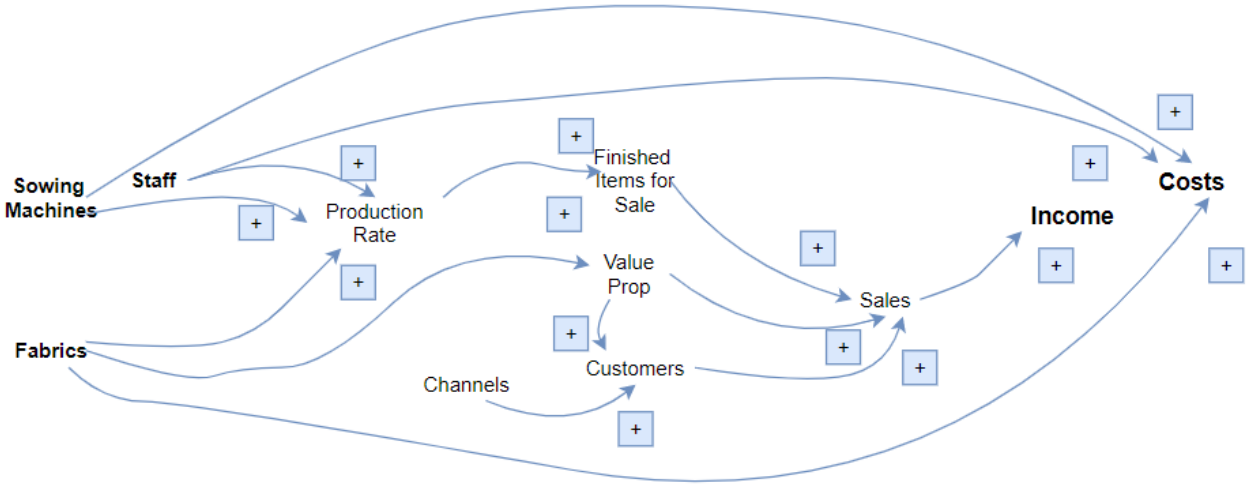


Figure 5

The input in this logical sequence is Fabrics, Sowing Machines, Staff, and customers. The first three are easier to acquire to the point where they can be considered part of the company through regular purchasing agreements etc, but the number of customers is more difficult to secure for this type of business. This means that the business logic can be secured by validating the causal chain of relationships between the factors of production, hereinafter FOP, and the income and costs. The BMC does not include profits or an equivalent concluding element, however generating profits, or being self-sustaining has been named the goal of the business model(Osterwalder, 2004 p. 15). This study thus assumes that the BMC can be dynamically represented by an open loop system, hereinafter referred to as an an OLS.

This study further assumes that should the OLS be subjected to power outages, the Production Rate would be adversely affected, and that the mitigation strategy will compensate for the effect on production. This study also hypothesises that if an OLS like this one was to be subjected to competition, that would impact the performance of the company.

Figure 7

Both the BMC and the Business Model Patterns are tools that can be used to validate the business logic of a company. While business logic is not explicitly defined in the literature it has been described as the logic required to earn a profit (Teece, 2010). One of the central assumptions of these open loop systems is that it is always possible to acquire the input needed for production, and there is no feedback from the generation of profit to the acquisition of input to production. On that basis it is safe to assume that a linear approach to business model generation is incomplete. This finding finds various sources of support in literature (Khodaei & Ortt, 2019).

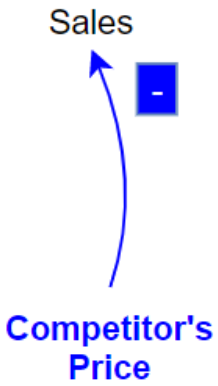
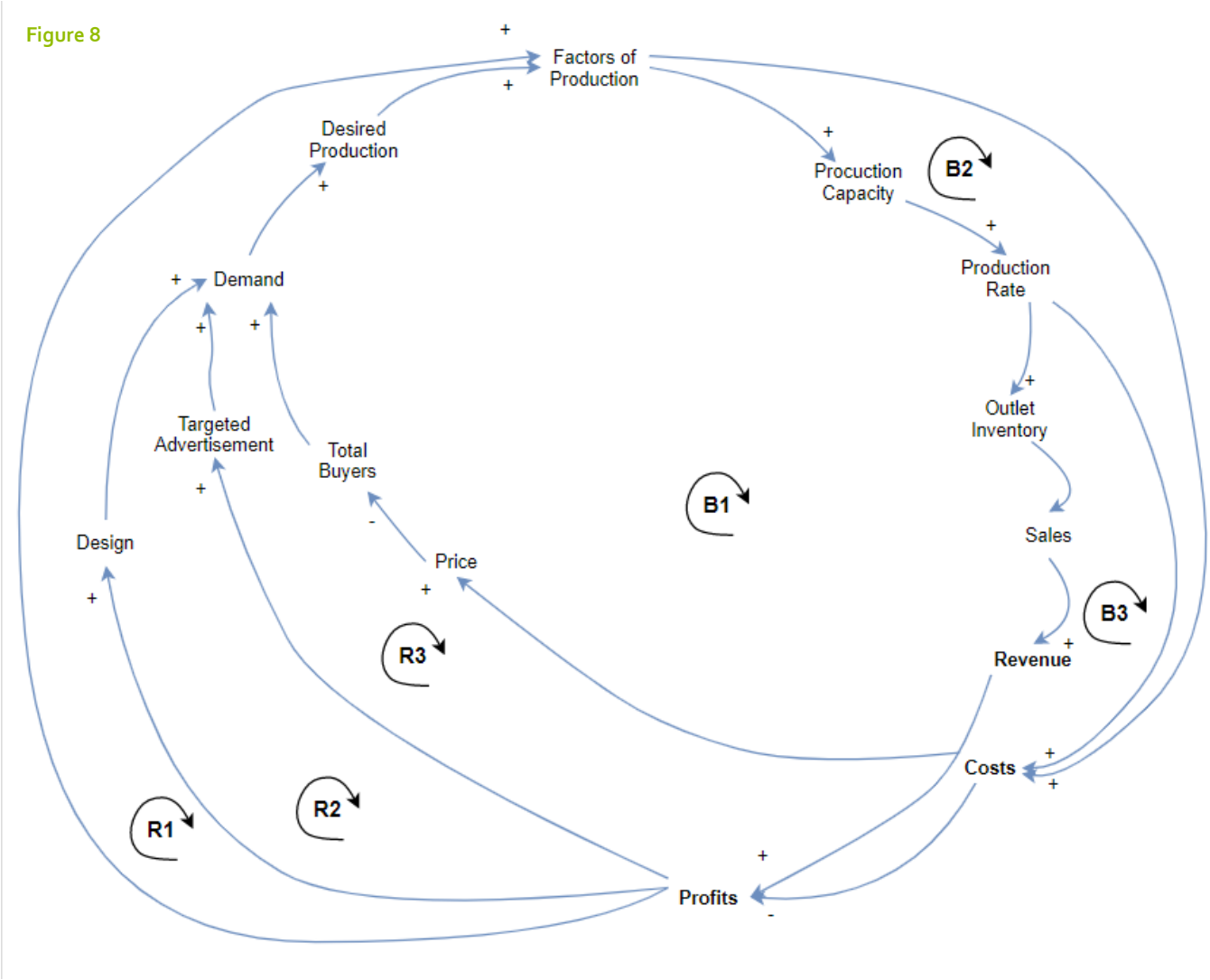


Figure 6

A selection of the definitions of a business model presented above refer to the value creation process. In order to reach income>costs the value creation process has to result in the production output being more valuable than the production input. While access to factors of production, such as raw material, staff or machinery often depends on third parties or exogenous forces, the extent to which these factors are utilized is largely up to the management of the company. The open loop approach provided by BMC and Business Model Patterns shows how f. ex 1 sowing machine, 1 seamstress and 50 m2 of fabric would be 50 finished products that could be sold, but it does not comprise enough information to assess whether or not the same company will be able to repeat this process in order to have a continuos production.

A closed loop system, hereinafter CLS, could showcase if the system could sustain productivity and the generation of profits over time. The dynamic hypothesis requires the re-negotiation of the model boundaries in order to create a business model that can generate profit over time including an assessment of non-linearities that form part of the dynamics of the system. The hypothesis builds on the assumed causal relationships deduced from the business model canvas, and the nature of these relationships are demonstrated below.

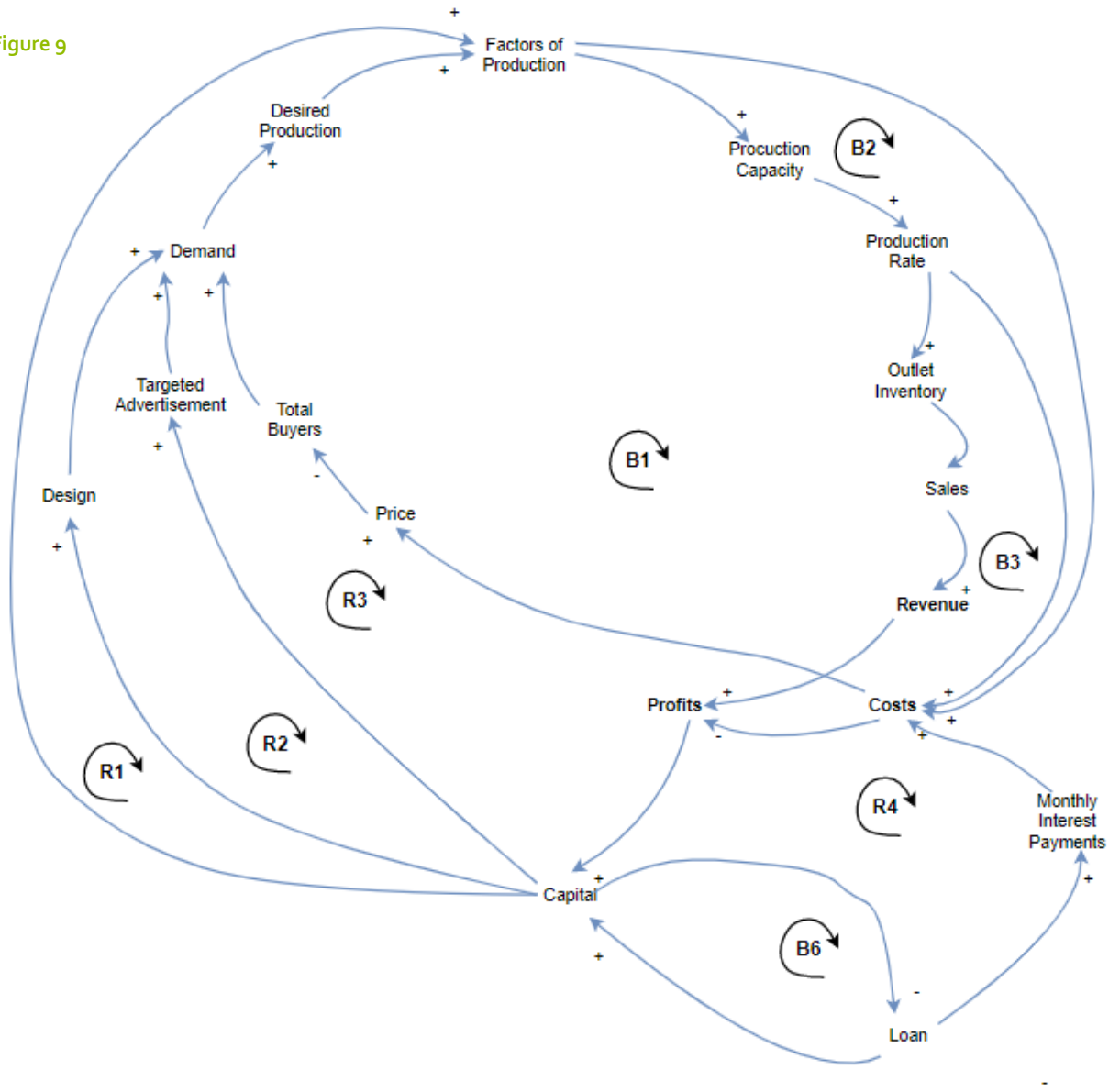
Figure 8



With regards to question 2

The dynamic hypothesis presented above builds exclusively on elements included in the BMC (except for Profits, which are only implied in the canvas) and still only represents a very limited representation of the reality. This system will continue production only as long as profits can cover the it, and has an implicit starting capital. In this system there is a risk that the profits are insufficient to continue production. Many companies face a shortage in money during the first period of their business, and a common risk mitigation strategy is taking a loan, the dynamics of that is displayed in Figure 9 below.

Figure 9



In observing that acquiring debt may activate a reinforcing debt loop (R4), it becomes necessary to ask whether excluding funding from the business model framework can give a misconstrued understanding of "business logic", and as a consequence why the source of funding should be part of business model generation.

This thesis hypothesizes that the assumptions that are legitimized in business model generation tools such as BMC or BMP might not be valid anymore when the business model is contextualized in a real life environment. The hypothesis above presents how the assumption of sufficient funds might drive the reinforcing debt loop and thus greatly undermine the company's profit-making ability. In the same way that funding is excluded from the BMC and BMP, risks are also considered an exogenous element outside the boundaries of the business model. It is also considered an element to which the business model should adapt in order to maintain its logic.

Although this is a fictitious case it is assumed to have the same growth pattern as a majority of start-ups and micro, small and medium enterprises, an s-shaped curve. Initial constraint by few customers, debt and limited investment capacity, exponential growth after a tipping point when the company starts generating a profit and shifting to exponential decay in the maturity phase(Overall & Wise, 2015).

Often risk management is tackled as a separate issue from business model generation, but you would still see evidence of risk management strategies in the business model. An example of this is how electricity is an assumed input in most businesses, but doesn't find a natural place in the BMC. The key resources section, which is where you would think to put electricity is normally used for elements that could be owned, leased or acquired through key partners. However solar cell panels or generators, which are relevant risk mitigation tools fit perfectly into the business model frameworks under key resources, in spite of risk being explicitly excluded from the business model canvas (Osterwalder, 2004) and these elements being acquired as risk mitigation strategies.

In this study two types of risk are considered, a production risk and a business risk. The production risk relates to a risk that would limit production or make sustaining production at the appropriate level much more expensive. The business risk relates to being overtaken by competitors. The specific example of production risks presented in this study is the risk of not being able to utilize all productive hours due to lack of electricity/power shortages. The business risk presented in this study relates to the price competition from a central competitor. Their dynamic impact on the system is presented in the CLD below.

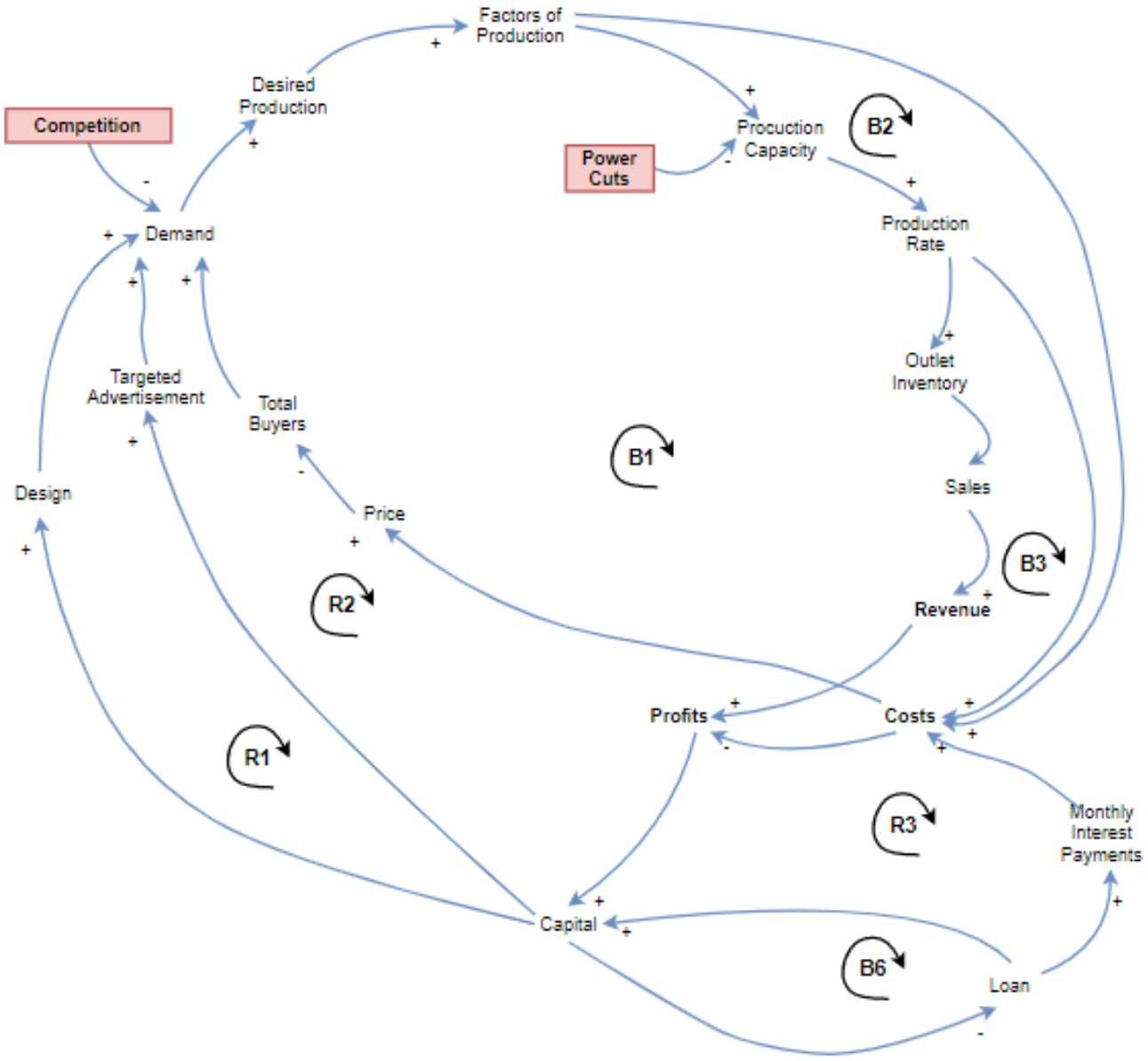


Figure 10

The dynamic hypothesis is that loops R1 and R2 are the major drivers of growth which is balanced by all the other loops presented in the CLD. The two risk elements that are presented can be of such importance that they may invalidate the assumptions that constitutes the business logic of the company altogether. According to Sterman's Business Dynamics (Sterman, 2000) subjecting a system to unstable and sensitive exogenous parameters will generate unfavorable behavior.

