**NTNU – Trondheim**
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# Framework for Experimental Learning: Replicable Business Models in Rural Electrification

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**Student:** Jeg erklærer herved at jeg har satt meg inn i gjeldende bestemmelser for mastergradsstudiet og at jeg oppfyller kravene for adgang til å påbegynne oppgaven, herunder eventuelle praksiskrav.

Partene er gjort kjent med avtalens vilkår, samt kapitlene i studiehåndboken om generelle regler og aktuell studieplan for masterstudiet.

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# Preface

This master thesis is the work of Kenneth Hole. The author is currently pursuing a M.Sc. degree in Entrepreneurship at the Norwegian University of Science and Technology (NTNU), School of Entrepreneurship. This thesis is based on research conducted in the period February- July 2014.

The master thesis is associated with the Centre for Sustainable Energy Studies- CenSES, which is a national research center for sustainable energy. Through the CenSES program, the author was given the opportunity to travel to India to investigate the business of rural electrification. The interactions with researcher and practitioners of rural electrification offered a unique insight on today's situation on rural electrification, and helped form the ideas and gather the material for this thesis.

The author hopes and believes that the insight gained from this research can help entrepreneurs in their commercialization effort of organizing their business model innovation process to enable replication of their business model into new geographical areas.

I wish to thank my supervisors, Associate Professor Lars Øystein Widding and PhD candidate Vivek Sinha at Department of Industrial Economics and Technology Management. They have provided invaluable guidance, support and feedback throughout this period, helping me shape my research and sharpen my objectives.

Further, I like to thank Nikhil Jaisinghani (Cofounder and CEO of Mera Gao Power) for providing me valuable information about his business. I also want to thank Professor Anil Gupta (Indian Institute of Management), Shrashtant Patara (Development Alternatives), Chaitanya Sure (Deputy Manager at TARA) and Rajiv Parti (Consultant at Applied Solar Technology) for taking their time to talk to me, to give me a better understanding of the rural electrification market in India.

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Kenneth Hole

# Abstract

Lack of access to electricity is a significant hindrance to boost economic development, knowledge creation and health improvement in developing countries, specifically for people in rural areas. Even though governments play a key role in building infrastructure, they do not have the capacity or the financing to fulfill these needs. Thus entrepreneurs play a vital role by introducing solutions for electricity based on renewable energy. They are able to perceive the risk, willing to take it and able to develop customized functional solutions that also are based on sustainable business models. In this paper, the author does multiple case studies and the theoretical backbone consists of literature about business models, business model innovation, replication and literature describing the challenges in the context of bottom of the pyramid markets in developing countries. Based on the findings, the author has developed a conceptual framework for experimental learning, which clarifies the business model innovation process to enable replication in the context of rural electrification by community-level mini-utilities. Divided into two phases, the framework first describes the learning process and how the process of accumulating knowledge about the Arrow Core and developing rules are best conducted. It recommends a linear but iterative process, where the firm enters one village at the time and develops the needed sustainable local business model for each specific village. In doing so it accumulates knowledge both about the business model and the context, which it can then exploit to build a larger company through replication in the second phase. The contributions are twofold: the author first suggests a more dynamic approach than the existing business model innovation literature by developing a step-wise conceptual model. Second, this model has practical implications for entrepreneurs, describing the process that can be used in their own commercialization efforts.

# Sammendrag

Mangel på tilgang til elektrisitet er et stort hinder for å styrke den økonomiske utviklingen, kunnskapsutviklingen og helsen for personer i utviklingsland, og spesielt for personer på landsbygda. Selv om myndighetene spiller en nøkkelrolle i å bygge infrastruktur, så har de ikke alltid kapasitet eller økonomi til å dekke behovet. Dermed har entreprenører en viktig rolle ved å introdusere nye løsninger for elektrisitet basert på fornybar energi. Entreprenører har muligheten til å ta risiko, er villig til å ta risikoen og er i stand til å utvikle nye løsninger som er basert på bærekraftige forretningsmodeller. Forfatteren har studert flere bedrifter og har brukt litteratur angående forretningsmodeller, forretningsmodell innovasjonsprosesser og replikasjon av forretningsmodeller sammen med litteratur som bemerker utfordringene i markedet som beskrives som ”bunnen av pyramiden”. Som resultat har forfatteren utviklet et konseptuelt rammeverk for eksperimentell læring. Rammeverket tydeliggjør innovasjonsprosessen som gjør det mulig å replikere forretningsmodellene til bedrifter som tilbyr strøm til landsbyer i ”bunnen av pyramiden”- markedet i utviklingsland. Fokuset er på bedrifter som genererer elektrisitet ved hjelp av små kraftverk. Videre så tar rammeverket for seg læringsprosessen med å akkumulere kunnskap om hva som er replikerbart og ikke replikerbart, sammen med hvordan man lager de operasjonelle reglene. Rammeverket anbefaler en lineær, men iterativ prosess, hvor entreprenøren først går inn i en landsby og utvikler den nødvendige bærekraftige forretningsmodellen der, før han/hun går til neste landsby. Ved å følge en slik prosess akkumulerer entreprenøren kunnskap om både forretningsmodellen og konteksten som han/ hun kan utnytte til å bygge et større selskap, gjennom å følge en replikasjonsstrategi i neste fase. Bidraget fra denne artikkelen er ment å være todelt: For det første foreslår forfatteren en mer dynamisk tilnærming enn hva den eksisterende litteraturen om forretningsmodell innovasjonsprosesser gjør, ved å utvikle en steg-vis konseptuelt rammeverk. For det andre, så har denne modellen en praktisk virkning for entreprenører, ved å beskrive en prosess som de kan bruke i sitt eget forsøk på å kommersialisere løsninger for å gi elektrisitet til landsbyboere i ”bunnen av pyramiden”-markedet i utviklingsland.

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# 1 Introduction

Today, more than 1.2 billion people live without electricity and most of these people live in rural areas of developing countries (International Finance Corporation, 2012). Rural electrification has many positive impacts such as enhancing the quality of lighting, improving health by reducing indoor pollution, strengthening the cold chain, extending clinic, study and business hours, and increasing connectivity through mobile phones, radio and television (Schillebeeckx et al., 2012, World Bank, 2008). Universal access to modern energy services has received increasing attention in recent years and the year 2030 has been declared as the target year for achieving this by the United Nations (International Finance Corporation, 2012).

Providing improved access to energy has traditionally been seen as the role of state-owned power utilities, through centralized generation and distribution. In order to close the energy gap it is estimated that USD 48 billion needs to be invested each year, but only USD 14 billion is currently invested annually from the public sector (International Finance Corporation, 2012). This highlights the deficit from other sectors, in particular the private sector with its capital and innovation that will be critical to close the energy access financial gap.

Each year, the poor, defined as the people who are living for less than $2 per day (Martin et al., 2009), spend USD 37 billion on poor-quality energy solutions to meet their lighting and cooking needs (International Finance Corporation, 2012). This represents a large and untapped market for the private sector and as the “base of the pyramid” (BOP) populations have become more recognized as potential customers, the energy access gap is gradually being recognized as a commercial opportunity as well (ibid).

Several entrepreneurs have in recent years entered the rural electrification business with emphasis on renewable energy technologies. The market can be divided in to three broad sectors based on the kind of product or service being offered: household-level devices and systems, community-level mini-utilities, and grid extension. The author focuses on renewable energy based community-level mini-utilities, which generates and distributes power based on a local grid. Mini-utility systems are an important contributor in rural electrification as they can offer a much broader set of energy services than simply lightning, such as running productive machineries and manufacturing or service activities which can support income generation and economic development (International Finance Corporation, 2012).