From system dynamics theory we know that by endogenizing such elements it is possible to have more control in generating the desired behavior. A risk inclusive business model is presented in the CLD below.

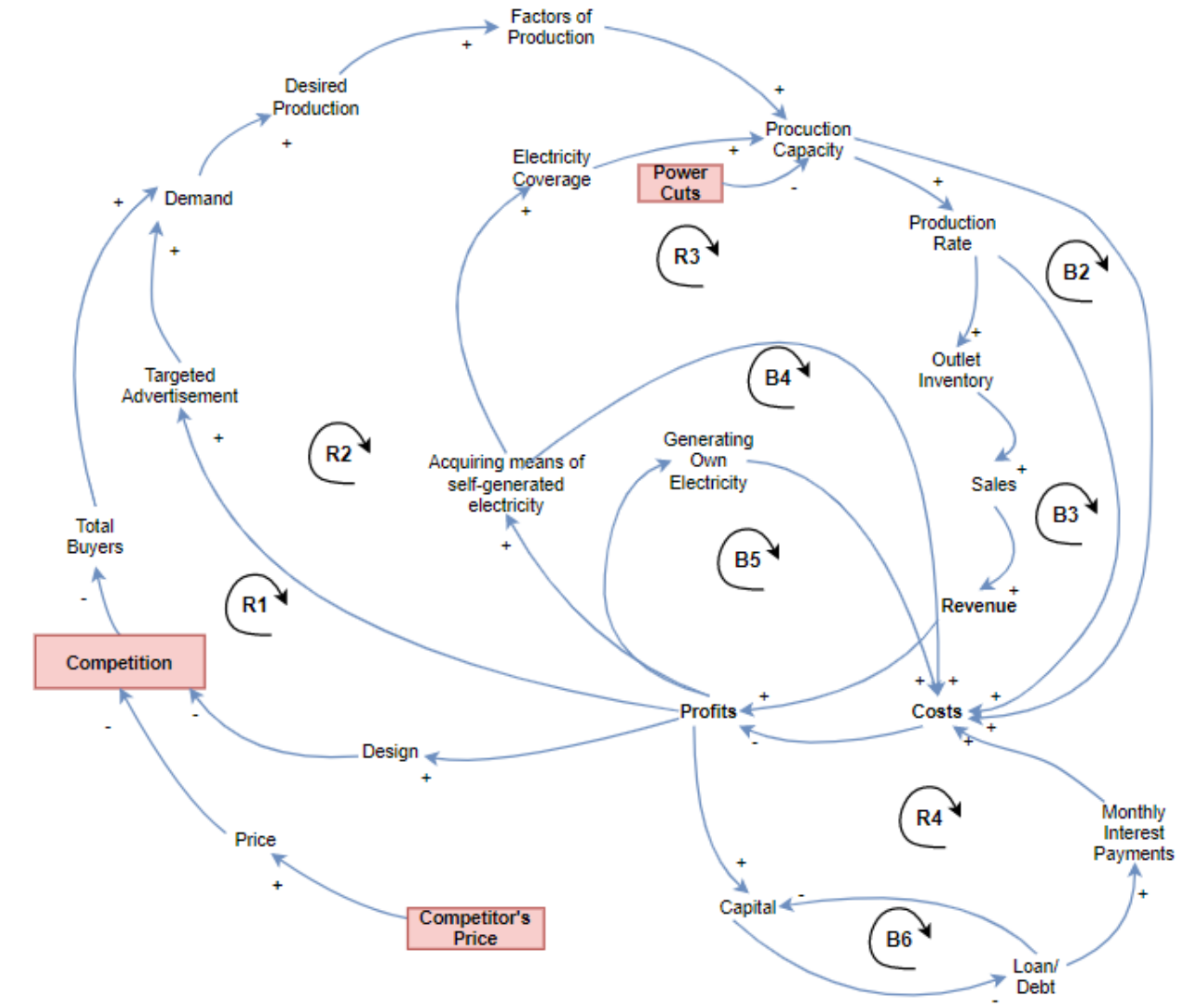


Figure 11

With regards to question 3:

Following the considerations displayed in the paragraphs above this study assumes that by using simulations to document the difference in results under the different results, it can highlight that structure drives behaviour and highlight structure that springs out of a BMC as well as the behavior that will result from such a structure.

3. Method

3.1 Understanding the BMC and the BMP from a dynamic perspective

This chapter will demonstrate the deconstruction and reconstruction of the BMC and BMP. Using a BMC to create a hypothetical or future business is a common point of departure for start-ups world-wide and this study has followed the procedure recommended by Osterwalder (Osterwalder & Pigneur, 2010) in order to identify what should be included in the Business Model Canvas. The first considerations in deconstructing a BMC through a dynamic lense are

1. Identifying the corresponding dynamic terms or language for the static concepts contained in the Business Model Canvas, f.ex does the dynamic term “sales rate” effectively capture the BMC concept of “Sales”?

2. Identifying causal relationships between the components and sectors in the Business Model Canvas. This does not only entail identifying that one component, f.ex Sowing Machines impacts another, f.ex Production, but also breaking the causal relationship down to its smallest steps, identifying the nature of the relationship and quantifying the impact of the former on the latter. Due to the fact that each conceptual causality must be represented through a causal chain that might be comprehensive, this study has not managed to provide a “simple” dynamic translation of a Business Model Canvas.

3. Deconstructing each element and relationship identified in the BMC to the necessary level of aggregation in order to maintain or achieve unit consistency

While the BMC deals with conceptual identification without “capturing unit margins, velocity and volume” (Türko, 2016 p. 57) these elements are essential to constructing a valid system dynamics model. Looking at Figures 2-4 it can be said that Fabrics + Sowing Machines + Staff = Revenue – Costs, however each of the elements on the left side of the equation carry different units (m^2, Machines, Person) which are all different from the two elements on the right side of the equation ($) and none of which are quantified which makes it impossible to estimate the unit margins. Furthermore the information provided in Figures 2-4 does not imply any time frame for the value creation chain.

The conceptual framework of the model is built on the Business Model Patterns approach meaning that the identified elements from the BMC have been reorganized under the four categories Supply, Transformation, Delivery and Monetization. The categorization of the Business Model Framework is unsuitable for a dynamic model. The process-oriented approach of the Business Model Patterns is more suitable for dynamic simulations as it has greater emphasis on capturing and highlighting the processes within the firm. This model is thus built on the contents of the BMC presented in previous chapters and the structure of the Business Model Patterns (Camila Romero et al., 2017). Although Romero et al produced a business model canvas that can be simulated it fails basic model validation tests such as unit consistency tests and model patterns tests, meaning that although it is a product built on a system dynamics foundation the model is not a valid system dynamics model. Further discussion on model validation will be presented in chapter 5.

Building on the foregoing paragraphs the system dynamics model OLS was built on the basis of Figure 4. The required level of disaggregation became clear through continuous scrutiny of unit consistency, the conceptualization of the idea of the business has happened in dialogue with the entrepreneurs at

VibrantCreator and the proprietor at Mama Lizzy Ventures. A dynamic conceptualization of the assumptions contained in the BMC promotes a discussion of how expansive does the model have to be in order to be valid and an additional calibration of model boundaries in addition to the fact that it needs to satisfy at a minimum the lowest requirements for model completeness presented in the completeness matrix showcased in table 2.

While the conceptual variables have been extracted from the BMC and the causal relationships have been extracted from Figure 5 the quantification of the variables have been estimated on a comparative basis looking at the business models of other comparable enterprises or estimated based on data. The method of creating credible assumptions correspond to what entrepreneurs use to estimate the success of a not-yet-established or early phase start-up.

4. Model Presentation

4.1 Model Purpose and Presentation

This specific model is built in order to examine the dynamic outcome generated by the structure given by the defining framework of the BMC and BMP by explicitly highlighting the complex feedback structures included in a business structure. Additionally this model is designed in order to serve as a digital laboratory for the exploration of model boundaries. In the modelling process principal consideration has been given to secure a dynamically appropriate inclusion of the structural assumptions presented in the BMC and BMP particularly considering model boundaries and key variables and the causal relationships between them. The manner in which this has been prioritized will be elaborated under the sub-chapter on model validation below.

The model consists of four sectors, building on the work on executing business model patterns (Romero, María Camila, Sanchez, Mario, Villalobos, 2016). The elements listed in the business model canvas have been placed in the corresponding sector as provided in the table below.

Sector	**BMC Element**	**SD Representation**
Supply	**Key Resources** 1. Fabric 2. Sowing Machines 3. Staff 4. *Solar Panels/Generators*	1. Fabrics Inventory 2. Sowing Machines 3. Staff in Workshop 4. *Solar Panels/ Diesel Generators*
Transformation	**Key Activities** 1. Manufacturing Clothes	1. Production Rate
Delivery	**Key Activities** 1. Sales **Customer Relationships** 2. Awareness 3. Casual Shoppers	1. Sales Rate 2. Aware Potential Visitors 3. Casual Visitors 4. Frequent Visitors

	4. Frequent Shoppers **Channels** 5. Targeted Adverts 6. Outlet **Customer Segment** 7. Women in Accra from the middle class ranging from 25 to 35 years of age **Key Resources** 8. Staff **Value Prop** 9. Affordability 10. Design	5. Advertisement Campaigns 6. N/A 7. Total Addressable Market 8. Staff in Outlet 9. VP 2 Affordability 10. VP 1 Design
Monetization	**Cost Structures** 1. Staff costs 2. Machine Maintenance Costs 3. Machine Acquisition Costs 4. Electricity Costs 5. Alternative Energy Costs 6. Fabric Costs **Revenue Streams** 7. Sales **Partners** 8. Household Mechanics Ltd.	1. Monthly Outlet Staff Costs + Monthly Ws Staff Costs 2. Monthly Machine Maintenance Costs 3. Monthly Machine Acquisition Costs 4. Electricity Costs for Productive Hours 5. Total Diesel Generator Running Costs OR Total Solar Generation Costs 6. Fabric Acquisition Costs 7. Revenue Rate 8. Partnerships for Machine Maintenance

Table 6

Table 4 highlights how the BMP complements the BMC as well as how the BMC places major emphasis on identification of the elements of the business model and less on examining the nature of these elements. The BMP outlines the value creation chain from FOP to profit balance. In the OLS this is represented as a chain rather than a loop, meaning the major feedback loops are deactivated. Furthermore the growth in consumers is based on exogenous assumptions rather than endogenous generation. This is based on the limited human ability to predict customer growth at an early stage in the business conceptualization.

The assumptions for growth in this model is based on assumptions including a 2% monthly growth in the Familiarization Rate and a 10% growth in the Entering to Buy Rate and the Returning to Buy Rate. The determinants for growth are the decision rules on how much to invest in the FOP. The numbers are based on simple assumptions tied to the choice of channels and emphasis on recruitment in the BMC, similar to how assumptions are made in the ideation phase of a start-up. The business logic is secured by the profit formulation of

$$Price = UnitProductionCosts + ProfitMargin$$

The purpose of the model has been presented in this chapter as well as in previous chapters, but in order to answer the research questions set out in chapter 1 it is necessary to be able to subject it to different scenarios. The scenarios are described below:

Normal	Baseline Run - The behavior of the system without considering exogenous risks.
Power Shortage	Reduced ability to produce due to only having access to electricity 75% of the production time
Endogenized Power Generation	Full ability to produce in spite of power shortages due to electricity generated by solar panels or diesel generators
Exogenous Competition	Competitor has a lower price which affects the assumption of growth in customers
Endogenized Competition	The price structure is based on maintaining competitive advantage

Table 7

4.2 Model Validation

The purpose for this model has been extensively described and the validation of the construction has been carried out with the purpose in mind. According to Yarman Barlas "no validity test can be carried out in the absolute sense, without reference to the specific purpose" (Barlas, 1996 p. 188). As the case in question in this thesis is hypothetical and the questions are of a theoretical rather than practical nature, the emphasis in validation will be validating the structure. In terms of validation through reference modes, this hypothetical case has no reference mode of its own, but as stated previously most start-ups exhibit an s-shaped growth curve.

In order to create a model that serves the purpose of this research, by providing meaningful insight into the conceptual understanding of a business model, it is necessary to validate that 1. The structure comprises all the key assumptions and elements in a BMC/BMP and 2. That the endogenously generated behavior stems from the structure rather than the wishful thinking input. The primary concern thus becomes validating the structure through direct structure tests and structure-oriented behavior tests (Barlas, 1996), but also testing the assumptions through behavior pattern tests (Barlas, 1996). Creating a credible simulation environment is an essential prerequisite for testing a policy.

Structure Confirmation Tests:

The structure of this model has been scrutinized on a continuous basis throughout the modeling process. The conceptual presentation of the structure was constantly scrutinized through extensive literature review on the composition and representation of BMCand business model structures and in dialogue with actors at VibrantCreator and affiliated partners. This dialogue has aided in understanding identifying and confirming the dynamic relationships between the different components of the business model canvas. The choice of how each component of the BMCshould be represented differs from the approach provided by Romero, Sánchez & Villalobos (2015) and the difference is explained in tables 1-3 provided in chapter 2.

The rationale for the input in the variables is further elaborated in the documentation, but the general source for defining the range of parameters has been literature.

Extreme Conditions Test:

Different parts of the model has been subjected to extreme conditions throughout the model building process, as well as subjecting the model as a whole to extreme conditions. This has been done by setting exogenous variables to extreme conditions to examine if the system reacts the way it should react to extreme conditions. The variables that have been manipulated to create extreme conditions are:

- Electricity Coverage Fraction: Set to 25 and 0
- Init Debt: Set to $150 000
- Total Addressable Market: Set to 20
- Interest Rate: Set to 1%, 10% and 20%

Model Pattern tests:

The model has consistently been subjected to model pattern tests in accordance with Barlas (1996), and these tests have been the main source of identifying flaws in the model that have been addressed and improved in the modeling process.

Unit consistency test:

This model has also continuously been subjected to scrutiny to dimensional consistency testing aided by the Stella Architect software.

Sensitivity test:

The purpose of this test s to determine “those parameters to which the model is highly sensitive, and asking if the real system would exhibit similar high sensitivity to the corresponding parameters” (Barlas, 1996 p. 191).The most important sensitivities in this study are those pertaining to the decision rules of the expansion of production as this study questions whether or not the open loop framework produces enough insight to generate relevant results. The sensitivity analysis reveals that the system is remarkably robust to changes within the chain of production, however the OLS stock control for the stocks of FOP, Sowing Machines, Staff in Workshop and Fabrics Inventory, are the most sensitive parameters in the model as well as being remarkably sensitive in a general sense. This is the expected behavior from this system as the OLS is powered by constant input, but the context changes in terms of market saturation etc, and the literature confirms that business models constructed in these formats require constant adjustment to the environment. The general robustness of the structure and the sensitivity to decision rules makes it a good experimental environment for understanding a business model and how often the assumptions contained therein should be re-assessed, and which elements that indicate when it is appropriate to reconsider the assumptions.

5. Analysis

With reference to the diversity in definitions provided in Table 1 it is clear that the business model is understood as a process-structure oriented tool that should be used as a framework to validate the business logic of the company. The business logic of Milly Dresshouse Ventures is showcased in Figure 3 suggests that input ((FOP) / Production) * Sales * Price = Revenue>Costs. The system dynamics model shows whether and when this assumption holds true and under which conditions. Although the BMC and BMP frameworks do not present profits as an integral part of the business model generation framework it is established as a primary goal of the business and a reason why more research into tools for business model generation is required (Sterman, 2000 p. 3). For the entirety of this study the Profit Performance is used as a primary indicator of the state of a company.

5.1 Results

Baseline run and production risks:

The initial acquisition of FOP as well as initial costs tied to Outlet Staff and Rent means that while costs start running from before the business is open, the revenues start from 0, as can be seen in all the runs presented in Figure 12. By looking at the baseline run called normal we can start to understand why the system behaves with initial growth, slower growth and finally extreme negative growth. The initial profit development is negative for the first two quarters the company is operational due to Cost Rate>Revenue Rate as shown in Figure 14. The demand produces an s-shaped curve where the last growth phase of exponential decay is the dominant feature. Because the constant OL Familiarization Assumption is multiplied by what is initially the entire customer segment in the Unaware

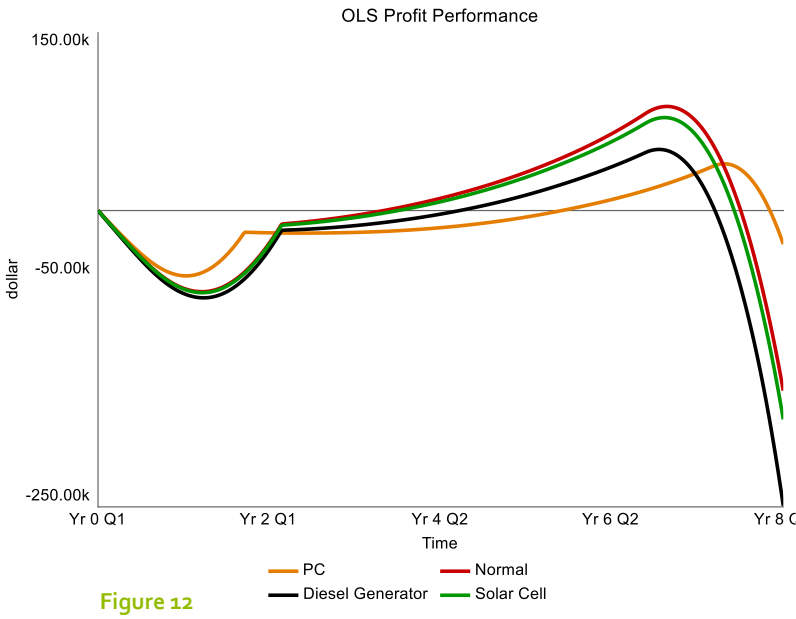


Figure 12

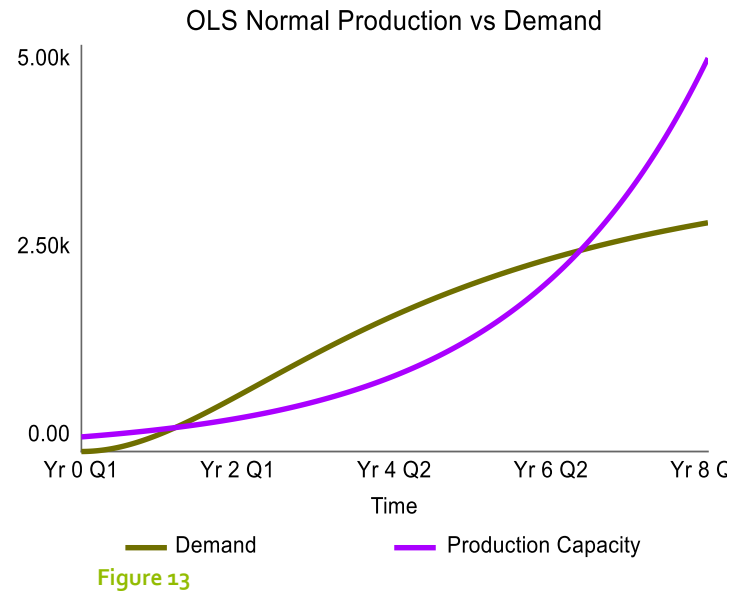


Figure 13

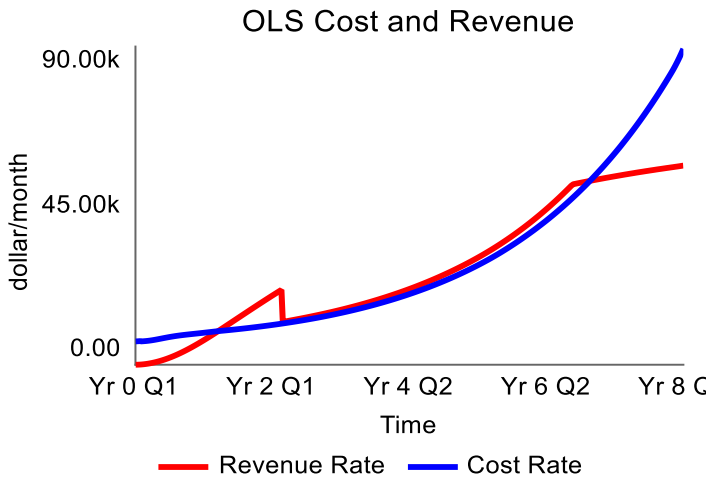


Figure 14

People in the Customer Segment stock. Demand exceeds Production Capacity at Yr_1Q_2 as can be seen in Figure 13, and this is what causes the points of inflection at Yr_2Q_2 in time in Figures 12

and 14. While Demand increased the Revenue Rate showed a sharp drop and the Profit Performance went from strong positive growth to moderate positive growth, because the Sales Rate was lower than the Demand due to a lack of manufactured products to sell. Although the profit generation grew slower after Yr_2Q_2 it was still positive. The difference between the Revenue Rate and the Cost Rate increases from Yr_2Q_2 to Yr_6Q_2 meaning that the not only is the profit accumulating every month, but the amount that it accumulates every month is also increasing. The gap between the Demand and the Production Capacity is also closing at Yr_6Q_2 meaning the company is able to have Sales Rate = Demand. However the FOP drives the level of production and because it is based on a constand OLS Growth Assumption to produce regardless of demand, which will drive the costs up while there is no new generation of customers.

The system generates more stable profits when it is subjected to power cuts. In this scenario the initial negative profit growth is weaker than in all other scenarios while also lasting for a shorter amount of time. The positive profit growth starts earlier and lasts longer. This is because when the production capacity is decreased due to power shortages Demand>Production Capacity for a longer amount of time as compared to in the baseline run, and because all the manufactured products are sold the price formulation secures that Revenue Rate>Cost Rate. The positive profit development caused by the modest profit margins and the low level of items produced leads to the point of breaking even occurring only at Yr_5Q_3. This run also ultimately ends in extreme negative profit development as shown in Figure 12, however the point of inflection is postponed from Yr_6Q_2 to Yr_7Q_3. It is worth noting that in this specific instance the lower production which leads to the company operating far below capacity with unused production resources that generate cost, but not revenue still produces growth for longer than in the baseline run.

For the scenarios where the risk is addressed by a risk mitigation strategy such as the acquisition and utilization of solar cell panels or diesel generators the profit follows the same pattern of the baseline run in terms of points of inflection and direction of growth. Figure 12 demonstrates a significant difference between the two mitigation strategies where the use of solar cells generates a profit almost the same as the baseline run, while the use of diesel generators generates lower profits has stronger initial negative growth, both initially and at Yr_6Q_2.

Baseline run and competition risks:

The exposure to competition risks seem to have a more significant impact on the profit performance of the company than the exposure to power shortages. This implies that as long as the produced items are sold, the cost-based price formulation will succeed in generating a positive profit development. In the case of competition however, recruitment of customer is lower and the system consequently has a lower sales rate as demonstrated in Figures 16 and 17 below.

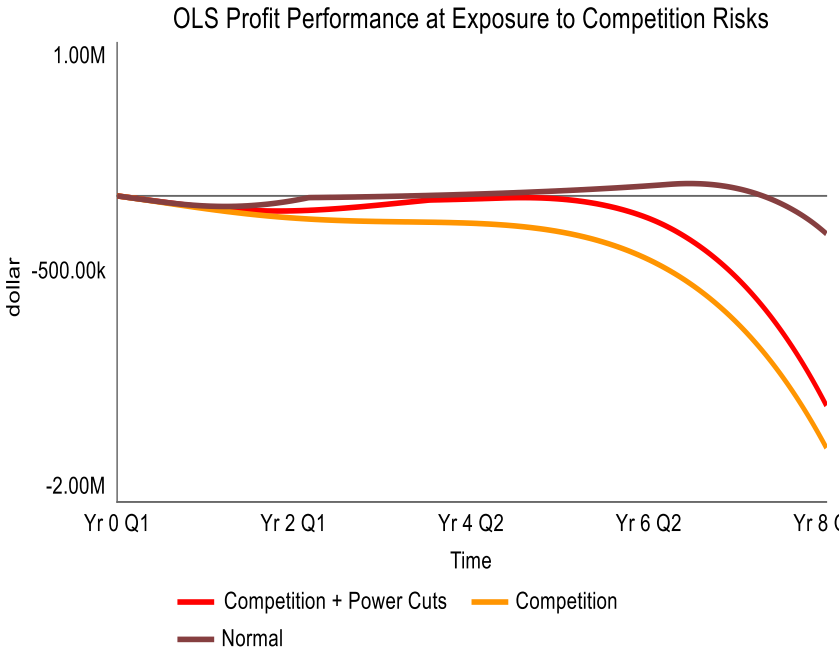


Figure 15

In Figures 16 & 17 below the Revenue Rate for the baseline run can be divided into 3 phases, one lasting from Time 0 to Yr_2Q_1 where the company satisfies the demand, and phase nr 2 from Yr_2Q_1 to Yr_6Q_1 where the company does not manage to meet the demand and

subsequently misses revenue, to phase 3 which lasts from Yr_6Q_1 where the sales again satisfies the demand and the revenue is as follows.

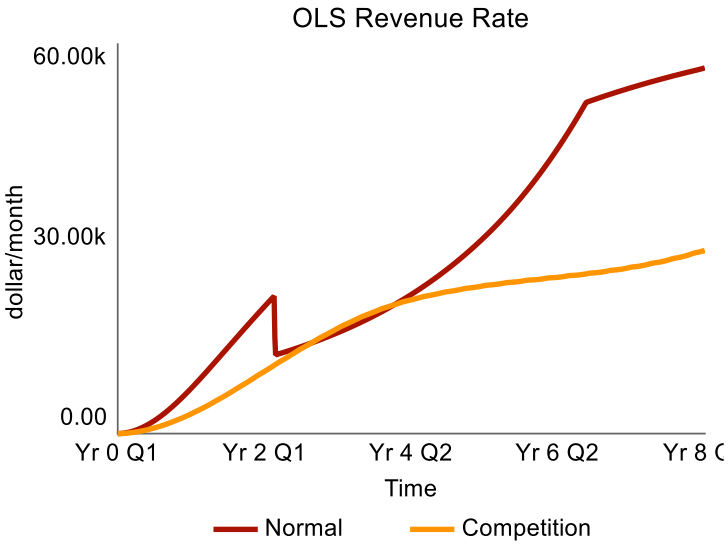


Figure 17

The phases above are also visible in the profit performance graph in Figure 15 above. Phase 1 shows normal development in profits as costs are initially higher than revenue, phase 2 with missed revenue shows slow but sustained growth and phase 3 in which demand is met, but production is excessive profits decline. Not only does the sustained profit deficit that follows as a consequence from phase 2 generates lower income, but it also generates higher costs because it accumulates more debt that generates interest which needs to be paid monthly as can be seen in figure 18 below.

When exposed to competition risks the system cannot generate enough customers to generate the same Sales Rate or Revenue Rate as in the baseline run, except for at a very limited period of time where the baseline run has the worst performance with respect to making the Sales Rate = Demand due to shortage in production. Shortly put, the best performance of the system when subjected to external competitions is just slightly better than the worst performance of the system in its baseline run.

Not only do the interests that ought to be paid compound, they also make out a higher percentage of the total costs incumbent on the company as presented in Figure 19 below.

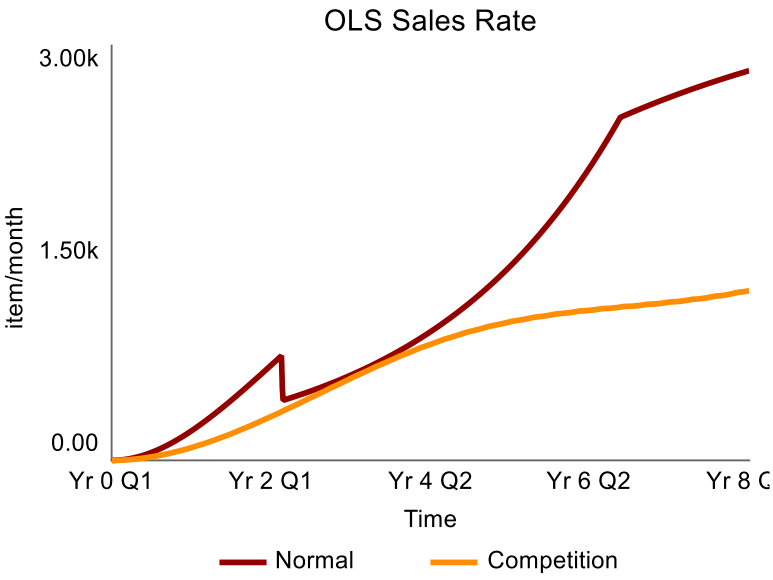


Figure 16

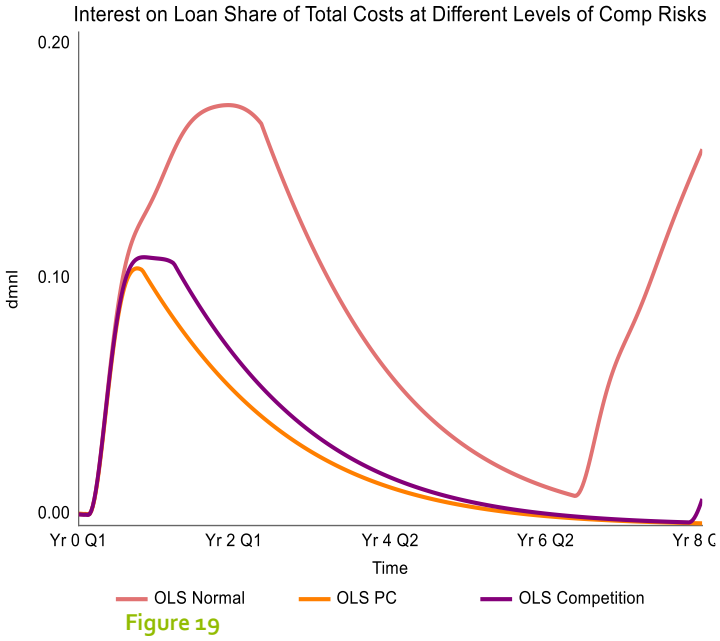


Figure 19

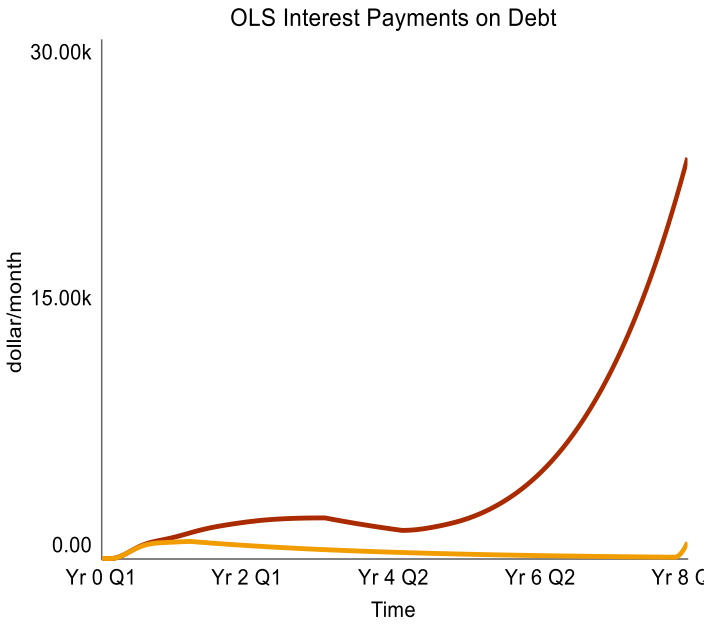


Figure 18

5.2 Findings

BMC and BMP are complementary frameworks that, together, help create an understanding of the structure-process framework of a business. It showcases the creation of value from the different elements provided by the BMC through a flow of processes structured by the BMP.