Achieving scale in this sector has however been a challenge. Many entrepreneurs are running mini-utility plants that are cash flow positive without public sector financial support, but most of them are only running single systems. A few companies are running multiple plants, but growth is challenging. A refinement of the business models is necessary if the models should become more easily replicable and scalable. In particular, due to the characteristics of demand where the population is spread out, the amount is highly variable, and individual capacities to pay for electricity services are limited (Zerriffi, 2011), it is imperative to find solutions that can overcome the fact that there will be a low profit per customer, but which can rather benefit from the huge market instead. One such solution is to conduct a replication strategy since its main strength lies in reaching a large market quickly, rather that the depth or length of the return (Winter and Szulanski, 2001).

Replication entails the creation and operation of a large number of similar outlets that deliver a product or perform a service (ibid). The advantages that can flow from the replication in multiple locations are based on the potential for the repeat sites to benefit from the experience gained in earlier implementations (Dunford et al., 2010). This is particularly suited for achieving scale in rural electrification through mini-utilities, where the requirement is to spread to multiple sites, both to meet the goal of electrification as well as for sustained profitability of the venture. Given the limited success that currently operating mini-utility businesses in rural electrification have had with replication (International Finance Corporation, 2012) the process by which such businesses can replicate is of interest. Replication strategy has been described as a process that involves exploration in which the business model is created and refined, followed by exploitation in which the business model is stabilized and leveraged through large-scale replication (Winter and Szulanski, 2001).

Although there is a discussion among scholars about business model innovation process in the context of bottom of the pyramid (BOP) markets (Thompson and MacMillan, 2010, Sanchez and Ricart, 2010, Yunus et al., 2010, Seelos and Mair, 2007), the replication process in general (Aspara et al., 2010, Winter and Szulanski, 2001, Sosna et al., 2010) and the need for building replicable business models in rural electrification (Schillebeeckx et al., 2012), the literature review shows that there is a lack of theoretical exploration on the nature of replication in this context. Due to the challenging conditions that the entrepreneurs face in rural electrification, and since these challenges can change from location to location, the entrepreneur needs to establish which business model components are more or less flexible or subject to change, relative to others. Under these conditions a more dynamic perspective is needed for developing a replicable business model of the firm, which can allow for a replicable core that together with the more flexible components constitute a coherent whole as the firm's business model.

The aim of this paper is to close this theoretical gap and to help the entrepreneur to organize the business model innovation process to enable replication in the context of low-income markets. The author asks:

**Q:** How should the entrepreneur organize the business model innovation process to enable replication in the context of rural electrification by community-level mini-utilities in developing countries?

The author tries to answer this question by first reviewing the literature about business model innovation, replication from the strategic literature and the challenges in the BOP-market. Thereafter, the author has bundled the most interesting findings and come up with a theoretical framework, which is further developed through a case study of two Indian firms, which has managed to replicate to scale with two different business models. Here, the business model is set as the unit of analysis, employing the six-component framework proposed by Morris et al. (2005) as the analytical lens.

The key contribution is a conceptual framework for experimental learning, which clarifies the business model innovation process by which entrepreneurs can ascertain which components of a (local sustainable) business model can be kept constant and which components have to be modified when going from an established business model in one rural area to new areas for replication in the context of rural electrification by community-level mini-utilities.

# 2 Methodology

## 2.1 Literature review

Rural electrification by entrepreneurs using renewable energy technology is a relatively new phenomenon, making this an emerging area of study. Further, the study of business models and business model innovations has also only recently evolved (Zott et al., 2011). Therefore, in order to develop a better understanding of this topic, the author started with an extensive literature review. The author has focused his search on two key areas: business model innovation by new venture creations and replication, and challenges in rural electrification in developing countries. The author conducted the literature search by using queries with keywords such as business model, business model innovation, replication, entrepreneurship, rural electrification and base of the pyramid, in different combinations for finding relevant literature in online databases such as Science Direct, where the keywords occurred anywhere in the text. The initial search results were then screened for relevance to the research question. Early in the process it became apparent that several reports from international policy agencies and books describing concepts and frameworks that are discussed by researchers and practitioners were also useful. It was therefore decided that these were eligible for inclusion in addition to refereed articles. In all a total of 44 articles, five reports and three books have been covered in the review.

The most interesting findings for answering the research question are presented in the next chapter: Literature Review and Initial Construct.

## 2.2 Case study design

To further develop the framework beyond the initial construct from the literature review, the author has conducted a qualitative case study. The case study method in this paper is a holistic multiple case study, aiming to develop new valuable insight for how the process of replication occurs in the context of rural electrification in developing countries. In this study, the unit of analysis is the business model. As the author has prior knowledge about the chosen firm's outcomes and aim to further develop the framework, the author has followed a literal replication design (i.e. predicts similar results), which can explain how the exemplary outcomes have occurred (Yin, 2013).

## 2.3 Case selection

In this case study, two companies are treated. As the author tries to reflect on some theoretical interest by developing a conceptual model, more than two cases would have been preferred to provide compelling support to the findings (Yin, 2013). However, the nature of this study makes it difficult to find appropriate case companies; there are few companies that have managed develop a viable business model in the context of rural electrification by mini-utilities, and therefore has never come to the phase where they can consider to conduct a replication strategy. This sets a natural limitation on which companies to choose from. Given the limited number of cases which can be studied, it is preferable to choose extreme cases and polar types (Eisenhardt, 1989). Therefore, the author has chosen companies with different business models to make the research more generalized to strengthen the framework.

Also, as the research is based on process that has already happened, it requires that the interviews are conducted in a retrospective manner. This implies that the author had to select companies where the persons involved in the process were still working in the company.

Third, as these firms operate in rural areas, it makes it costly to travel to collect data. The author was invited to a workshop on rural electrification in India, which made India the chosen country to collect data in. India is however a large country, and some companies work in very remote places, where it is difficult, costly and sometimes dangerous to travel to, which sets an even more strict limitation to which companies to research.

Based on these reasons, the companies that are analyzed are Husk Power System and Mera Gao Power. A short introduction to the companies is given below:

**Table 2.1: Short review of the case companies.**

| Husk Power System (HPS) | Mera Gao Power (MGP) |
|---|---|
| HPS was founded in 2007 and deliver electricity to households and enterprises in the state of Bihar, India. At the time they were founded, HPS produced their power from biomass gasification systems, where rice husk is the main source for biomass. In the later years they have also added solar cell systems as their source for power. Since their start in 2007, they have been provided electricity to over 200 000 people. HPS has approximately 350 employees across the state of Bihar, and more people are employed indirectly through their distributors. | MGP was founded in 2010 and deliver a product of two lights and a phone charger to households in the state of Uttar-Pradesh, India. MGP produce their power from solar cell systems. Since their start in 2010 they have been provided light and mobile phone charging to over 100 000 people, and has approximately 80 employees. |

## 2.4 Data collection

The data was collected by shorter case study interviews of about an hour per interview. The author's supervisor collected the data concerning Husk Power System in 2012, where the questionnaire was based on open-ended questions about the business model development process. The open-ended questions allowed for additional information (Yin, 2013), which made the collected data appropriate to use in the author's specific research. The data concerning Mera Gao Power was collected by the author in 2014, where a refined version of the same questionnaire was used. A positive outcome of collecting the data at different times is that both the companies were approximately 4-5 years old when the interviews took place. All interviews were recorded electronically by a tape recorder and were later transcribed in their entirety. In addition to the interviews, the author has used online newspapers to help clarify details that were not mentioned explicitly in the interviews. This is a good approach to remedy the main challenge with retrospective studies, namely that current situation influences the informant's earlier version (Flick, 2009).

## 2.5 Analysis method

The analysis was performed using the Grounded Theory concept. The specific analysis method used is thematic coding. In the first stage, the author did a within-case analysis with seventeen pre-determined categories. These were generated based on the author's prior knowledge on the topic. After analyzing the first case, the author found it necessary to expand the numbers of categories to 28 to be able to extract all the important information. These categories are found in Appendix A. The first case was analyzed once more based on the new

categories before the second case was analyzed. The coded data was then used to analyze the firm's business model through the lens of Morris et al. (2005) six component framework, first separately and then compared to each other.

## 2.6 Considerations about the method

When studying contemporary phenomenon in a real life context, which is the case of this study, case-study research is advantageously selected among the different research methods used in social science (Yin, 2013). Conducting case-study research is also ideal when doing research in new research areas (Eisenhardt, 1989), which is the case in the field of business models in rural electrification. In general, a holistic design has the disadvantage that the researcher can avoid examining any specific phenomenon in operation detail outside the unit of analysis, which can affect the results (Yin, 2013), but as the unit of analysis is a business model, which is built up by a broad set of interrelated components, the author find this disadvantage to be minimal in this study. Further, the author can be criticized for asking leading questions during a conversation-based interview. As the interviews for one of the two cases was conducted by a second person and was first analyzed after the data was gathered from the second case, the author has a strong case against such critiques.

# 3 Literature review and initial constructs

Replication strategy is derived from the resource-based view and involves efficient redeployment of knowledge and competences from one economic setting to another (Wirtz et al., 2007). In this case, the knowledge and competences is tied up to the business model. Although there is a discussion among scholars about business model innovation process in the context of bottom of the pyramid (BOP) markets (Thompson and MacMillan, 2010, Sanchez and Ricart, 2010, Yunus et al., 2010, Seelos and Mair, 2007), the replication process in general (Aspara et al., 2010, Winter and Szulanski, 2001, Sosna et al., 2010) and the need for building replicable business models in rural electrification (Schillebeeckx et al., 2012), the literature review shows that there is a lack of theoretical exploration on the nature of replication in this context.

To answer the research question the author has first reviewed the literature about business models, business model innovation for new venture creations, replication from the strategic literature and the challenges in the BOP-market. The most interesting views and models are presented in the following subsections. Thereafter, the author has bundled the most interesting findings and constructed a conceptual framework, which takes the challenging conditions from the BOP-market into account.

## 3.1 Business model

Business models have received increasing attention over the last decade, from both academics and practitioners (Chesbrough and Rosenbloom, 2002, Morris et al., 2005, Teece, 2010, Zott and Amit, 2007). A business model has been variously defined as "the architecture of the revenue" (Chesbrough and Rosenbloom, 2002); "management's hypothesis about what customers want, how they want it and what they will pay, and how an enterprise can organize to best meet customer needs, and get paid well for doing so" (Teece, 2010); The logic of the firm, the way it operates and how it creates value for its stakeholders (Casadesus-Masanell and Ricart, 2007); "Depicting the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities"(Amit and Zott, 2001). While there is no consensus in the academic literature regarding the definition or nature of a business model (George and Bock, 2011) and the diversity in definitions has made it challenging to limit the nature and components of a business model and determine what constitutes a good model (Morris et al., 2005), researchers and practitioners agree that all companies have a business model and at the core, a business model describes three important functions: to create, capture and deliver value (Holm and Günzel, 2013). Different authors have presented different conceptualizations of business models, and some of which are relevant for the research question is presented below.

### Business models as conceptual tools

Business models can be viewed as a conceptual tool, which here means it can work as a tool to conceptualize the way a company does business in order to reduce the complexity to an understandable level (Osterwalder et al., 2005). In a static approach, it provides a blueprint of what constitutes the company's operational and physical form (Nadler et al., 1997) and it helps to capture, visualize and understand the business logic (Nadler et al., 1997, Osterwalder et al., 2005). It helps the entrepreneur to reflect upon the business model by considering each

of the elements individually but at the same time understand that the elements are related to each other and that it is important to see the business model as a whole (Hulme, 2011). It aids in the process of building typologies and study the relationship between a given business model and performance (Baden-Fuller and Morgan, 2010). In a transformational approach, the business model is considered a conceptual tool to analyse the logic of the firm, address change and focus on innovation, either in the organization or in the business model itself. In this approach, a sustainable business model normally requires progressive refinements to create internal and external consistency (Demil and Lecocq, 2010).

Giving the business a graphical face it works as a tool to communicate the business to stakeholders and help in the discussion of how to align activities and allocate resources (Osterwalder and Pigneur, 2010). The relationship between the elements is important, because it is the way these elements are arranged, combined and integrated which determines if the firm may succeed (Baden-Fuller and Morgan, 2010) and gain competitive advantage (Morris et al., 2005).

### Business model as a reflection of realized strategy

Business models can also be viewed as a reflection of realized strategy where the "choice of business model through which the firm will compete in the market place" is the strategy of the firm (Casadesus-Masanell and Ricart, 2010) as seen in Figure 3.1. However, strategy is more than just a selection of a business model. It is also a plan of action of how the business model should be configured depending on what kind of situation that might occur in the future, outside the firm's control (Casadesus-Masanell and Ricart, 2010).

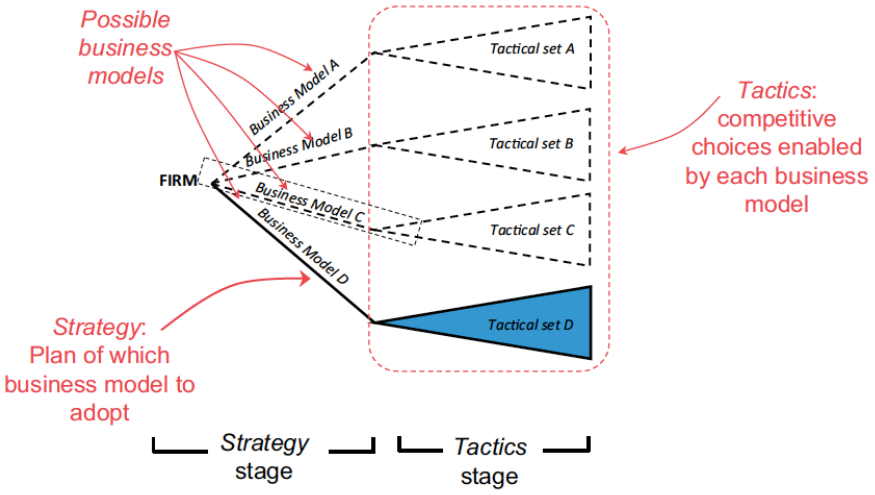


**Figure 3.1: Difference between business model and strategy. Source: Casadesus-Masanell and Ricart (2010).**

### Business model as a representation of an interrelated set of decision variables

The business model can also be seen as a concise representation of an interrelated set of decision variables (Morris et al., 2005) where choices on these variables determines a particular configuration of the model. Morris et al. (2005) has developed a framework that consists of three increasingly specific levels of decision making, termed the "foundation", "proprietary" and "rule" levels.

The three levels reflect the different managerial purposes of a model. At the foundation level, there is a need to make generic decisions regarding what the business is and what it is not, to ensure such decisions are internally consistent. The proprietary level enables development of unique combinations along decision variables that result in market advantage. At the rule level the entrepreneur creates guiding principles governing execution of decisions made at foundation, and proprietary levels.

At each level, six basic decision areas, which constitute the six components that construct the framework, are considered. These components are: factors related to offering, market factors, internal capability factors, competitive strategy factors, economic factors, and personal/investor factors. The complete framework is given in Appendix B.