The BMC ontology being static presents the business logic of a company as a time-independent concept, but through applying a dynamic analysis it becomes evident that it is quite useless to talk about business logic without taking into account the time frame of value creation. If business logic is referred to as the generation of profit, which it most often is[2], no start-ups have business logic because every business starts with some level of upfront costs before generating revenue, this does not mean that none of these business have business model with valid business logic that can be demonstrated *over time.* If business logic is referred to as the validation of the sequential logic of value creation without prejudice to the monetization aspect, it is irrelevant to think about business logic as a time-independent concept because the value creation process takes time, and the time that it takes is a not-insignificant indicator for how valuable the finished product is. In all cases the business operates over time and the same business logic can make sense at one point in time, but not in another.

Using a static framework for a concept that is expected to interact with a constantly changing environment requires paying constant attention to and overview of the structure and its sensitivities. Even a solid business model relies on appropriate and changing inputs to production. The dynamic OLS can be used to experiment with which inputs create the optimal outcome at different points in time, the BMC however would have to be complimented by several other tools to gain the same insight. The BMC provides the channels through which the customers are recruited, which types of relationships exist with the customer base and who the customers are, but it does not detail the recruitment of customers as an activity of the company and for that reason the recruitment rate is given as an exogenous parameter.

[2] Osterwalder himself also referred to business logic as « an abstract comprehension of the way a company makes money, in other words, what it offers, to whom it offers this and how it can accomplish this.»(Osterwalder, 2004)

The fact that the system presents a longer sustained period of positive growth in the profits when it operates below capacity raises serious questions to the logic of the structure. There are several serious concerns to the validity of the model should the OLS structure on its own be considered a complete system dynamics model. Among these concerns are the fact that no price can make the customer recruitment flows go negative, that there is no network effect and that the amount invested in advertisement does not impact how many people are recruited.

While real life operating companies have natural feedback processes through historical data, companies that are not yet operational do not have that as a point of departure to envision the future. The OLS is reliant on exogenous input, and because the structure does not include feedback we must assume that the decision rules that regulate growth in production come, not from feedback from the system, but the assumptions about the initial customer segment. Because the customer segment is a qualitative rather than a quantitative element of the BMC there are few implications to growth in this variable. It could be argued however that narrowly defining the customer segment and the value prop such as f.ex selling luxurious yacht holidays to the upper middle class would imply a limitation to growth as the market is so clearly finite, but this would be nothing more than an indication of a limit to growth, not an actual tangible limit. The OLS also has Items Purchased Per Customer set as an exogenous parameter which sets obvious limits to growth, however reading from the BMC of the case study in question the company does not classify Items Purchased Per Customer as a defining aspect of its customer relationships, which means that this aspect does not form part of the business model of Milly Dresshouse Ventures.

Reading from the previous paragraph it can be argued that the exogenous input that powers the OLS is based on little information and a synthetization of the Value Props and the Channels. The sensitivities in the regulation of the FOP stocks imply that the inputs have to be calibrated often and with precision in order to generate the optimal outcome, and even small miscalculations and mis-calibrated input might activate a debt spiral that skews the whole order of the business. Although financial projections do not form a part of the intended areas of use of the BMC, the sensitivities of these assumptions show the weakness of presenting a business model as an OLS because it is the OLS that gives rise to these sensitivities.

While a solid cost-based price formulation adds robustness to the model and to some extent offsets the sensitivities generated by the OLS. However it cannot alone generate the desired result when the production costs for unsold items exceed the profits generated by the items sold which they do in phase 3 of all OLS simulations.

6. Policy Proposals

While the OLS is a simulation of how a proposed business would operate, with constant input, and as such not a realistic representation of the performance of a business, it can still serve as a learning tool for negotiating the model boundaries of a business model. This relates both to closing the loop of the business model and to negotiating the inclusion of elements of risk. In the CLS runs all variables, except for the endogenizations listed below, have remained at the same value and causal relationships have maintained the same direction.

6.1 Closing the Loop and Endogenizing Customer Recruitment

Throughout the previous chapter this thesis has attempted to establish why the OLS is an appropriate dynamic interpretation of a business model as defined through the BMC and BMP approaches. This sub-chapter will argument for why the CLS is a better way of understanding a business model, and back this up

by showcasing how and the CLS generates the desired behavior while it provides insight into how decisions could effectively be made under the relevant conditions. Departing from the thought of an OLS and closing the loop to create a CLS is done on the basis of closing the major feedback loops as outlined in Figures 8 to 11.

	OLS Assumptions	**CLS Endogenization**
Regulation of Workshop Staff	OLS WS Staff Desired Expansion - Exogenous assumption based on wishful thinking	Desired Hiring Rate* Fraction of Desired Expansion Covered By Liquid Funds
Regulation of Fabrics Inventory	OLS FI Desired Expansion – Exogenous assumption based on wishful thinking	Desired Fabric Expansion * Fraction of Desired Expansion Covered by Liquid Funds
Regulation of Sowing Machines	OLS SM Desired Expansion – Exogenous assumption based on wishful thinking	Desired Machine Acquisition Rate * Fraction of Desired Expansion Covered by Liquid Funds
Estimation of Demand	OLS Purchase Per Customer (1) * Average Monthly Customer Visits	Average Monthly Customer Visits * **f**(Affordability)
Familiarization Rate	Unaware People in Customer Segment * OLS Familiarization Assumption (0.2)	Unaware People in Customer Segment * **f**(Investment in Targeted Advertisement)
Entering to Buy Rate	Aware Potential Visitors * OLS Recruitment Assumption	**Conditional on First Recruitment Fraction:** [Aware Potential Visitors * First Recruitment Fraction] OR {Casual Visitors * First Recruitment Fraction]
Returning to Buy Rate	Casual Visitors * OLS Recruitment Assumption	**Conditional on Customer Retention Fraction:** [Casual Visitors/AT * Customer Retention Fraction] OR [Frequent Visitors / AT * Customer Retention Fraction]

Table 8

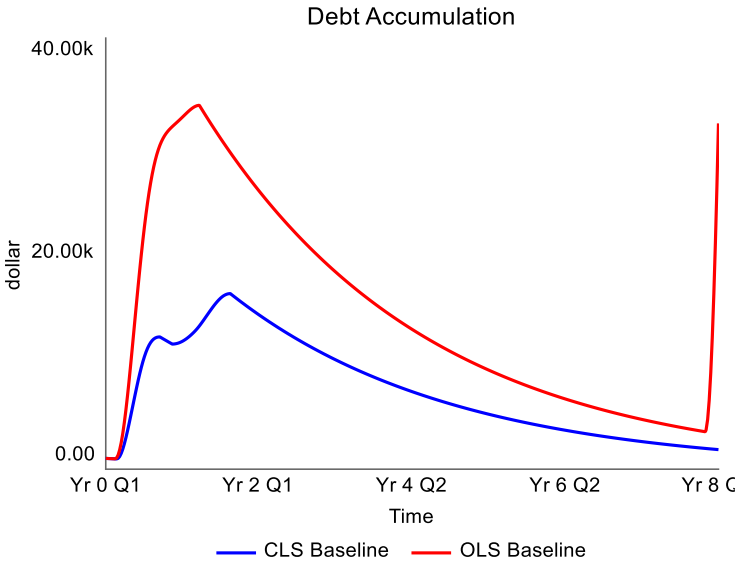


Figure 22

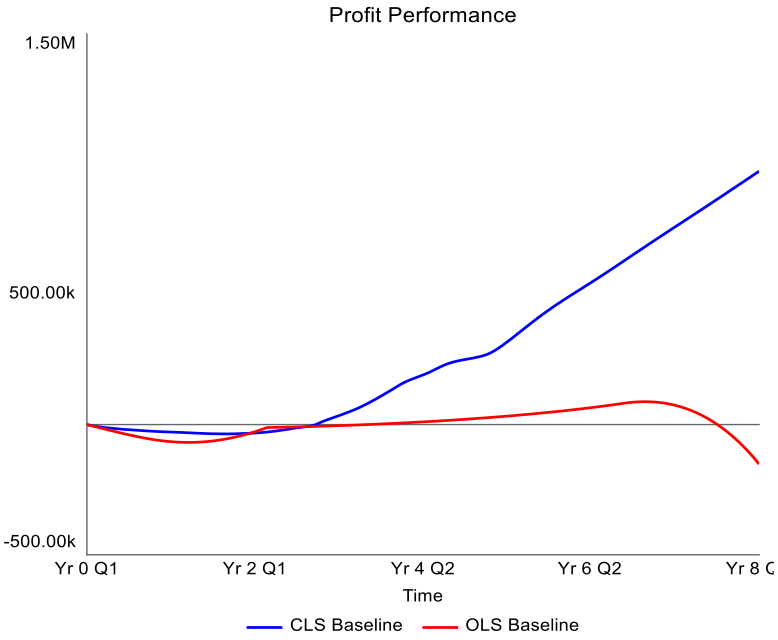


Figure 21

Although real life operative businesses have data and experience that forms the basis for current decision-making, early stage companies do not have this. Their assumptions about growth are based on limited information. Miscalculated and misunderstood assumptions about the growth and profitability of a company that is just entering the operative phase of its journey might make bad estimations of their potential earnings and as an consequence may be accumulating unexpected debt and/ or lost earnings. The effect of the averse economic performance at an early stage may significantly decrease the company's chances of surviving the start-up phase. The system's sensitivity to assumptions about growth indicates that constructing a business model needs to contain a time element and the validation could carry be seen in a cyclical perspective. The CLS sets the available funding as a condition for growth, and in that way the business logic is secured as a coherent continuous concept rather than unrelated reproductions of the same system, which might be logical sometimes, but not others. This is done by way of connecting profits and available funds to the investment in new FOP as shown in Figure 8.

The major differences between the CLS and OLS is that the CLS is controlled by major reinforcing loops that run from the available funding to the FOP, and that the generation of customers is a result of endogenous dynamics rather than exogenous input. Although the OLS starts generating a profit earlier than the CLS the CLS breaks even earlier because it has a stronger positive profit development then the OLS and a weaker negative growth. Furthermore the CLS manages to produce sustained positive profit generation in every simulation in this study as shown in Figure 24.

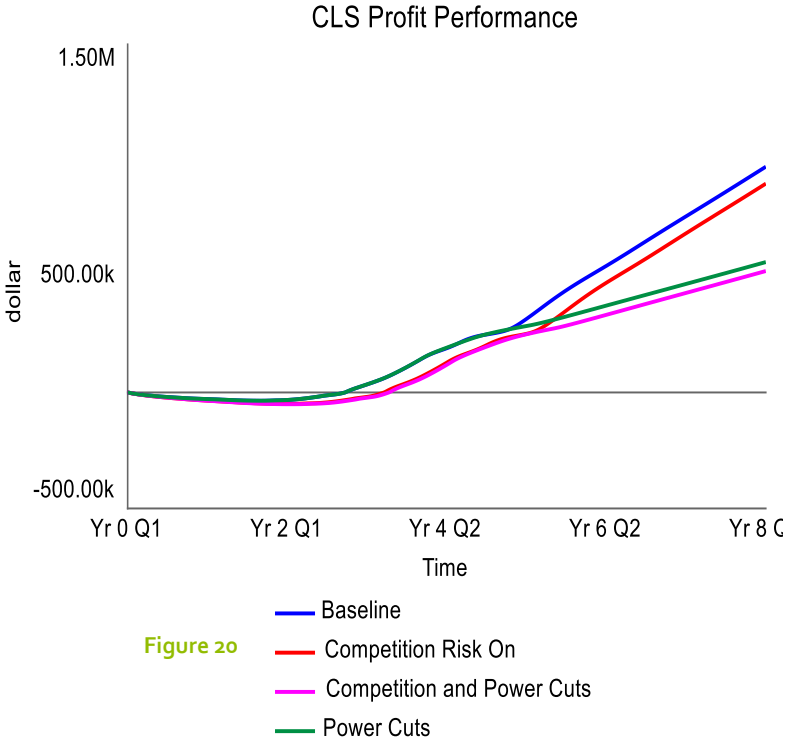


Figure 20

In addition to endogenizing the various recruitment rates and the Items Purchased per Customer the CLS accumulates notably less debt

than the OLS because it bases its expansion on the existence of sufficient funds instead of incurring debt as a consequence of expanding the production. The points of inflection Debt to the Bank is caused by the Liquid Cash stock fluctuating around 0, and the final point of inflection at time Yr_1Q_4 is caused by sustained positive growth in Liquid Cash.

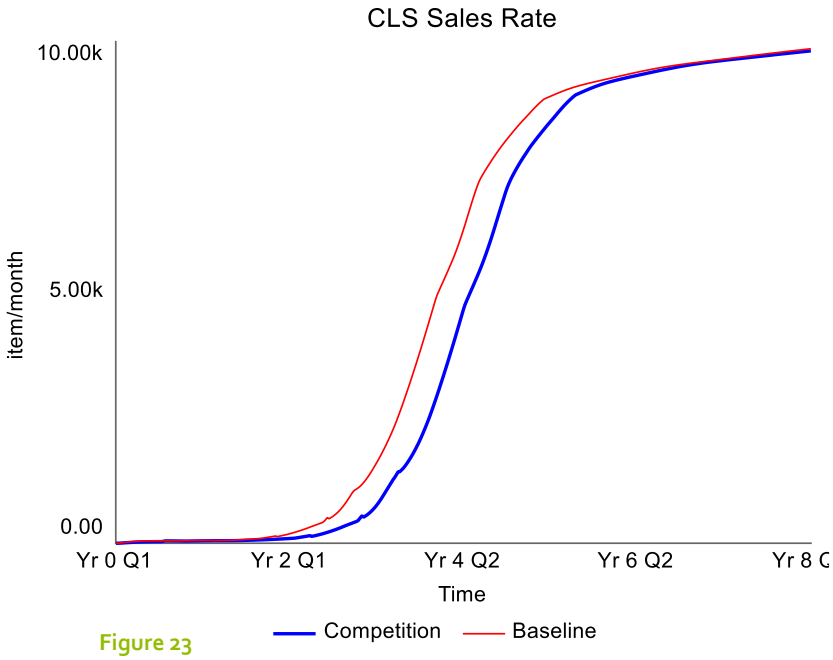


Figure 23

The inclusion of the network effect and auto-generated customer recruitment allows for learning about trade-offs in risk management. While the OLS was more sensitive to the competition risks the CLS is more sensitive to the production risks. The effect of competition can be seen as more significant in the period of rapid growth, and at low levels of sale, while the network effect ensures that the competition risks have an almost insignificant impact at high levels of sales. The effect that can be observed for different values of Competitor's Price is a delay in the Sales Rate, but ending up at the same attractor.

The initial Max Production Capacity is given by the Fabrics Inventory, and subsequently by the Staff in Workshop while the Machine Based Production Capacity doesn't become the limiting factor until Yr_4Q_2.

6.2 Endogenizing Risks

We are already familiar with the effect of risks in the OLS, and the previous chapter gives a brief overview of the effect of risks in the CLS. This thesis has already described how risk management strategies such as the owning or acquisition of a generator often finds their way into the BMC in spite of the explicit intention for the BMC to exclude risk factors.

Production Risks:

The presentation of risk management strategies such as diesel generators in the BMC could not be considered as a part of value creation without also considering how the exposure to risk can negatively impact profit generation. A generator does not add value to a company that already gets the electricity it needs off the grid, but this thesis hypothesizes that it can add value to a company that is impacted by power cuts by providing alternative electricity in order to keep the utilization of resources to a max depending on the cost of acquisition and operation. The same goes for other sources of alternative energy such as solar cell panels. The risk mitigation strategy does not remove or impact the occurrence of power shortages, but it mitigates the effect of these shortages and that is what is meant by endogenization of risk in this thesis. The model has been simulated with the inclusion of unmitigated power cuts and with the two mitigation strategies solar cell and diesel generator. The results are showcased in Figures 24 & 25.