## Business models as a source for learning

A business model can be seen as composed of a profit model and a business system, as seen in Figure 3.2. The business system is the system that actually produces and delivers the firm's products or services to its customers, within and beyond its boundary. Embedded within this business system is the learning system. The learning systems accumulate information from actions, and it is the organizations that do the actions that will learn (Itami and Nishino, 2010). To be able to learn from the operations, it is important to do some core activities in-house to build a proper delivery system that the firm learns from, and Itami and Nishino (2010) propose three important determinants to focus on when designing the business system:

1. Division of outsourcing vs. internal procurement
2. How to organize its in-house working system
3. How to control the activities of its trading partners

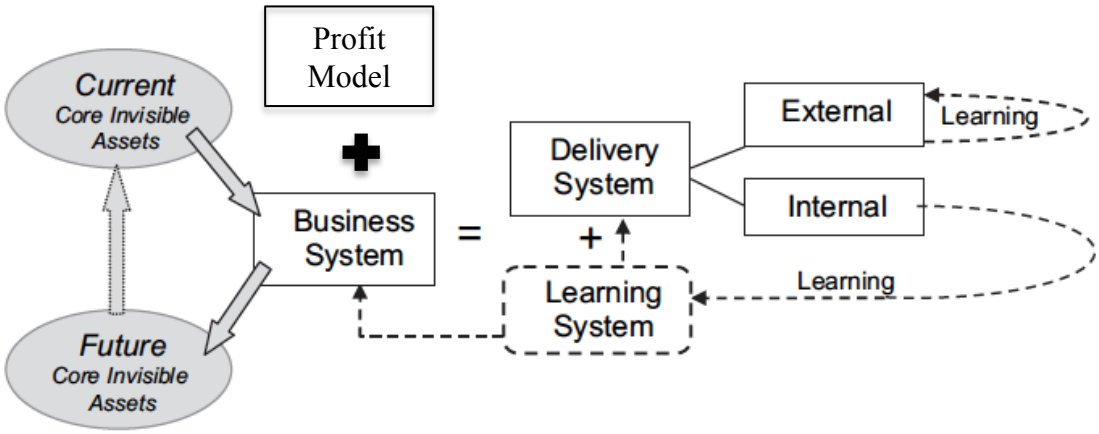


**Figure 3.2: Concept of a business model that emphasize learning. Separated into a profit model and business system. Source: (Itami and Nishino, 2010)**

## The usefulness of multiple views to answer the research question

The subsections above provide different ways of looking at a business model, which are all useful to help the entrepreneur organize the business model innovation process to enable replication. It is rare that the ideal business model appears early in emerging businesses (Teece, 2010), and there is typically a process of trial and error and experimentation that leads

to the refinement of the business model (Teece, 2010, Chesbrough, 2010). Business model replication also relies on learning (Winter and Szulanski, 2001) and it is therefore important to look at business models from a perspective which enables that. Such a view is supported by Itami and Nishino's (2010) model, as they help the entrepreneur to understand the importance of doing some core activities internally.

Decision of outsourcing and partnership is one example of a strategic question that underlies the business model. To uncover such questions, which are important in the development of the business model prior to replication, and through the learning phase of replication, the author has chosen to use Morris et al. (2005) six-component framework as the lens of analysis throughout the case study. The author has used Morris et al. (2005) definition of a business model as follows:

*"A concise representation of how an interrelated set of decision variables in the area of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets"*

As codification and transfer of knowledge are fundamentals of replication (Wirtz et al., 2007), it fits well to look at replication through the lens of Morris et al. (2005) framework, as their framework talks about transformation of the business model from foundation level to proprietary and rule level to gain sustainable advantage. The process of going from foundation level to proprietary and rule level is also the final part of the process of developing an Arrow Core, which the author will describe further in Chapter 3.3 – Replication strategy.

As it will be important to communicate the replicable business model to the new outlets, the author includes the concept of a business model as a conceptual tool. At last, as the notion of business model can seems to materialize similar to strategy, the author has included Casadesus-Masanell and Ricart (2010) model to the paper, to help distinguish strategy from business model.

## 3.2 Business model innovation

To find a flexible and appropriate business model is important for any firm, and a well constructed business model increases the entrepreneurial firm's performance (Zott and Amit, 2007). A new firm that tries to find fundamentally new ways of doing business that will disrupt an industry's existing competitive rules or find new markets and competitive space are involved in business model innovation (Ireland et al., 2001). The search for an appropriate business model can be divided into two stages (Blank, 2013):

1. Design the new business model, which is meant to set the boundaries of the organizational structure.
2. Prove its scalable and reproducible character.

Entrepreneurs that aim to discover and exploit new business models must employ a strategy based on experimentation and learning rather than conventional strategy that emphasize analysis (McGrath, 2010). This is because there might be insufficient data available to analyze the case (Chesbrough, 2010), and the more uncertain, complex and rapid-changing the environment is, the more this becomes true. To be able to reveal and generate new information, the firm must take experimental action (Chesbrough, 2010).

While experimenting with their business model, the principle about the fidelity (i.e. the degree the experiment is representative under actual use conditions) should be in the entrepreneurs mind when designing the experiment (Thomke, 2003). In this case, the most efficient experiment regarding fidelity is to test your business model on real customers paying real money in real economic transactions (Chesbrough, 2010). The degree of fidelity, the cost of conducting the experiment, both directly and the cost of failures, the time required to obtain feedback (iteration time) and the degree of change from the normal status are all factors affecting the learning by experimentation (Thomke, 2003). Therefore firms should try to create processes that provide high fidelity as quick and cheap as possible with the goal of a high degree of cumulative learning (Chesbrough, 2010).

Different academics present different views of how these processes should be organized and the following sections present some of these views:

### Experimenting through visualizing the business model

From the perspective of the business model as a conceptual tool, the experimentation can be organized through visualizing the business model. Constructing maps of business models can help clarify the interconnection between the business model elements and how they affect each other. This can become a source of experiments considering alternative combinations of the elements, helping creative entrepreneurs and managers to build new business models (Osterwalder et al., 2005, Chesbrough, 2010, McGrath, 2010). One such conceptual tool is the Business Model Generation Canvas, developed by Osterwalder and Pigneur et al. (2010). The Business Model Generation Canvas is given in Figure 3.3.

As the Canvas makes it easier to visualize the logic of the firm, it makes it easier to analyze it as well. Measuring, observing and comparing it against other companies' business models in the same or other industries will help improve the model and modify certain elements as the environment changes over time.

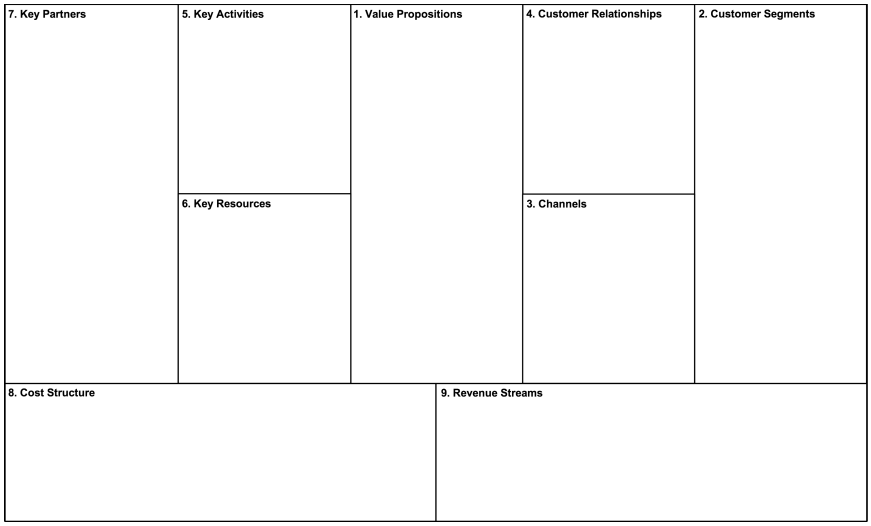


**Figure 3.3: The Business Model Canvas. Source: (Osterwalder and Pigneur, 2010)**

### Customer development model

Some authors emphasize real life experimentation and learning processes. Blank's (2013) Customer Development Model is a four step iterative process, which simultaneously explores the market and develops the product or service, as seen in Figure 3.4. This model was constructed due to the fact that so many start-ups fail while following the product development model. Blank (2013) believes the most important thing to do as a start-up is to learn about the customer, but the product development model does not give room for learning before the product is done, which is often too late.

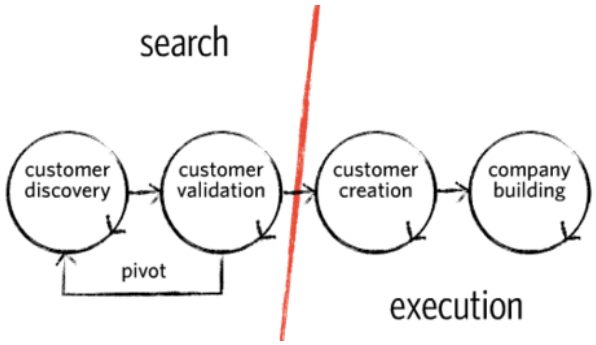


**Figure 3.4: Customer development process. Source: Blank (2013)**

The first step is "customer discovery" and is the first step to evaluate if the core of the business model makes sense. It focuses on understanding the costumer's problems and needs and helps to evaluate if there is a real market for the product/service. This step is based on one of Blank's principles: the vision of the company is based on the entrepreneur's idea or technology. The venture needs to find those customers that fit with their idea or technology, and it should not be the other way around. Only if the firm can't find these customers, or the value given is not enough for the customers, should the entrepreneur change his vision. This principle comes from the fact that since start-ups have so few resources, they can't afford to receive requests for new features from all early customers. They first need to find those customers that fit their vision the most.

The second step is "customer validation", which tries to build a replicable sales road map. Here the firm tries to get some early costumers with a repeatable sale process to verify the existence of customers, the perceived value, and to check if the price and delivery channel is appropriate. This step is essential to verify if the firm has a product/service that customers want to buy and if they have the right perception of which channels to use (Blank, 2013). From this step it is an arrow back to the customer discovery step to show that this is an iterative process that goes in a loop until the firm has found product-market fit.

The third step, "customer creation", has the goal of creating and deriving end user demand and is based on the success the company had in its initial sales. The fourth step, "company building" takes the firm from learning and discovery driven customer development to structuring the company to make it capable of exploiting the company's early market success.

It is important to emphasize here that the process depicted is highly iterative and re-examining is a natural process and a valuable part of the learning process. The model stresses the need for enough success at each step before the firm goes forward to the next step, which will help to create a robust business model (Blank, 2013). By not investing in their non-product

development team before the business is proved viable, it will help the firm to keep a low cash burn rate during the verification process and to help not scale prematurely.

This process of experimentation to develop a robust business model first and then going to exploitation of the business model is supported by Sosna et al. (2010), in their study of an incumbent firm. They identified four stages: initial business model design and testing, business model development, scale-up with suitable business model, and sustained growth though organization wide learning. The first two stages are grouped as "exploration", while the latter two as "exploitation", as seen in Figure 3.5. Here too the emphasis is on testing the hypothesized model on real customers and using the learning to adapt the business model to a more robust version that can be used to scale-up.

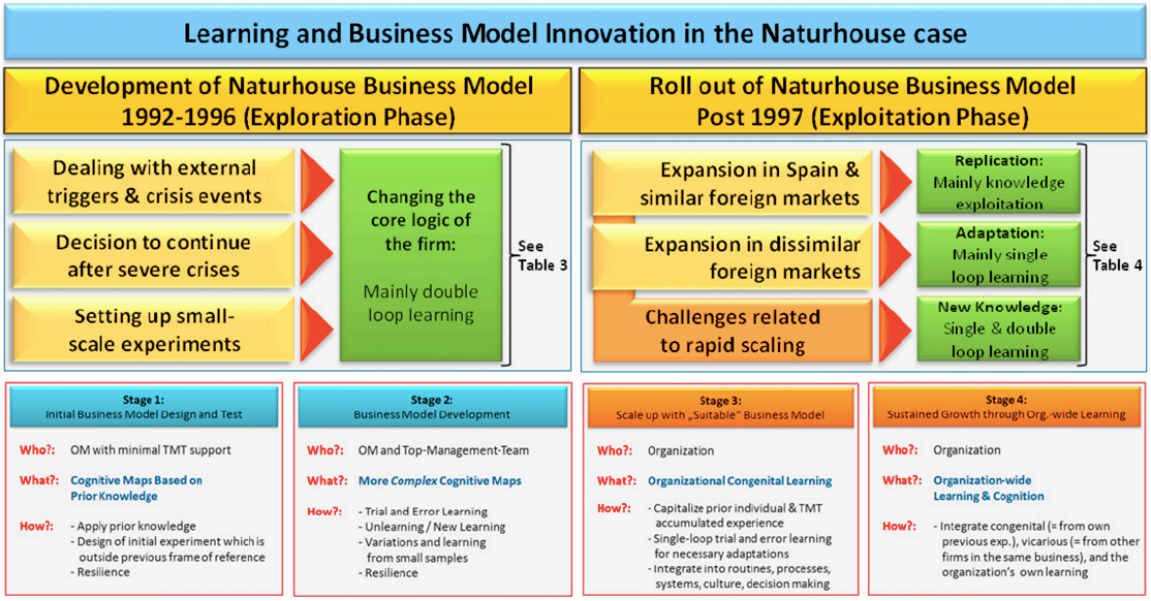


**Figure 3.5: Framework for learning and business model innovation process.**
**Source: Sosna et al. (2010)**

## Purposeful experimentation- a sequential approach

Commenting on what the experiment itself should look like, some authors emphasize the idea of "purposeful experimentation" where the entrepreneur first identifies a decision to be made, then builds separate hypotheses for the different outcomes and tests these hypotheses by real world actions through investments and prototype development. After conducting the tests, the entrepreneur evaluates the results before taking further actions. This approach is a very analytical and has been called purposeful experimentation as they have originated in a conscious manner rather than the opposite which may be called haphazard and opportunistic experimentation (Murray and Tripsas, 2004).

The "minimum viable product" (MVP) in The Lean Start-Up advocated by Ries (2011) is an example of purposeful experimentation where the MVP which only containa the most necessary features of the product is tested by putting it in the hands of the customers to get direct feedback and ascertain if the core of the business model makes sense. By turning ideas into MVP, the firm can measure the customer's response and learn whether to continue or change the hypothesis (persevere or pivot).

Ries (2011) takes the principles from lean manufacturing and agile development, stating that the entrepreneur should learn from short production cycles which will give continuous improvement and agile methodologies to the entrepreneurial context of helping the firms to design its products/ services and its business model (Trimi and Berbegal-Mirabent, 2012).

By having smaller and faster iterations for testing a hypothesis, the approach utilizes the firm's scarce resources by not using the resources on anything else than what creates value for the customer. On these bases, Ries (2011) has developed a diagram called "build-measure-learn" which shows the process conceptually (Figure 3.6). The circle represents an iterative process and Ries (2011) argues that a sequential method gives the best result by emphasizing the importance of minimizing the time through the loop.