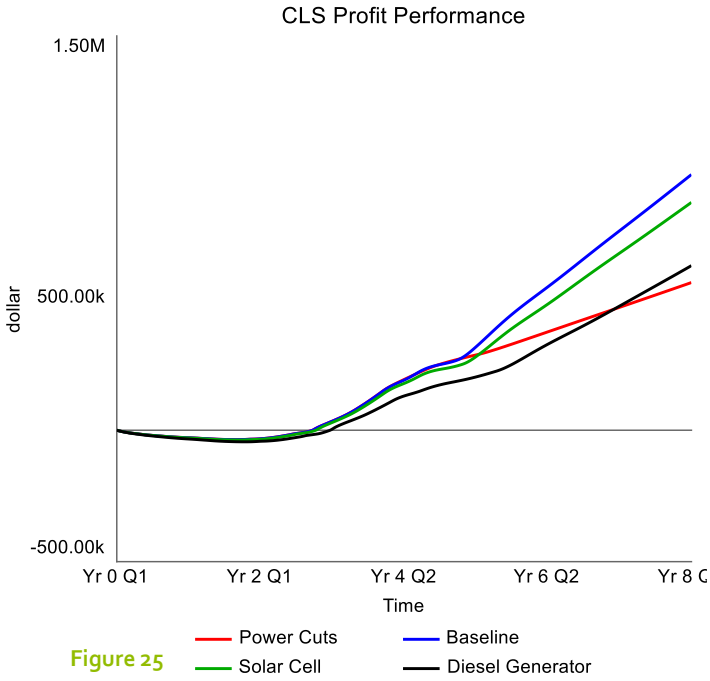


Figure 25

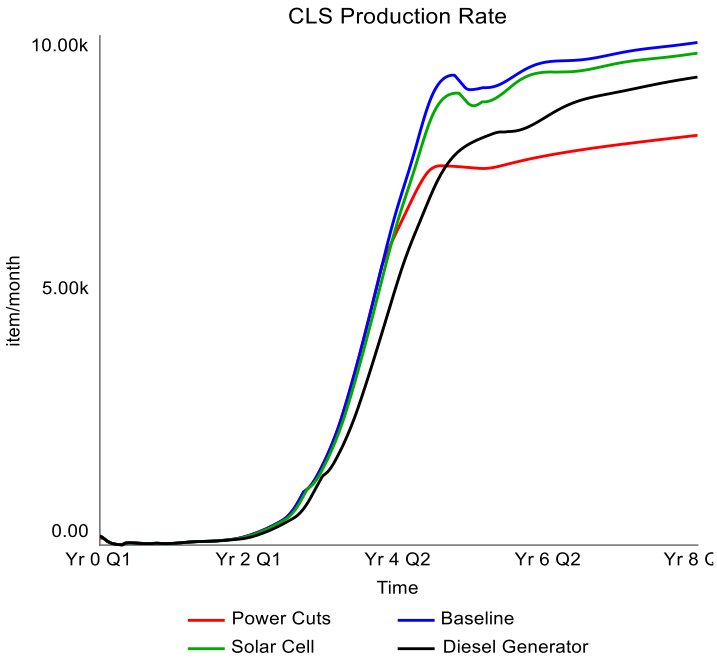


Figure 24

From this we can see that the mitigation strategies eventually generate better performance than a non-mitigated system subjected to power cuts, but the performance however never attains the levels of a system that was never exposed to risk in the first place. This demonstrates that auto-generated electricity forms part of the value creation process and thus has a role in business model generation. It also becomes evident that the choice of risk management strategy can be a relevant part of a business model because the cost level affects the price in a cost-based price formulation. Based on trends in real life power generation markets the use of diesel generators might be subject to consumer and state sanctions in the upcoming years, in addition to getting more expensive and subject to more restrictions in terms of operation and disposal while solar cell is projected to decline in price and improve in availability.

Business Risks:

While competition in general is portrayed as an external pressure to the business model, the BMC is designed to maintain its' competitive advantage through its revenue streams and cost structures. The model is thus supposed to be reactive to the competitive environment in which it exists, but there is no space for intersection of risk analysis in the business model framework. The system is highly sensitive to the exposure to competition and the same structure that produces a very satisfactory baseline run can generate a much less

satisfactory run when exposed to one level of competition and completely succumb at another level of competition. Although the structure in itself is sufficient to generate a profit, the lack of consideration of the competitive environment in which it exists gives a false impression of the profit potential of the company. However negotiating the scope of the business model to also include, or endogenize competition through changing the price mechanism secures a better result. By making the product price a set fraction of the competitor's price the company gains competitive advantage. The competition of low pricing also has the added advantage of emphasizing the value prop of affordability which generates an increase in Purchase per Customer meaning that the effect of the lower price is exacerbated. The endogenization of competition not only compensates for the delay of the point of breaking even when the system is subjected to competition, but even generates better profits than in the baseline run. In a scenario where the competitor's price is $23 the business logic of the company is completely invalidated once the system is subjected to the competition, however the endogenization of competition not only re-establishes the business logic of the company, but performs even better than in the baseline run.

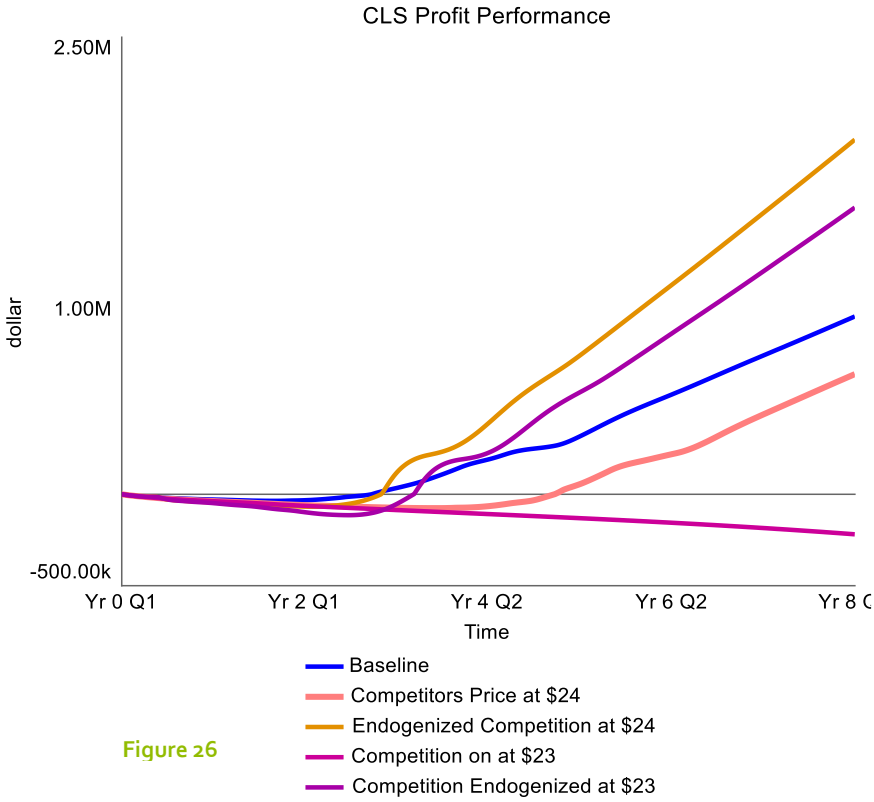


Figure 26

The early accumulation of customers due to competitive advantage, albeit at a low price, generates a deficit that exceeds the one of the baseline run, but it in turn activates the network effect and as the production costs per unit falls it generates a higher profit which enables the expansion of production. The initial deficit is off-set by a sustained and solid growth in profit generation.

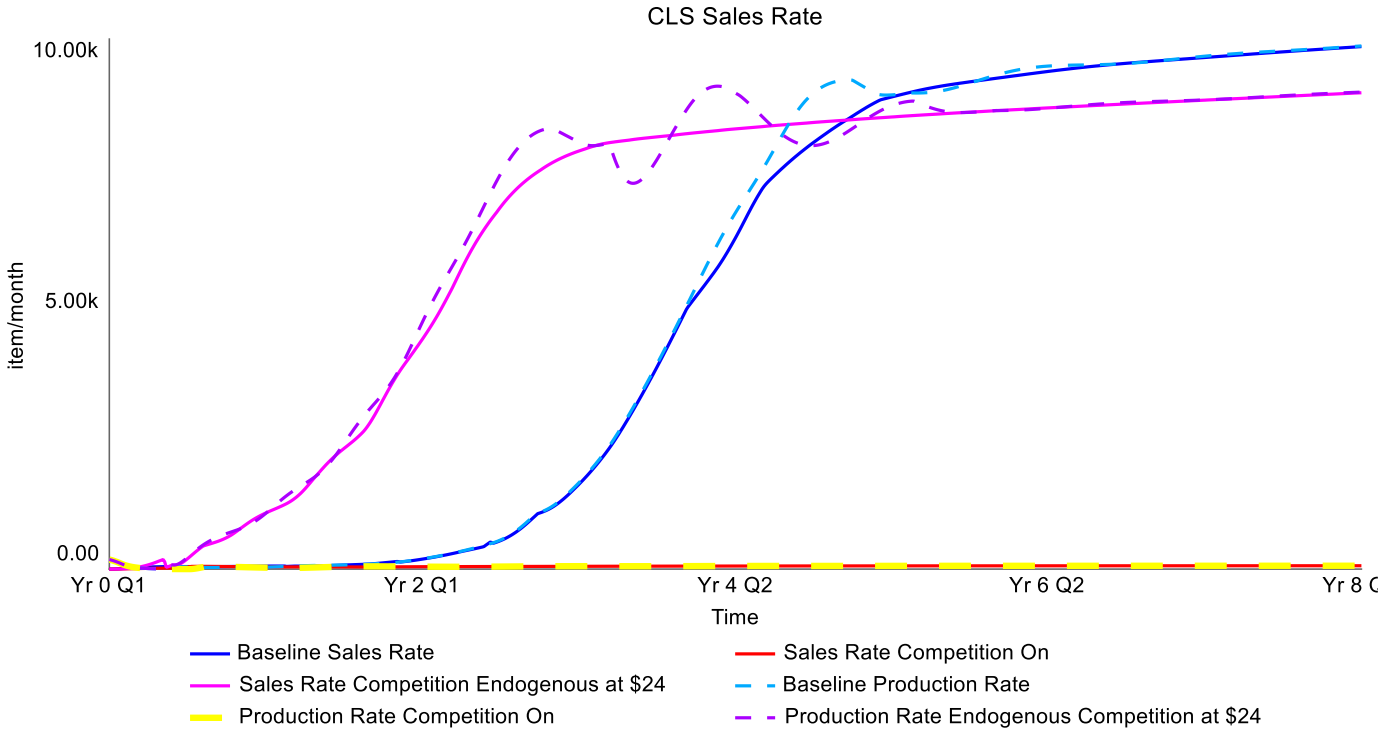


Figure 27

7. Discussion and concluding remarks

With respect to research objective 1:

In order to conclude or whether or not the frameworks presented in this study are sufficient to determine whether or not a company has valid business logic it is necessary to look at the defining characteristics of the frameworks that were identified through the dynamic deconstruction of the business model concept.

While the nine sectors of the BMC indicate some level of causal relationships through an implicitly understood value creation chain, they are all presented as objects which can fit more than one element within it, but the use of nouns for indicating place in a value creation chain is not conducive to process oriented thinking. While the four sectors of the BMP approach are much more conducive to imagining an actual value creation chain, the approach does not provide the same level of guidance as to how to identify relevant elements and which elements are relevant. While this allows for an intuitive analysis of which elements constitute a complete value chain, similar to a system dynamics approach, BMP unlike system dynamics does not contain instructions relating to unit consistency or other validation rules.

The BMC piecemeal approach to model construction that is focused only on identification of a category of elements frames how the different conceptual elements that are identified are captured on paper in the BMC. While the lack of weight given to dynamics is an obvious and common critique of the BMC, another perhaps more relevant critique, is that the piecemeal approach is more conducive to create nine clusters of elements present in your business rather than an actual coherent structure. It is especially difficult to use the BMC or the BMP each separately or both together in order to validate the business logic of a new, not yet operational company because of the issues of validation described in the paragraph above. While they can imagine a value creation chain there is little emphasis on tools or techniques to make sure that the value creation chain is even complete.

On the note of assessing completeness we have to re-visit the business model completeness matrix that was presented in Chapter 2.1 in this study.

Criteria	**How complete is the BMC according to Khodae and Ortt** (Khodaei & Ortt, 2019)	**Completeness of the BMP**
Completeness	Not complete in internal company variables or external company variables	Not complete in internal company variables or external company variables
Interrelationships	No interrelationships distinguished	Relationships specified
Interrelationships over time	No interrelationships over time distinguished	Relationships over time assumed, but not specified
Framework changes	No framework changes specified	Framework changes assumed, but not specified

Table 9

In my own analysis I would conclude that the BMC scores better than the BMP on the first criteria which relates to identification of elements because it is more targeted towards that. The BMP however has a

wider scope which could be condusive to examining all relevant elements. For the following three criteria the BMP scores higher than the BMC because of its emphasis on dynamics and process flows as well as increased flexibility in terms of considering elements such as time.

The lack of consideration of time is a major impediment to validating the business logic of a company. As has been demonstrated in every simulation of this model, the initial months of a company's operative stage, the costs will be higher than the revenue. If the business model should only validate whether or not the company can make money today, the concept is obsolete for new businesses. If it is irrespective of time the a business could in theory produce a deficit for the first 10 years and the business logic could still be valid.

In short the frameworks presented are good for identifying and understanding central elements of a company it does not present any tests or validations for that these central elements together, without the inclusion of other actors or elements, can create value. The fact that elements and activities in a business model *can* produce a profit does not mean that it *will*.

With respect to research objective 2:

The crucial flaw of the BMC and the BMP approach is the open loop structure. The OLS generates growth based on input based on assumptions which could be good or bad. It generates a repetitive chain of flows which should generate value without consideration to the former or the subsequent iteration of the production. This leads to the an ability for the production to be maintained or expanded regardless of whether or not the company can afford it.

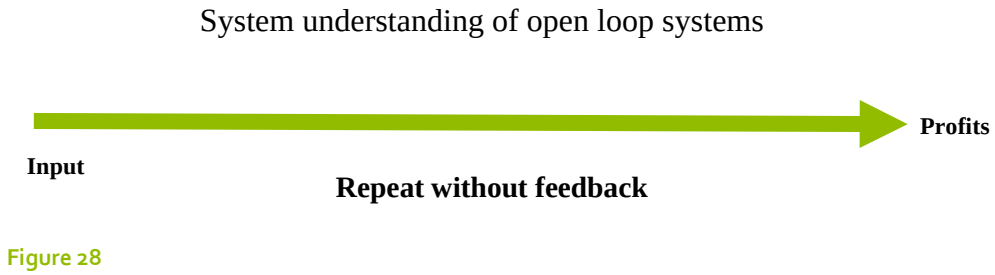


Figure 28

The lack of consideration of the element of time was briefly covered in the discussion of research objective 1, but it is closely ties to the question of whether or not the business should be seen as a series of independent productions or as one consistent chain of value creation. If the business model is the framework for every single production sequence, then the money making logic needs to hold true for every production sequence. In that case the first sequences would not be validated and the whole business model could in theory be disregarded as invalid. However if the business is considered a closed loop system, a consistent chain of value creation, it would suffice that the business would generate and maintain profit at some point in the value creation chain. Could that point be after 10 years of generating a deficit however? That is not for this study to conclude, but it merely points out the need for every business model to be contextualized in order to be validated.

System understanding of closed loop systems

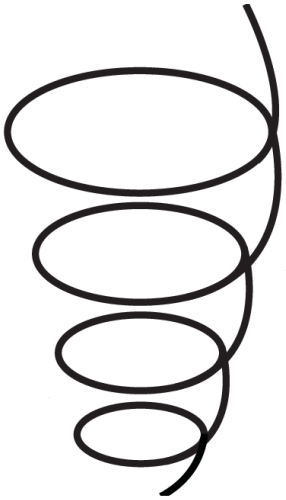


Figure 29

A Closed Loop System

Value Creating Chain with learning

The point of contextualization is central to this study. The danger of using simplified frameworks for designing systems that gain complexitiy and that interact with a complex world is that the products of the frameworks may hold a level of abstraction that makes it inappropriate for use in the real world. A company could have business logic in the abstract, like the CLS baseline simulation, but the business logic is completely invalidated by an exogenous parameter such as a competitor's price being set to $23. While the business logic may be present, it may only be valid under the circumstances of the hypothetical experiment in which it was created. In this study it became evident that the exposure to competition could invalidate business logic that was validated in isolation, which implies that the scope of the business model generation should be expanded to always address risk. An even stronger argument is the fact that the simulation that endogenized the competition exhibited a behavior that was superior to the baseline run. The findings from subjecting the CLS to power cuts and the two mitigation strategies also demonstrate good reasons for including risk and risk management in business model generation. The simulation of power cuts show that no mitigation strategy is necessary until the stock of sowing machines becomes the limiting factor which is Yr_4Q_2, and why a diesel generator might not be relevant as a mitigation strategy in general.