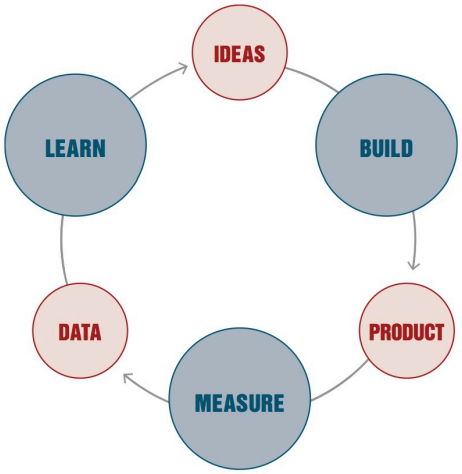


**Figure 3.6: Build-measure-learn diagram. Source: Ries (2011)**

### The different views helpfulness to answer the research question

Common to all the processes above is that they emphasize the importance of learning based on experimental action, and to set up a hypothesis about the entrepreneur beliefs about what constitutes a good business model through a framework like the Business Model Generation Canvas. This is helpful in the process of doing the experiment and evaluating the results afterwards before the company goes into an execution phase of growing the venture.

The processes above achieve the goal of high fidelity as all the authors emphasize trial-and-error through real life experiments. However, even if the authors talk about the importance of experimenting at the lowest possible cost and time, cost and time are still very industry specific and is not well described in the literature.

The customer development model, and build-measure-learn diagram emphasizes the need for learning about your customer, their habits and how to attract and retain them, which is also emphasized as important in the literature of BOP (Schmidt et al., 2013).

## 3.3 Replication strategy

### Concept of Arrow Core to find a replicable model

Replication is a strategy to gain firm growth, and companies that have a high strategic emphasis on both business model innovation and replication have a higher average financial

performance than companies that don't (Aspara et al., 2010). Replication is done by refining the business model, by choosing the necessary components to replicate that model into new geographical markets and by developing capabilities to efficiently transfer knowledge (Winter and Szulanski, 2001). The main strength of a replication strategy lies in reaching a large market quickly, rather that the depth or length of the return (1bid).

Because speed of replication is important in a competitive setting, the replicator must use its experience with the business model to understand which traits of the business model is replicable and which actions must be taken to reproduce these traits, and not at least which traits are worth replicating. This knowledge about what is replicable and what is worth replicating, together with the knowledge about the characteristics of the environment in which the business model creates satisfying value, is called the Arrow Core (Winter and Szulanski, 2001). The traits mentioned above include, among others, knowledge about the features of the product/service that gives value at each "outlet", the procedures involved in local production and commercialization, and the procurement methods needed to be dealt with locally and site-specific supply and demand information.

The goal is to replicate only those components of the business model that are replicable and add value. The Arrow Core must be acquired by experimental learning, where the Arrow Core is first set up, as a hypothesis about what is profitable and what is not profitable to replicate. A central organization that has the capabilities to transfer the Arrow Core to new outlets is recommended. As the hypothesis is verified or disproved and refined through creation of new real outlets (experiments), the firm can easier distinguish the Arrow Core from the "working example" called a template. The template will include features that are not a part of the Arrow Core: for example the, unique personality to the manager in a specific outlet. The most successful outlet is regarded as the template - a guiding example of how a desired outlet should look. Winter and Szulanski (2001) has developed a conceptual framework that describes the process, see Figure 3.7.

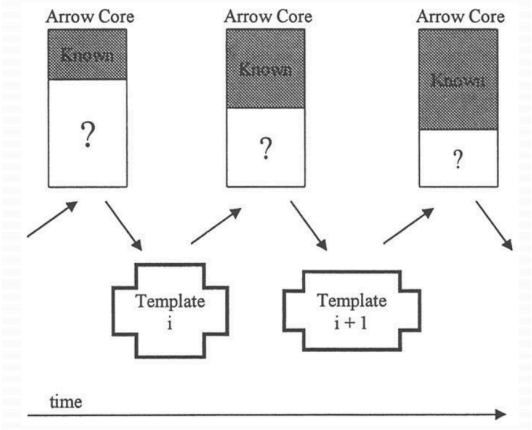


**Figure 3.7: Experimentation to find the Arrow Core as a linear process.**
**Source: (Winter and Szulanski, 2001)**

It is the learning from experience of setting up new outlets that drives the recognition that there is a successful Arrow Core that may create a replicable business model. This exploration phase is most effective when a clear hypothesis about the Arrow Core is developed. Unfortunately, the largest cost to find the Arrow Core of a business model is in the early life of the chain. Due to the high cost of setting up a new outlet and the high cost of failure, parallel testing of different untested business models at different outlets are rare, and Winter and Szulanski (2001) recommend linear processing at the start. Later on, when the firm

commits to a large-scale replication and when more outlets exist, different outlets might be used at the same time as the template to create the desired new one.

In this setting, replication is defined as creating new outlets with the capabilities for local productions, or creating local services. Hence, if the new outlet is only selling a product and the mother firm is only sending out materials and instructions without support and involvement to the internal processes and operations of the outlet, the extent and scope of knowledge transfer would have been minimal.

As already mentioned, the main strength of a replication strategy lies in reaching a large market quickly, rather that the depth or length of the return (Winter and Szulanski, 2001). This is a perfect fit with the nature of the market of rural electrification where there is a need for serving a large amount of poor who have a low purchasing power. However, even if there is growing academic interest around the strategic orientation of doing business model innovation to be able to enter low income markets (Seelos and Mair, 2007, Sanchez and Ricart, 2010, Thompson and MacMillan, 2010), replication of its own successful business model as a potential strategic decision for firm growth has only been described in general (Aspara et al., 2010, Winter and Szulanski, 2001, Sosna et al., 2010), but no model takes the challenging conditions related to the BOP-market into account.

## 3.4 Challenges in rural electrification in developing countries

Rural electrification is a challenging task, especially in the developing world. It is characterized by the need to serve dispersed populations, in low-density settings and high variations in demand coupled with low ability to pay (Zerriffi, 2011).Very few organizations have been able to scale-up in this setting (Zerriffi, 2010). One of the primary reasons for this is that there is a lot of uncertainty associated with off-grid electricity supply. When the dimension of renewable energy technologies is added to the tough conditions of the rural electricity market, matching this new technology to the already unpredictable demand adds to the uncertainty in this market. On the demand side, for people in rural areas with low and seasonal income, electricity is not an integrated part of life. It is therefore difficult to predict user behavior and willingness to pay in this setting (Martinot et al., 2002).

This shows that applying the presented models directly might be insufficient in such a challenging context. Therefore, the following section gives an overview of the challenges related to rural electrification, which need to be taken into account in the development of such a framework. The literature on rural electrification can be categorized into four different lenses: technology, institutional, viability and a user-centric lens (Schillebeeckx et al., 2012), and are used to categorize the following sub-sections.

### Challenges related to technology

The chosen technology is linked to the local cost of energy and the environmental impact. The cost of energy is a function of several parameters such as the availability of natural resources (water flow, solar, wind, bio etc.), price volatility of diesel for diesel generators, and the available infrastructure for transporting input resources and setting up the system (Raffaella and Garside, 2013, Schillebeeckx et al., 2012). Developing countries with its low quality of infrastructure are also more vulnerable for extreme weather, which also is a driver of technology choice (Schillebeeckx et al., 2012).

The lack of after-sales maintenance network in the remote rural areas also has bearing on this (Palit and Chaurey, 2011). This makes it difficult to decide upon the "right" technology for rural electrification.

## Challenges regarding the users

### *Affordability*

Most people at the base of the pyramid have a low income, few savings and a lack of experience in purchasing durable goods, which hinders their affordability of electricity services (Banerjee and Duflo, 2007, Zerriffi, 2010). Though they spend money on kerosene, diesel and mobile charging services, this is more on an ad-hoc basis and periodic payments may therefore be difficult. They often need credit to invest in electricity generating technologies, but the credit market often is non-existent or poorly developed and lenders who consider such systems as consumable goods often require regular income, which the poor often do not have (Sengendo, 2001). It is thus a challenge to fix price and payment schedules.