The rigid set-up of the BMC format imposes limitations on contextualization and the scope of the business model. Increased flexibility or opportunities for adding complexity would take the BMC with the BMP from a framework that could potentially validate a theoretical business logic to a framework that could develop a practical system for creating value.

Without prejudice to the fact that a BMC should normally be complemented by strategy documents and a financial model, examining the BMC in light of Osterwalder's own objectives gives an indication as to the desired effect of the BMC. His motivation for promoting the studies on business models includes establishing a better foundation for creating more robust business models that can withstand and adapt to a market with higher volatility. Therefor the business logic of the company must be considered not only profits that could *theoretically* be realized, but which may actually be *practically* realizable. Osterwalder further promotes simulations and testings of the business model in order to understand the performance of the structure, however the incompleteness of the BMC makes it close to impossible to use this as a point of departure for exploring the model through simulations. The BMP approach establishes a more holistic

understanding of the value creation elements, and the process oriented approach makes it easier to consider elements like time, recruitment of customers and strengthening the value prop(s).

While the author also understands that the BMC should be offered as part of a larger strategic package of documents, it is relevant to also consider the critiques presented earlier in this study which i.a shed light on the perspective that the over simplification of the BMC creates extra work (Türko, 2016).

The creation of extra work is a counter intuitive effect of the simplification of the business model structure. Through applying a system dynamics approach layers of complexity could be added as the entrepreneur would be famliarized with business model generation.

With respect to research objective 3:

In line with the rest of the study we must also consider the system dynamics approach to business model generation through the completeness matrix presented earlier.

Criteria	Degrees in Which Criteria is met in this system dynamics model
Completeness	Complete in business model variables
Interrelationships	Relationships specified
Interrelationships over time	Relationships over time specified
Framework changes	Framework changes specified

Table 10

The system dynamics approach to business model generation scores high on all aspects of completeness as presented by Khodaei and Ortt (2019). Of the entire modelling process the system dynamics modelling process adds two central perspectives of value to how we should approach business models. It fills the gaps or the shortcomings of the BMC that were presented by Türko(2016).

1. System dynamics modelling forces you to constantly pay attention to unit consistency in the value creation process. When turning raw material whether tangible or intangible into a product or a service that should deliver a specific value to the end user, you have to question what the necessary steps are in order to convert fabrics, manpower or machines into dresses and how dresses could be converted into money. This will bring attention and certainty to inclusion of critical elements. In this process it also becomes very evident how central the concept of time is in a process-oriented understanding of value creation. It forces you to establish not only the causal relationships, but the nature and content of such relationships.
2. A system dynamics model makes it easy to test and simulate what kind of behavior the designed structure generates. Furthermore it can be used to explore how robust the structure is by subjecting it to various scenarios, and test potential policies in various scenarios which can help in decision-making. Because it is possible to simulate and test various scenarios and conditions at the same time the business model could be made more robust and sustainable through experimentation.
3. When using system dynamics to construct a CLS business model based on information from a BMC/BMP the negotiation of what should be endogenous and exogenously generated behavior adds insight into defining the model boundaries of the concept of a business model. The focus of the model is defined by the purpose, namely validating the business logic of the company. This requires looking at not only which channels are utilized to establish and maintain contact with

customers, but also how these channels are utilized. It also helps prioritize where emphasis should be made. While complicated to learn and manage properly, system dynamics seems to have the ability to be a tool which can be used to develop a coherent model which includes both strategy, business model and business plan.

Appendix I. Documentation

Top-Level Model:

Aware_Potential_Customers(t) = Aware_Potential_Customers(t - dt) + (Familiarization_Rate - Entering_to_buy_Rate) * dt

INIT Aware_Potential_Customers = IF EQ_switch=1 THEN 0 ELSE 50

UNITS: people

DOCUMENT: Number of individuals in the customer segment who are aware of the existence of the business and its products, but who have not purchased anything

Casual_Shopper(t) = Casual_Shopper(t - dt) + (Entering_to_buy_Rate - Returning_to_buy_Rate) * dt

INIT Casual_Shopper = 0

UNITS: people

DOCUMENT: Number of individuals in customer segment who have bought goods from the company, but who remain a casual relationship with the company

Debt_to_the_bank(t) = Debt_to_the_bank(t - dt) + (Lending_rate) * dt

INIT Debt_to_the_bank = 1000

UNITS: dollar

DOCUMENT: The amount of money owed to the bank

Fabrics_Inventory(t) = Fabrics_Inventory(t - dt) + (Fabrics_Acquisition_Rate - Fabrics_Consumption_Rate) * dt

INIT Fabrics_Inventory = 27

UNITS: m^2

DOCUMENT: Fabrics inventory is the production raw material available to produce the sales items

Frequent_Shopper(t) = Frequent_Shopper(t - dt) + (Returning_to_buy_Rate) * dt

INIT Frequent_Shopper = IF EQ_switch=1 THEN 70 ELSE 0

UNITS: people

DOCUMENT: The number of individuals who have established a good relationship with the company who choose to return to this company to do their shopping.

Liquid_Capital(t) = Liquid_Capital(t - dt) + (Change_in_Funds) * dt

INIT Liquid_Capital = INIT(Private_Equity)+INIT(Debt_to_the_bank)+INIT(Profits)

UNITS: dollar

DOCUMENT: The monetary capital available to the company

Outlet_Inventory(t) = Outlet_Inventory(t - dt) + (Production_Rate - Sales_Rate) * dt

INIT Outlet_Inventory = Desired_Outlet_Inventory+0*20

UNITS: item

DOCUMENT: Number of items produced, that are available for sale, but are not yet sold

Price(t) = Price(t - dt) + (Change_in_Price) * dt

INIT Price = Total_Costs_per_Item_Produced*INIT(Desired_Profit_per_Item)

UNITS: dollar/item

DOCUMENT: Price per item

Private_Equity(t) = Private_Equity(t - dt) + (- Investment_rate) * dt

INIT Private_Equity = 2000

UNITS: dollar

DOCUMENT: Private equity, private investments

Profits(t) = Profits(t - dt) + (Revenue_rate - Cost_Rate) * dt

INIT Profits = 0

UNITS: dollar

DOCUMENT: Current profits of the company

Solar_Cell_Panels(t) = Solar_Cell_Panels(t - dt) + (Change_in_Panels) * dt

INIT Solar_Cell_Panels = 0

UNITS: Panels

Sowing_Machines(t) = Sowing_Machines(t - dt) + ("Machines_Acquisition._Rate" - Machines_Discard_Rate) * dt

INIT Sowing_Machines = 1

UNITS: machine

DOCUMENT: Number of sowing machines available

Staff_in_Outlet(t) = Staff_in_Outlet(t - dt) + (Change_in_Outlet_Staff) * dt

INIT Staff_in_Outlet = 265/176

UNITS: people

DOCUMENT: Number of persons working in the outlet

Staff_In_Workshop(t) = Staff_In_Workshop(t - dt) + (Hiring_Rate - Attrition_Rate) * dt

INIT Staff_In_Workshop = 1

UNITS: people

DOCUMENT: The number of people working in the workshop sowing and producing items for sale at any given time.

Unaware_People_in_Customer_Segment(t) = Unaware_People_in_Customer_Segment(t - dt) + (- Familiarization_Rate) * dt

INIT Unaware_People_in_Customer_Segment = Customer_Segment_1

UNITS: people

DOCUMENT: Initialized by all the customers in the customer segment

VP_1_Design_1(t) = VP_1_Design_1(t - dt) + (- Change_in_Strength_of_Value_Prop) * dt

INIT VP_1_Design_1 = Initial_VP_Design_1

UNITS: dmnl

DOCUMENT: This stock indicates the strength of the design as a value prop that aims to recruit and convince customer segment 1

"Machines_Acquisition._Rate" = IF Available_Funding_by_Coverage_Ratio>1 AND Desired_Machine_Acquisition_Rate>0 THEN MAX(Sowing_Machines/Sowing_Machine_Lifetime, Desired_Machine_Acquisition_Rate)*Available_Funding_by_Coverage_Ratio ELSE Desired_Machine_Acquisition_Rate

UNITS: machine/month

DOCUMENT: The rate at which new sowing machines are being acquired in order to maintain or expand production.

Attrition_Rate = Staff_In_Workshop/Normal_Working_Time

UNITS: person/month

DOCUMENT: The rate at which people quit working at the company

Change_in_Funds = (((Profits-HISTORY(Profits, TIME-1))+Investment+New_Loan)/Time_correction)

UNITS: dollar/month

DOCUMENT: Net change in the captial available to the company

Change_in_Outlet_Staff = (Desired_Staff-Staff_in_Outlet)/AT_staff_outlet+(Staff_in_Outlet/Normal_Working_Time)

UNITS: persons/month

DOCUMENT: change in number of persons working in the outlet store

Change_in_Panels = "Solar_Cell_ON/OFF"*(Desired_Panels-Solar_Cell_Panels)/Solar_Panels_Adjustment_Time-(Solar_Cell_Panels/Lifetime)

UNITS: Panels/Months

Change_in_Price = (Desired_Price-Price)/Price_AT

UNITS: dollar/item/Months

DOCUMENT: Net change in price

Change_in_Strength_of_Value_Prop = ((VP_1_Design_1*Outdating_per_month)-Updating_VP_1_Design)

UNITS: dmnl/month

DOCUMENT: This flow indicates the net change in the strength of the value prop. Consisting mainly of outdating and updating

Cost_Rate = Costs_Related_to_Production+Costs_not_related_to_production

UNITS: dollar/month

DOCUMENT: The costs of the business per month

Entering_to_buy_Rate = IF First_Recruitment_Fraction<0 AND Casual_Shopper>0 THEN Casual_Shopper*First_Recruitment_Fraction ELSE (Aware_Potential_Customers*First_Recruitment_Fraction)/Recruitment_AT

UNITS: person/month

DOCUMENT: Income level and age are the biggest factors (see litt list).

Fabrics_Acquisition_Rate = MAX(0, Necessary_Fabric_Acquisition)

UNITS: m^2/month

Fabrics_Consumption_Rate = Total_Fabrics_Used_for_Production_Per_Month+(Total_Fabrics_Used_for_Production_Per_Month*Fraction_Wasted_Material)

UNITS: m^2/month

Familiarization_Rate = ((Advertisement_Effect_on_Awareness*Unaware_People_in_Customer_Segment))*Total_visitors_effect_on_recruitment*(1-EQ_switch)

UNITS: person/month

DOCUMENT: Familiarity with name or location is a level of relationship with the customer segment where the potential customers have knowledge of a business, but have not yet frequented this business. Knowledge of an enterprise or its products is a required prerequisite in order to buy their products.

Hiring_Rate = IF Available_Funding_by_Coverage_Ratio>0 AND Available_Funding_by_Coverage_Ratio<1 THEN MAX(0, (Additional_Sowing_Personell_Needed-Staff_In_Workshop)/WP_adjustment_time)+(Staff_In_Workshop/Normal_Working_Time)*Available_Funding_by_Coverage_Ratio ELSE (Staff_In_Workshop/Normal_Working_Time)+((Additional_Sowing_Personell_Needed-Staff_In_Workshop)/WP_adjustment_time)

UNITS: person/month

DOCUMENT: The rate of new people being hired

Investment_rate = 0

UNITS: dollar/month

DOCUMENT: New investments into the company

Lending_rate = (IF Liquid_Capital<0 THEN -Liquid_Capital/Loan_AT ELSE -Debt_to_the_bank/Time_to_pay_back_loan)

UNITS: dollar/month

DOCUMENT: The net change in the loan from the bank

Machines_Discard_Rate = Sowing_Machines/Sowing_Machine_Lifetime

UNITS: machine/month

DOCUMENT: The rate at which sowing machines are being discarded because they are worn out.

Production_Rate = MAX(0, Production_Capacity) {UNIFLOW}

UNITS: item/month

DOCUMENT: The number of items produced per month

Returning_to_buy_Rate = IF Customer_to_Staff_Ratio_Effect_on_Return_Decision>0 THEN
(Casual_Shopper/Recruitment_AT)*Customer_to_Staff_Ratio_Effect_on_Return_Decision ELSE
(Frequent_Shopper/Recruitment_AT)*Customer_to_Staff_Ratio_Effect_on_Return_Decision

UNITS: person/month

DOCUMENT: Number of customers changing their relationship with the company from Casual, to Frequent and vice versa.

Revenue_rate = MAX(0, Sales_Rate*Price)

UNITS: dollar/month

DOCUMENT: The company's income stream, amount of money earned per month

Who pays, what do they pay for and how often

Sales_Rate = IF Outlet_Inventory/DT>Indicated_Sales_Rate THEN Indicated_Sales_Rate ELSE Outlet_Inventory/DT

UNITS: item/month

DOCUMENT: The number of items sold per month

Acquisition_Cost_of_Expansion_of_Sowing_Machines = Desired_Machine_Acquisition_Rate*Acquisition_costs_per_machine

UNITS: dollar/months

Acquisition_costs_per_machine = 100

UNITS: dollar/machine

DOCUMENT: Costs per machine

Additional_Sowing_Personell_Needed = (Desired_Sowing_working_hours/"Working_Hours_per_seamstress/month")

UNITS: people

DOCUMENT: The desired adjustment of the staff in workshop. Provides the direction and size of growth for the Staff in Workshop stock.

Advertisement_Campaigns = 1

UNITS: Adverts

DOCUMENT: The number of advertisements that are promoted to the customer segment

Advertisement_Effect_on_Awareness = GRAPH(Investment_in_Targeted_Advertisement/Advertisement_Campaigns)

Points: (0, 0.0000), (300, 0.0374206117706), (600, 0.0771949393897), (900, 0.119471029029), (1200, 0.164406238802), (1500, 0.212167824479), (1800, 0.262933562034), (2100, 0.31689240936), (2400, 0.374245209594), (2700, 0.435205438688), (3000, 0.5000) {GF EXTRAPOLATED}

UNITS: dmnl/month

DOCUMENT: The effects of investment/advertisement campaign on the awareness

Affordability_Effect_on_Decision_to_Enter = GRAPH(VP_2_Affordability)

Points: (0.500, 1.500), (0.750, 1.487), (1.000, 1.447), (1.250, 1.275), (1.500, 0.958), (1.750, 0.145), (2.000, 0.040), (2.250, 0.020), (2.500, 0.026), (2.750, 0.013), (3.000, 0.000)

UNITS: dmnl

DOCUMENT: Estimated effect of affordability on decision to frequent the shop given by the set price over indicated price.

AT_staff_outlet = 2

UNITS: month

Available_Funding_by_Coverage_Ratio = IF Profits>0 THEN Liquid_Capital/Costs_of_Desired_Production_Capacity ELSE 0 {DELAY CONVERTER}

UNITS: dmnl

Average_Monthly_Customer_Visits = (Casual_Shopper_Visits_per_Month+Avg_Frequent_Shoppers_Visits_per_Month)

UNITS: visits/Months

DOCUMENT: Total average number of visitors per month

"Average_visits/hour" = Average_Monthly_Customer_Visits/"Total_Shop_Hours/month"

UNITS: visits/Hours

DOCUMENT: Average visitors per hour

Avg_Frequent_Shoppers_Visits_per_Month = Frequent_Shopper*Visits_per_Frequent_Shopper_per_Month

UNITS: visits/Months

DOCUMENT: Average number of frequent shoppers visiting per month

"Back-Up_Power_ON/OFF_SWITCH" = (IF "Generator_ON/OFF"+"Solar_Cell_ON/OFF" = 1 THEN 1 ELSE 0)*"POWER_CUTS_ON/OFF_SWITCH"

UNITS: dmnl

Casual_Shopper_Visits_per_Month = (Casual_Shopper*Visits_per_month_CS)

UNITS: visits/Months

DOCUMENT: number of casual shopper visits in outlet per month

Combined_Rent = 800

UNITS: dollar/months

DOCUMENT: Rental price for the outlet per month

Competitor's_Design_Strength = 0.9

UNITS: dollar/item

Cost_of_Fabrics_at_Expansion = Necessary_Fabric_Acquisition*"Price_per_M^2"

UNITS: dollar/months

DOCUMENT: Cost of increasing the production capacity by fabrics

Cost_of_Initial_Technical_Equipment = (Acquisition_costs_per_machine*INIT(Sowing_Machines)/Initial_Costs_AT)+"Generator_ON/OFF"*+STEP (-(Acquisition_costs_per_machine*INIT(Sowing_Machines)/Initial_Costs_AT)+"Generator_ON/OFF", 2)+INIT(Total_Acquisition_Cost_Panels)

UNITS: dollar/months

DOCUMENT: Cost for the initial stock of machinery for production

Cost_of_Staff_Expansson = Additional_Sowing_Personell_Needed*Costs_per_Staff_per_Month

UNITS: dollar/months

DOCUMENT: Cost of expanding the staff level

Cost_per_KwH_Solar_Powered_KwH = GRAPH(TIME {BloombergNEF: Based on manufacturing and installationcosts})

Points: (1.00, 0.3260), (12.00, 0.2449), (23.00, 0.2097), (34.00, 0.1709), (45.00, 0.1551), (56.00, 0.1392), (67.00, 0.1233), (78.00, 0.1145), (89.00, 0.1075), (100.00, 0.1040)

UNITS: dollar/kwh

DOCUMENT: Price per gallon of fuel

Cost_Rate_Growth_Trend = Cost_Rate//HISTORY(Cost_Rate, TIME-01)

UNITS: dmnl

DOCUMENT: The direction and size of growth of Cost Rate

Costs_not_related_to_production = (Monthly_loan_interest_payment+Investment_in_Targeted_Advertisement)+Combined_Rent+Monthly_investment_staying_up_to_date+Outlet_Staff_Costs

UNITS: dollar/months

DOCUMENT: The business cost that dont change on the basis of production

Costs_of_Desired_Production_Capacity = Acquisition_Cost_of_Expansion_of_Sowing_Machines + Cost_of_Staff_Expansson + Fabric_Acquisition_Costs {SUMMING CONVERTER}

UNITS: dollar/months

Costs_per_Staff_per_Month = 1500

UNITS: dollar/person/month

DOCUMENT: Costs per employee per month

Costs_Related_to_Production = Cost_of_Initial_Technical_Equipment+Machine_acquisition_costs+Fabric_Acquisition_Costs+Machine_Maintenance_Costs_per_Month+WS_Staff_Costs_Per_Month+Electricity_Costs_for_Productive_Hours+"Total_S-G_el_running_costs"+Solar_Costs_per_Month+Total_Acquisition_Cost_Panels+("Generator_ON/OFF"*Generator_Acquisition_Costs)

UNITS: dollar/months

DOCUMENT: Costs that pertain to the production of items for sale

Customer_Segment_1 = 5000

UNITS: people

DOCUMENT: Women between 25 and 30 with an income between (xx dollar/month to xx dollar/month

Customer_Segment_Payment_Ability = Income_level_for_CS_1*Price_Adjustment_Time*Item_value_by_fraction_of_income

UNITS: dmnl

DOCUMENT: Indicated price gives a suggestive price for the goods on sale based on the income level of the customer segment.

The strength of this value prop for the corresponding numerical customer segment.

By making it a pct of the income level for the customer segment it also indicates the level of the business (luxury vs necessity) and internalizes external fluctuations.

Customer_to_Staff_Ratio_Effect_on_Return_Decision = GRAPH("Customer/_Staff_Ratio")

Points: (0.000, 1.400), (0.820, 1.384), (1.640, 1.313), (2.460, 1.194), (3.280, 0.902), (4.100, 0.514), (4.920, 0.238), (5.740, 0.024), (6.560, -0.150), (7.380, -0.253), (8.200, -0.300)

UNITS: dmnl

DOCUMENT: Customer care effect on return rate

"Customer/_Staff_Ratio" = "Average_visits/hour"/Outlet_Staff_per_Hour

UNITS: visits/Hours

DOCUMENT: Number of customers per staff per hour. This is a primary indicator of the level of customer care in the corporation

Days_in_Month = 30.5-4

UNITS: days/month

DOCUMENT: Number of days per month

Demand_Perception_Adjustment_Time = 2

UNITS: month

Design_Competitiveness = VP_1_Design_1/Competitor's_Design_Strength

UNITS: 1/item

Design_Competitiveness_Effect_on_Recruitment = GRAPH(Design_Competitiveness)

Points: (0.000, -0.185275727967), (0.150, -0.160430338083), (0.300, -0.0956630790094), (0.450, 0.0622464284487), (0.600, 0.391671127014), (0.750, 0.900), (0.900, 1.40832887299), (1.050, 1.73775357155), (1.200, 1.89566307901), (1.350, 1.96043033808), (1.500, 1.98527572797)

UNITS: 1/item

Design_effect_on_Buying_Decision = GRAPH(VP_1_Design_1)

Points: (0.000, 0.0831726964939), (0.100, 0.127861566319), (0.200, 0.191545348561), (0.300, 0.276878194876), (0.400, 0.382252125231), (0.500, 0.500), (0.600, 0.617747874769), (0.700, 0.723121805124), (0.800, 0.808454651439), (0.900, 0.872138433681), (1.000, 0.916827303506)

UNITS: dmnl

DOCUMENT: The effect of the design value prop on the recruitment of aware customers.

Literature suggests that design is the most important factor in attracting customers in the

textile and clothing industry

- Bansah, Pearl Fafa

Dabi, Michael

Dzorvakpor, Edem

Nwodo, Hilda "The Effect of Branding on Consumer Buying Behaviour among Textile Ghana Fabric Users in the Ho Municipality of Ghana"

Desired_Fabric_Inventory = (Desired_Production_Rate*Fabrics_Required_Per_Iitem)*Inventory_Coverage_Time

UNITS: m^2

Desired_Machine_Acquisition_Rate = MAX(0, (Desired_Machines-Sowing_Machines)/Machine_Stock_Adjustment_Time+Machines_Discard_Rate)

UNITS: machine/month

DOCUMENT: The number of additional sowing machines needed in order to produce at the Desired Production Rate

Desired_Machines = Machine_Hours_Required_Per_Month/"Hours/Machine/Month"

UNITS: Machine

Desired_Outlet_Inventory = Desired_Outlet_Inventory_Coverage*Indicated_Sales_Rate

UNITS: Item

DOCUMENT: Desired number of items in the Outlet Inventory

Desired_Outlet_Inventory_Coverage = 1

UNITS: months

DOCUMENT: The desired number of items in the Outlet in relation to the items in demand

Desired_Outlet_Staff_per_Hour_by_Avg_Visitor_per_Hour = GRAPH("Average_visits/hour")

Points: (0.00, 1.00), (6.00, 1.00), (12.00, 2.00), (18.00, 3.00), (24.00, 4.00), (30.00, 5.00) {GF EXTRAPOLATED}

UNITS: dmnl

DOCUMENT: Desired staff per hour given by the level of visitors per hour

Desired_Panels = Sowing_Machines/Machines_per_Panel

UNITS: panel

Desired_Price = MIN (100, Total_Costs_per_Item_Produced*Desired_Profit_per_Item)

UNITS: dollar/item

DOCUMENT: Covering 100% of the costs per item produced + the set desired profit per item.

Desired_Production_Rate = (Inventory_Discrepancy/Production_Rate_Adjustment_Time)+Expected_Demand

UNITS: item/month

DOCUMENT: The desired production level needed in order to both satisfy demand and securing satisfactory level of inventory given by "Desired inventory".

Desired_Profit_per_Item = GRAPH(Total_Costs_per_Item_Produced)

Points: (0.00, 1.1805), (9.00, 1.04793179839), (18.00, 1.02297457296), (27.00, 1.01101212599), (36.00, 1.00527831003), (45.00, 1.00252998892), (54.00, 1.00121266919), (63.00, 1.00058125415), (72.00, 1.0000), (81.00, 1.0000), (90.00, 1.0000)

UNITS: dmnl

DOCUMENT: The desired profitability of the produced items

Desired_Sowing_working_hours = MAX(0, SMTH1(Desired_Production_Rate/Items_Per_Hour_Produced_Per_Sowing_Staff, 1.5))

UNITS: hour/month

DOCUMENT: The total number of working hours needed in the workshop to meet the level of Desired Productivity

Desired_Staff = Staff_per_Hour_Discrepancy*Staff_in_Outlet

UNITS: people

DOCUMENT: Desired number of workers in the outlet

Effect_of_invetment_on_VP = GRAPH(Monthly_investment_staying_up_to_date)

Points: (0.0, 0.000), (50.0, 0.044), (100.0, 0.128), (150.0, 0.220), (200.0, 0.308), (250.0, 0.383), (300.0, 0.493), (350.0, 0.604), (400.0, 0.736), (450.0, 0.850), (500.0, 0.974)

UNITS: dmnl

DOCUMENT: The effect of the chosen size of investment on the value prop

Effect_of_Partnership_on_Costs = IF Partnerships_for_Machine_Maintenance=1 THEN 0.6 ELSE 1

UNITS: dmnl

Effect_of_Price_on_Life_Time = GRAPH(Acquisition_costs_per_machine)

Points: (0.0, 0.500), (8.33333333333, 0.57428392331), (16.6666666667, 0.651728397662), (25.0, 0.732467894722), (33.3333333333, 0.816642607508), (41.6666666667, 0.904398693819), (50.0, 0.995888530013), (58.3333333333, 1.09127097559), (66.6666666667, 1.19071164904), (75.0, 1.2943832154), (83.3333333333, 1.40246568606), (91.6666666667, 1.51514673135), (100.0, 1.63262200639), (108.333333333, 1.75509549083), (116.666666667, 1.88277984299), (125.0, 2.01589676918), (133.333333333, 2.1546774086), (141.666666667, 2.29936273474), (150.0, 2.45020397372), (158.333333333, 2.6074630406), (166.666666667, 2.77141299409), (175.0, 2.94233851071), (183.333333333, 3.12053637908), (191.666666667, 3.30631601526), (200.0, 3.500)

UNITS: dmnl

DOCUMENT: The time it takes for one sowing machine to be strained to the point where it should be discarded.

Electric_Supply = 0.75

UNITS: dmnl

DOCUMENT: "How Do African Firms Respond to Unreliable Power? Exploring Firm Heterogeneity Using K-Means Clustering"

Electricity_Consumption_per_Month = Productive_Hours_not_Covered_by_Grid_Electricity*Electricity_Consumption_per_Productive_Hour_per_Machine

UNITS: KwH/Months

Electricity_Consumption_per_Productive_Hour_per_Machine = 0.16

UNITS: KwH/hour

DOCUMENT: Electricity conumer per KwH

"Causes and Effects of Frequent and Unannounced Electricity

Blackouts on the operations of Micro and Small Scale Industries in Kumasi."

{https://sewingmachinetalk.com/electricity-sewing-machine-amps-volts-watts/}

Electricity_Cost_per_Productive_Hour = (Electricity_Consumption_per_Productive_Hour_per_Machine*Price_per_KwH)

UNITS: dollar/Hours

DOCUMENT: Cost of electricity per productive hour

Electricity_Costs_for_Productive_Hours = Productive_Hours_Covered_by_Electricity*Electricity_Cost_per_Productive_Hour

UNITS: dollar/months

DOCUMENT: Total cost of electricity by production level

EQ_switch = 0

UNITS: dmnl

Expected_Demand = SMTH1(Indicated_Sales_Rate, Demand_Perception_Adjustment_Time)

UNITS: item/month

Fabric_Acquisition_Costs = ("Price_per_M^2"*Desired_Fabric_Inventory)/Inventory_Coverage_Time

UNITS: dollar/months

Fabric_Based_Production_Capacity = (Fabrics_Inventory/Fabrics_Required_Per_Iitem)/DT+ 0*(Fabrics_Inventory/Fabrics_Required_Per_Iitem)/DT

UNITS: Item/month

DOCUMENT: The maximum amount of items that could be produced by the fabric inventory.

<i think you should use the formulation in Sterman where you operate with ta desired Inventory coverage and produce as desired until the inventory coverage is under its desired value, whereupon you limit your consumption of fabric using a table function; - the effect of Fabric Inventory Level on Max Production From Inventory.

Fabrics_Required_Per_Iitem = 2

UNITS: m^2/item

First_Recruitment_Fraction =
Design_effect_on_Buying_Decision*Affordability_Effect_on_Decision_to_Enter*Product_Availability_Effect_on_Recruitment*Total_visitors_effect_on_recruitment*Normal_Recruitment_Fraction*Design_Competitiveness_Effect_on_Recruitment

UNITS: dmnl

DOCUMENT: The fraction of aware persons among potential customers who are convinced to visit the outlet for the first time.

Fraction_Wasted_Material = 0.04

UNITS: dmnl

Fuel_Consumed_Per_Productive_Hour = KwH_produced_per_litre_diesel*Electricity_Consumption_per_Productive_Hour_per_Machine

UNITS: litre/Hours

Fuel_Price_per_Litre = GRAPH(TIME)

Points: (1.00, 1.033), (50.50, 1.014), (100.00, 1.000)

UNITS: dollar/litre

DOCUMENT: Price per gallon of fuel

Generator_Acquisition_Costs = PULSE(60, 1, 24)

UNITS: dollar

DOCUMENT: Price of buying a generator

https://www.researchgate.net/publication/315935958_Techno-Economics_of_Solar_PV-Diesel_Hybrid_Power_Systems_for_Off-grid_Outdoor_Base_Transceiver_Stations_in_Ghana

Generator_Maintenance_Costs = 25

UNITS: dollars/month

"Generator_ON/OFF" = "POWER_CUTS_ON/OFF_SWITCH"*"Generator_ON/OFF_SWITCH"

UNITS: dmnl

DOCUMENT: Switch deciding whether or not production continues also at times when there is no electricity.

Switch=1 means production continues at normal rate with an alternative energy source when the power shuts down

Switch=0 means that power cuts will stop productions altogether.

"Generator_ON/OFF_SWITCH" = 1

UNITS: dmnl

DOCUMENT: Switch deciding whether or not production continues also at times when there is no electricity.

Switch=1 means production continues at normal rate with an alternative energy source when the power shuts down

Switch=0 means that power cuts will stop productions altogether.

"Generator_ON/OFF_SWITCH_1" = 0

UNITS: dmnl

DOCUMENT: Switch deciding whether or not production continues also at times when there is no electricity.

Switch=1 means production continues at normal rate with an alternative energy source when the power shuts down

Switch=0 means that power cuts will stop productions altogether.

Hours_Covered_per_Panel_per_Month = "Hours/Machine/Month"*Machines_per_Panel

UNITS: Hours/(Months*panel)

"Hours/day" = 8

UNITS: hours/day

DOCUMENT: Number of working hours per day per employee

"Hours/Machine/Month" = 16*22.5

UNITS: hours/machine/month

DOCUMENT: The number of hours one machine is operational in one month. This is an exogenous decision rule. Each machine is expected to be operational 16 hours per day at every working day of the month (Monday through Friday).

Income_level_for_CS_1 = GRAPH(TIME)

Points: (1.00, 1810), (50.00, 1810)

UNITS: dollars/month

DOCUMENT: Avg income level of the customer segment

Indicated_Number_of_Items_Sold_Per_Customer_Visit = 2

UNITS: item/visits

DOCUMENT: Number of purchases per customer

Indicated_Outlet_Inventory_Coverage = Outlet_Inventory//Indicated_Sales_Rate

UNITS: month

DOCUMENT: The number of months of demand the current level of inventory cover before new products have to be put up in order to satisfy the demand

Indicated_Sales_Rate = (Average_Monthly_Customer_Visits*Purchase_per_Customer)

UNITS: Item/month

DOCUMENT: Expected Sales per month

Initial_Costs_AT = 1

UNITS: months

Initial_VP_Design_1 = 0.8

UNITS: dmnl

DOCUMENT: The strength of this value prop for the corresponding numerical customer segment

The initial value indicates how many % of the customer segment would become customers based on this value prop alone independently of the others

Interest_rate = 0.03

UNITS: dmnl/month

Inventory_Coverage_Time = 0.18

UNITS: months

Inventory_Discrepancy = Desired_Outlet_Inventory-Outlet_Inventory

UNITS: item

DOCUMENT: The discrepancy between desired inventory and actual inventory

Investing_interval = 8

UNITS: months

DOCUMENT: How often money is invested in keeping this value prop up to date

Investment = Investment_rate*Time_correction

UNITS: dollar

DOCUMENT: Amount of money invested per interval

Investment_in_Targeted_Advertisement = GRAPH(TIME)

Points: (1.00, 104.1), (9.25, 104.1), (17.50, 104.1), (25.75, 101.4), (34.00, 97.0), (42.25, 90.9), (50.50, 84.7), (58.75, 75.9), (67.00, 70.6), (75.25, 59.2), (83.50, 48.6), (91.75, 36.3), (100.00, 24.8)

UNITS: dollar/month

DOCUMENT: Advertisement targeted specifically at the customer segment based on data about the behavior of the customer segment.