### *Reliability*

Disregarding the affordability, the customer's decision to connect is also affected by the reliability of the power supply in relation to its quality, service level and sufficiency. Traditional supply with long feeder lines, poor maintenance and shortage of power generation often result in low quality electricity being delivered to rural customers (Zerriffi, 2010) and studies of rural electrification have shown that the quality of the electricity supply affects the household's decision to use electricity (Kemmler, 2006). This makes it harder to estimate the customer's response to availability.

### *Local embeddedness*

Cultural sensitivity, competence building and community involvement affect how electrification is embedded in the community. Cultural values, traditions, beliefs, societal norms and social structures are all parameters that need to be taken into account to ensure local acceptance of electrification (Schillebeeckx et al., 2012, Raffaella and Garside, 2013). Some studies report a mindset of "electricity is for free" which makes the investors and entrepreneur face the challenge of collecting electricity fees and avoiding electricity theft (Schmidt et al., 2013).

## Challenges in viability

The low density in rural population gives higher delivery costs and make the logistics of implementation and maintenance more complicated (Zerriffi, 2011). This combined with a low consumption gives an overall high capital costs spread over low returns, among the different distributed electricity alternatives (Zerriffi, 2010).

Like the customers, vendors also suffer from lack of access to credit. Since many of the entrepreneurial ventures in rural electrification have little credit history and it is hard to assess the risk, entrepreneurs find it hard to get loans from commercial lenders (Zerriffi, 2010). This high investment risk increases the financing costs and thereby the overall costs that has to be covered by the customers.

The poor's affordability problems and the lack of commercial lenders have brought subsidies into the picture. In addition to the positive, some subsidizing projects have given counter-productive results: one of these is destruction of viable markets for appropriate technologies

where some energy alternatives is favored (Zerriffi, 2010). Another problem can be that subsidizing creates a non self-sufficient market, which can terminate the market once the subsidies are gone.

### Institutional challenges

The electricity distribution sector in general has been structured nationally throughout the world, which has created a culture that gives resistance to rural electrification projects. The lack of a transparent energy policy set by the government stating who is allowed to build and operate power plants, to sell energy and gain access to transmission and distribution channels can make it hard to make investments in given areas (Schillebeeckx et al., 2012). Thompson and MacMillan (2010) also reports that every development project through the Wharton Societal Wealth Program had been plagued by one or more instances of inertia, lack of support, bureaucratic foot-dragging or corruption by opponents.

The lack of skilled local human resources to build, operate and manage the plant is a major challenge for running the plants efficiently (Schmidt et al., 2013).

Due to the resource scarcity in the BOP-market and the complexity of the market, there is often a need for partnership to capitalize on the strengths of each partner (Schillebeeckx et al., 2012, Yunus et al., 2010). These partners might be central and local government, international organizations, NGO's, monetary partners, communities and local entrepreneurs and businesses, which require new ways of arranging the business model. An absence of sustainable partners have hindered the scale-up of the technical innovations that provide distributed power (Chaurey et al., 2012).

### The different challenge's impact on the replication process

A table with examples of conditions under each of these lenses and their potential impact on the business model components is presented in Appendix C. Key points to note are that there are a number of unknowns and these unknowns can vary from village to village, area to area and region to region. For example, access to resources (for instance, bio-mass) can vary from location to location and season to season. Whereas, access to finance and subsidies, where available may be negotiable for all locations from one or a few agencies. This implies that the entrepreneur needs to establish which business model components are more or less flexible or more or less subject to change, relative to others. Under these conditions a more dynamic perspective is needed for developing a replicable business model of the firm, which allows for the development of a replicable core that together with the more flexible components constitutes a coherent whole as the firm's business model.

## 3.5 Multistep process to handle high uncertainty

The combination of challenges in rural electrification makes it a highly uncertain setting for entrepreneurs. In this context of uncertainty, where there is "little or no market structure, no clear meaning and unknown dependence" (Santos and Eisenhardt, 2009), the entrepreneur needs to act to reduce uncertainty, while also designing the business model (Thompson and MacMillan, 2010). Thompson and MacMillan (2010) have proposed a multistep process for the creation of a business model in the BOP context, designed to reduce the uncertainty to a level which the entrepreneurs can better handle. The key point in Thompson and MacMillan's (2010) process is to experiment, learn and develop a feasible business model at the lowest

possible cost. Due to the high uncertainty, Thompson and MacMillan (2010) take an effectuational perspective: encourage action, which stimulates response that can be the center of analysis and the results give input to the evolutionary development of the business model. This is summarized in Figure 3.8.

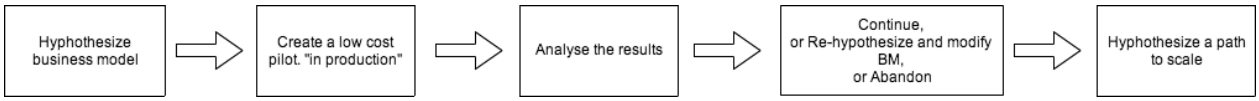


**Figure 3.8: Multistep process to handle high uncertainty in business model development. Source: author**

Their principle is to first develop a small-scale pilot based on a hypothesized business model, which is used to develop the actual business model. The pilot is used as an experiment from what the entrepreneur can learn at a low cost. The pilot should be an operative business, which tests the different aspects of uncertainty mentioned in the previous section. The results from the pilot give the entrepreneur three options: a positive result lets the entrepreneur go to the next stage, which is to make a plan about how to scale the business (meaning increasing the product/service capacity from a pilot to a larger, more cost effective business or to replicate the business to new geographical areas). Unsuccessful outcomes gives the entrepreneur the opportunity to either modify and re-hypothesize the business model and change the pilot, or to abandon the project if no redirection is possible. Thompson and MacMillan (2010) discovered that in all of their cases, there was a need to re-hypothesize, as the actual business model drivers unfold as the project develops.

Their process is interesting in the context of rural electrification, but they are focusing on the business model development process rather than replication process. The last step in their process can be said to end where the authors study begins, namely to organize the learning process to ascertain which components of the (local sustainable) business model can be kept constant and which components have to be modified when going from an established business model in one rural area to new areas for replication. Further, the author finds some key points useful in replication as well, such as creating a low cost pilot to be used when the entrepreneur should try to replicate the business to new geographical areas with the new potential challenges that comes with it.

## 3.6 Initial construct

The author has summarized the literature review and developed an initial framework for experimental learning in search for a replicable business model in the context of rural electrification by mini-utility systems. The first phase of the framework describes the actual learning process as shown in Figure 3.9.

To find the Arrow Core in rural electrification, a firm needs first to have a local viable business model in one village. The way the firm creates, captures and delivers value in this village will be the first template and the hypothesized business model for the second village. The firm should try to find a village that best fits the core components of the first business model.

Due to the changing conditions between villages, the multistep process presented by Thompson and MacMillan (2010) is useful in the development of the local (meaning village

specific) business model. Running a pilot, which includes all elements of the template, creates the opportunity to discover site-specific challenges that might affect the business model.

As the firm develops a local viable business model for the second village based on the first template, it will have the opportunity to see what components of the first business model is replicable. It is now developing its Arrow Core. The better run village will be the source for the template and the hypothesized (local) business model for the third village. This process continues with a sufficient numbers of villages until the firm has sufficient knowledge about its Arrow Core.