A scale from low penetration of the customer segment (0) to hard to miss (1)

Advertisement accounts for 49% of awareness raising of different brands in "The Effect of Branding on Consumer Buying Behaviour among Textile Ghana Fabric Users in the Ho Municipality of Ghana" p.119

Item_value_by_fraction_of_income = 0.02

UNITS: dmnl/dollars

DOCUMENT: Estimated value of the item to the purchaser based on fraction of monthly income

Items_Per_Hour_Produced_Per_Sowing_Staff = 1

UNITS: item/hour

DOCUMENT: An estimation of how many items each staff member in the workshop produces per hour

Items_Produced_Per_Hour_Machine_Time = 0.5

UNITS: item/hour

DOCUMENT: The number of items produced per machine per hour at normal capacity

KwH_produced_per_litre_diesel = 0.51

UNITS: litre/kWh

DOCUMENT: https://power-calculation.com/generator-diesel-energy-calculator-genset.php#consumptionvalues

Lifetime = 25*12

UNITS: years

Loan_AT = 1

UNITS: months

Machine_acquisition_costs = (Acquisition_costs_per_machine*"Machines_Acquisition._Rate")

UNITS: dollar/months

DOCUMENT: Costs of acquiring new machines

Machine_Based_Production_Capacity = ((Productive_Hours_not_Covered_by_Grid_Electricity*"Back-Up_Power_ON/OFF_SWITCH")+Productive_Hours_Covered_by_Electricity)*Items_Produced_Per_Hour_Machine_Time

UNITS: Item/month

DOCUMENT: Number of items produced on the basis of number of machines

Machine_Hours_Available_Per_Month = "Hours/Machine/Month"*Sowing_Machines

UNITS: Hour/month

DOCUMENT: The total amount of productive hours of all the machines in the workshop

Machine_Hours_Required_Per_Month = Desired_Production_Rate/Items_Produced_Per_Hour_Machine_Time

UNITS: hour/month

DOCUMENT: Desired amount of total hours of operative sowing machines

Machine_Maintenance_Costs_per_Month = Effect_of_Partnership_on_Costs*(Price_Level_Effect_on_Maintenance_Costs*Sowing_Machines)

UNITS: dollar/month

DOCUMENT: Cost of machine maintenance per month

Machine_Stock_Adjustment_Time = 1

UNITS: months

Machines_per_Panel = 2

UNITS: machine/panel

Materials_Wasted = Fabrics_Consumption_Rate*Fraction_Wasted_Material

UNITS: m^2/month

"Monthly_Hour_coverage/_employee" = ("Working_days/_person/_month"*"Hours/day")

UNITS: Hours/person/month

DOCUMENT: Total hours worked per employee per month

Monthly_investment_staying_up_to_date = Updating_VP_2_cost/Investing_interval

UNITS: dollar/month

DOCUMENT: How much is invested in staying up to date per month

Monthly_loan_interest_payment = Interest_rate*Debt_to_the_bank

UNITS: dollar/month

Necessary_Fabric_Acquisition = ((Desired_Fabric_Inventory-Fabrics_Inventory)/DT)+Fabrics_Consumption_Rate

UNITS: m^2/month

DOCUMENT: The desired amount of fabrics desired in order to meet the Desired Fabric Inventory

New_Loan = DELAY1(IF Lending_rate>0 THEN Lending_rate*Time_correction ELSE 0, 2.5)

UNITS: dollar

DOCUMENT: Additional loan provided to cover a deficiency in liquid funds

Normal_Life_Time = 40

UNITS: months

DOCUMENT: The time it takes for one sowing machine to be strained to the point where it should be discarded.

Normal_Recruitment_Fraction = 0.5

UNITS: dmnl

DOCUMENT: The fraction of aware customer segment that would visit the shop under a normal scenario

Normal_Working_Time = 40

UNITS: months

DOCUMENT: Amount of time an average employee works before quitting

Outdating_per_month = 0.05

UNITS: dmnl/month

DOCUMENT: The level of "depreciation" the value stock has per month

Outlet_Staff_Costs = Costs_per_Staff_per_Month*Staff_in_Outlet

UNITS: dollar/months

Outlet_Staff_per_Hour = Total_Outlet_Staff_Hours/"Total_Shop_Hours/month"

UNITS: dmnl

DOCUMENT: Number of people working in the outlet per hour

Partnerships_for_Machine_Maintenance = 1

UNITS: partners

DOCUMENT: Number of partners who facilitate machine maintenance

"POWER_CUTS_ON/OFF_SWITCH" = 0

UNITS: dmnl

Price_Adjustment_Time = 1

UNITS: month

Price_AT = 6

UNITS: months

Price_Level_Effect_on_Maintenance_Costs = GRAPH(Acquisition_costs_per_machine)

Points: (0.0, 25.00), (20.0, 19.8676606925), (40.0, 15.7889576556), (60.0, 12.5475861356), (80.0, 9.97164735404), (100.0, 7.924532247), (120.0, 6.29767671319), (140.0, 5.00480416354), (160.0, 3.97735003814), (180.0, 3.16082564051), (200.0, 2.51192845335)

UNITS: dollar/machine/months

DOCUMENT: The effect of the acquisition price on the costs related to maintenance

Price_per_KwH = GRAPH(TIME {BloombergNEF 2019})

Points: (1.00, 0.5300), (12.00, 0.5300), (23.00, 0.5300), (34.00, 0.5300), (45.00, 0.5300), (56.00, 0.5300), (67.00, 0.5300), (78.00, 0.5300), (89.00, 0.5300), (100.00, 0.5300)

UNITS: dollar/Kwh

DOCUMENT: Cost per KwH

Data for prices per MwH:

https://www.feem.it/m/publications_pages/2017-12-20-bonan-energyaccessdefinitivo.pdf

"Price_per_M^2" = 4

UNITS: dollar/m^2

DOCUMENT: Price per m^2 of fabric purchased

Price_per_Panel = 200 {https://www.nocheski.com/product/victron-energy-blue-solar-panels}

UNITS: dollar/panel

Product_Availability_Effect_on_Recruitment = GRAPH(Indicated_Outlet_Inventory_Coverage)

Points: (0.000, 0.00669285092428), (0.100, 0.0179862099621), (0.200, 0.0474258731776), (0.300, 0.119202922022), (0.400, 0.26894142137), (0.500, 0.500), (0.600, 0.73105857863), (0.700, 0.880797077978), (0.800, 0.952574126822), (0.900, 0.982013790038), (1.000, 0.993307149076)

UNITS: dmnl

DOCUMENT: Inventory coverage effect on recruitment

Production_Capacity = IF Fabric_Based_Production_Capacity>MIN(Machine_Based_Production_Capacity, Staff_Based_Production_Capacity) THEN MIN(Machine_Based_Production_Capacity, Staff_Based_Production_Capacity) ELSE Fabric_Based_Production_Capacity

UNITS: item/month

DOCUMENT: The number of items that could be produced by the factors of production contained in the company

Production_Rate_Adjustment_Time = 2

UNITS: months

DOCUMENT: Based on the largest adjustment time among the adjustment times in the Factors of Production

Productive_Hours_Covered_by_Electricity = IF "POWER_CUTS_ON/OFF_SWITCH"=1 THEN Electric_Supply*Machine_Hours_Available_Per_Month ELSE Machine_Hours_Available_Per_Month

UNITS: hour/month

DOCUMENT: Number of hours that have been running production on ordinary electricity

Productive_Hours_not_Covered_by_Grid_Electricity = ((1-Electric_Supply)*Machine_Hours_Available_Per_Month)*"POWER_CUTS_ON/OFF_SWITCH"

UNITS: hour/month

DOCUMENT: Number of hours of production that relies on alternative energy sources

Profit_Balance = Revenue_rate-Cost_Rate

UNITS: dollar/months

DOCUMENT: The current relationship between revenue and cost

Purchase_per_Customer = 2

UNITS: item/visits

DOCUMENT: Number of items purchased per customer

Recruitment_AT = 0.2

UNITS: Months

Revenue_per_Item_Sold = Price-Total_Costs_per_Item_Produced

UNITS: dollar/item

DOCUMENT: The monetary profit per item sold

Revenue_Rate_Growth_Trend = Revenue_rate//HISTORY(Revenue_rate, TIME-01)

UNITS: dmnl

DOCUMENT: The direction and size of growth of Cost Rate

Shop_Hours_per_Day = 10

UNITS: hours/day

DOCUMENT: Hours the shop is open per day

"Solar_Cell_ON/OFF" = (1-"Generator_ON/OFF")*("POWER_CUTS_ON/OFF_SWITCH"*"Generator_ON/OFF_SWITCH_1")

UNITS: dmnl

Solar_Costs_per_Month = Electricity_Consumption_per_Month*Cost_per_KwH_Solar_Powered_KwH*"Solar_Cell_ON/OFF"

UNITS: dollar/months

Solar_Panels_Adjustment_Time = 7

UNITS: months

Sowing_Machine_Lifetime = Normal_Life_Time*Effect_of_Price_on_Life_Time

UNITS: months

DOCUMENT: The time it takes for one sowing machine to be strained to the point where it should be discarded.

Sowing_Staff_Hours_Available_Per_Month = Staff_In_Workshop*"Working_Hours_per_seamstress/month"

UNITS: hours/month

DOCUMENT: The total number of hours worked by the entire staff in the workshop.

Staff_Based_Production_Capacity = Sowing_Staff_Hours_Available_Per_Month*Items_Per_Hour_Produced_Per_Sowing_Staff

UNITS: item/month

DOCUMENT: The total amount of items produced per hour based on the size of the staff

Staff_per_Hour_Discrepancy = Desired_Outlet_Staff_per_Hour_by_Avg_Visitor_per_Hour/Outlet_Staff_per_Hour

UNITS: dmnl

DOCUMENT: The ratio between the actual staff per hour and the optimal or desired staff per hour

Time_correction = 2

UNITS: months

Time_to_pay_back_loan = 3*12

UNITS: months

DOCUMENT: The time within which a loan should be paid back

Total_Acquisition_Cost_Panels = Solar_Cell_Panels*Price_per_Panel*"Solar_Cell_ON/OFF"

UNITS: dollar

Total_Buyers = Casual_Shopper + Frequent_Shopper {SUMMING CONVERTER}

UNITS: people

DOCUMENT: Total amount of purchasing customers

Total_Costs_per_Item_Produced = IF Production_Rate>1 THEN Cost_Rate//Production_Rate ELSE 0

UNITS: dollar/item

DOCUMENT: The total of the firms costs divided by the number of items produced

Total_Fabrics_Used_for_Production_Per_Month = Production_Rate*Fabrics_Required_Per_Iitem

UNITS: m^2/month

Total_Fuel_Consumption = Fuel_Consumed_Per_Productive_Hour*Productive_Hours_not_Covered_by_Grid_Electricity

UNITS: litre/Months

Total_Hours_Covered_by_Solar_Cell = Solar_Cell_Panels*Hours_Covered_per_Panel_per_Month

UNITS: Hours*Panels/(Months*panel)

Total_Outlet_Staff_Hours = Staff_in_Outlet*"Monthly_Hour_coverage/_employee"

UNITS: hours/month

DOCUMENT: The total number of hours worker put into the shop

"Total_S-G_el_running_costs" = Total_Fuel_Consumption*Fuel_Price_per_Litre+Generator_Maintenance_Costs

UNITS: dollar/months

"Total_Shop_Hours/month" = Days_in_Month*Shop_Hours_per_Day

UNITS: hours/month

DOCUMENT: Total operational hours per shop per month

Total_visitors_effect_on_recruitment = GRAPH(Total_Buyers)

Points: (0, 1.000), (200, 1.06120702456), (400, 1.12885124809), (600, 1.2036096767), (800, 1.28623051789), (1000, 1.3775406688), (1200, 1.47845399211), (1400, 1.58998046227), (1600, 1.7132362737), (1800, 1.84945501197), (2000, 2.000)

UNITS: dmnl

DOCUMENT: Word of mouth effect on recruitment

Updating_VP_1_Design = PULSE(Effect_of_invetment_on_VP, 0.05, Investing_interval)

UNITS: dmnl/month

DOCUMENT: How much and how often this value prop is updated

Updating_VP_2_cost = GRAPH(TIME)

Points: (1.00, 200.0), (2.00, 200.0), (3.00, 200.0), (4.00, 200.0), (5.00, 200.0), (6.00, 200.0), (7.00, 200.0), (8.00, 200.0), (9.00, 200.0), (10.00, 200.0), (11.00, 200.0), (12.00, 200.0), (13.00, 200.0), (14.00, 200.0), (15.00, 200.0), (16.00, 200.0), (17.00, 200.0), (18.00, 200.0), (19.00, 200.0), (20.00, 200.0), (21.00, 200.0), (22.00, 200.0), (23.00, 200.0), (24.00, 200.0), (25.00, 200.0), (26.00, 200.0), (27.00, 200.0), (28.00, 200.0), (29.00, 200.0), (30.00, 200.0), (31.00, 200.0), (32.00, 200.0), (33.00, 200.0), (34.00, 200.0), (35.00, 200.0), (36.00, 200.0), (37.00, 200.0), (38.00, 200.0), (39.00, 200.0), (40.00, 200.0), (41.00, 200.0), (42.00, 200.0), (43.00, 200.0), (44.00, 200.0), (45.00, 200.0), (46.00, 200.0), (47.00, 200.0), (48.00, 200.0), (49.00, 200.0), (50.00, 200.0), (51.00, 200.0), (52.00, 200.0), (53.00, 200.0), (54.00, 200.0), (55.00, 200.0), (56.00, 200.0), (57.00, 200.0), (58.00, 200.0), (59.00, 200.0), (60.00, 200.0), (61.00, 200.0), (62.00, 200.0), (63.00, 200.0),

(64.00, 200.0), (65.00, 200.0), (66.00, 200.0), (67.00, 200.0), (68.00, 200.0), (69.00, 200.0), (70.00, 200.0), (71.00, 200.0), (72.00, 200.0), (73.00, 200.0), (74.00, 200.0), (75.00, 200.0), (76.00, 200.0), (77.00, 200.0), (78.00, 200.0), (79.00, 200.0), (80.00, 200.0), (81.00, 200.0), (82.00, 200.0), (83.00, 200.0), (84.00, 200.0), (85.00, 200.0), (86.00, 200.0), (87.00, 200.0), (88.00, 200.0), (89.00, 200.0), (90.00, 200.0), (91.00, 200.0), (92.00, 200.0), (93.00, 200.0), (94.00, 200.0), (95.00, 200.0), (96.00, 200.0), (97.00, 200.0), (98.00, 200.0), (99.00, 200.0), (100.00, 200.0)

UNITS: dollar

DOCUMENT: How much money is allocated to updating the value prop

Visits_per_Frequent_Shopper_per_Month = 0.7

UNITS: visits/person/month

Visits_per_month_CS = 0.3

UNITS: visits/person/month

DOCUMENT: Number of visits per casual shopper per month

VP_2_Affordability = Price/Customer_Segment_Payment_Ability

UNITS: dollar/item

DOCUMENT: The set price over the payment ability gives an expression of affordability where an affordability value below 1 means very affordable and over 1 means less affordable

Research shows that price isn't the main indicator of whether or not people will purchase, affordability however plays a role "slight change in price will not change

my purchase decision" (The Effect of Branding on Consumer Buying Behaviour among Textile Ghana Fabric Users in the Ho Municipality of Ghana)

"Working_days/_person/_month" = 22

UNITS: day/month/person

DOCUMENT: Number of days worked per month

"Working_Hours_per_seamstress/month" = 8*22.5

UNITS: hours/person/month

DOCUMENT: Average working hours per day based on an 8 hour working day working Monday through Friday every month (approx. 22.5 days a month)

WP_adjustment_time = 2

UNITS: months

WS_Staff_Costs_Per_Month = (Staff_In_Workshop)*Costs_per_Staff_per_Month

UNITS: dollar/months

DOCUMENT: The costs associated with staff per month

{ The model has 190 (190) variables (array expansion in parens).

In root model and 0 additional modules with 16 sectors.

Stocks: 16 (16) Flows: 20 (20) Converters: 154 (154)

Constants: 57 (57) Equations: 117 (117) Graphicals: 18 (18)

There are also 16 expanded macro variables.

}

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