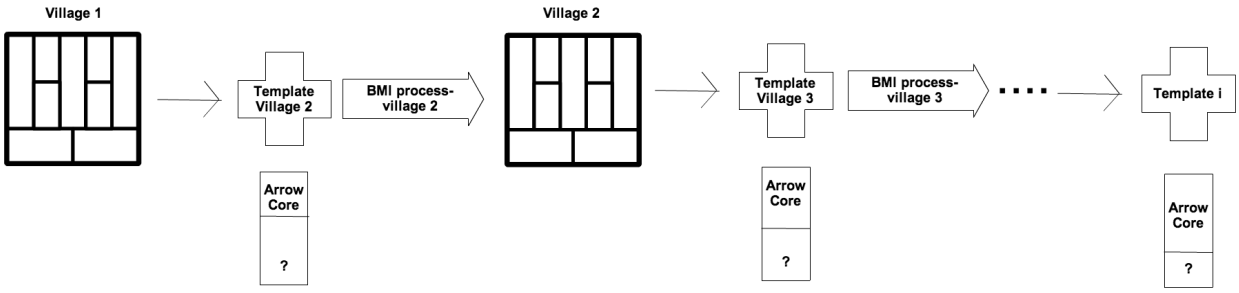


**Figure 3.9: Learning to replicate in rural electrification. Source: author**

In a detailed view, the process of developing the Arrow Core begins with the templates, which becomes the birthplace for creating a hypothesis about the Arrow Core, shown in Figure 3.10. The hypothesis is then tested and ends in a transformation of the business model from foundation and proprietary level toward the rule level. These rules ensure that the business model components on the foundation and proprietary level are reflected in ongoing strategic actions (Morris et al., 2005) and help the local manager to execute the local business model.

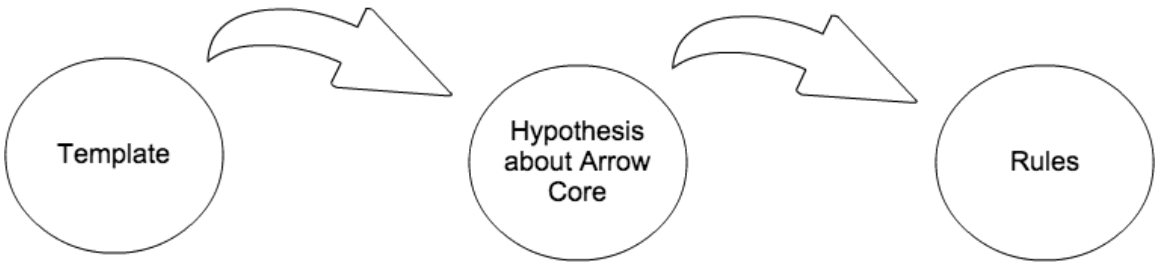


**Figure 3.10: The process of developing an Arrow Core. Source: Author**

This overall learning process can be related to the first two steps of Blank's customer development model (CDM), the search phase, as seen in Figure 3.11. In Blank's CDM, the first step is to hypothesize the business model and try to get it verified by talking to enough potential customers who can give feedback. This can be linked to the first step of finding a viable business model for the first village. The viable local business model in this village will be the entrepreneur's hypothesized business model for all subsequent villages. In CDM's second step, the firm tries to build a replicable sales road map based on the business model found in the first step. The business model is not developed fully yet and more details will be found as the firm tries to reach out to multiple potential customers. The firm is still trying to reach just a small amount of customers as they still are developing the business. In the

author's process, the single customers can be changed out with villages, and a sales roadmap includes the necessary partners and suppliers to serve the village. As the firm reaches more villages it will find a pattern over which parts of the business model are replicable, and what conditions the village should have to best fit the company's business model. If no such pattern is found, the company should go back and re-evaluate its business model. This is all part of the search phase.

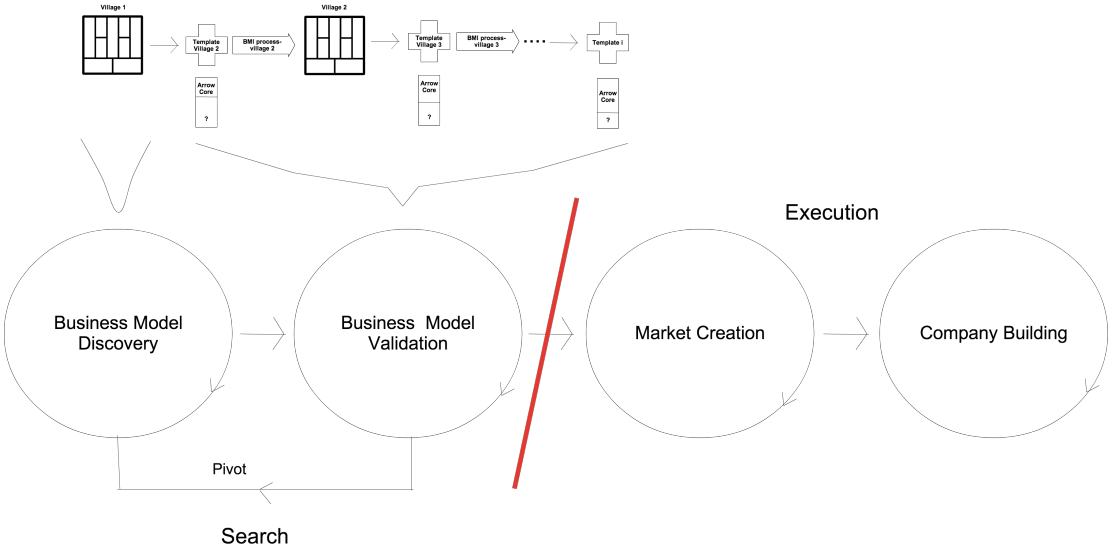


**Figure 3.11: Framework for managing the company building and the search for a replicable business model. Source: author, based on Blank (2013) framework "Customer Development Model".**

Only when the firm has sufficient knowledge about the customer, the delivered value proposition, which partners are needed in the different villages and what the firm should do when entering a new village, should the company enter an execution phase and start to build a larger organizations which can create demand and serve new villages simultaneously on a larger scale (CDM step 3 and 4). This is in compliance with Blank's philosophy of how a company should be built.

# 4 Data Analysis

While the unit of analysis is the business model, the data analysis is broken into three parts: the theoretical framework that the author derived from in the initial construct envisages that a company goes through an exploration phase followed by an exploitation phase. Therefore existence of an exploration phase followed by exploitation phase is the first parameter that will be used to explore the compliance between the framework and the case study firms. The process of going from hypothesis and learning into creation of operating rules is the nucleus in Arrow Core development and will be used as the second parameter. Finally, as identification of an Arrow Core is the foundation of the framework, the author will provide a snapshot of the Arrow Core at the time the case companies' step into the exploitation phase. Briefly summarized, the following parameters will be used to explore the consistency between the initial framework and the case study firms:

- Existence of an exploration phase followed by an exploitation phase
- The process of developing the Arrow Core
- The existence of an Arrow Core

The case study firms are first compared separately against the parameters. This is followed up by a comparison of the two companies' business models with the objective of understanding the similarities and differences' effect on the replication process. This will serve as the foundation for further development of the framework.

## 4.1 Existence of an exploration phase followed by an exploitation phase

The framework describes a shift in actions when going from the exploration phase and into the exploitation phase. The exploration phase consists of the learning process of finding the viable business model and the learning process of finding the Arrow Core, whereas the exploitation phase focuses on the execution of the replicable model by creating a market and building the company. The author tries here to present the existence of the two phases and will use the components and sub-components of Morris et al. (2005) framework to structure the section.

### Husk Power System

#### *Phase of exploration*

The founders started first to look at potential *technological solutions*. They investigated wind, hydro, thermal, solar and biodiesel but they all had some limitations regarding technology, price or ability to scale. They got to know about biomass gasification technology and tested this out on their first plant, which came up in Tamkuha in August 2007. This can be said to be the time when the founders stepped into the first step "business model discovery" in the theoretical framework.

Their gasification system consists of different components and the overall system had never been tried out earlier. The founders did not know how to make the components work together, make it work over longer periods of time and how to make it work with husk as the source of biomass. Therefore, they initially did a lot of *research and development*.

At the same time they developed the technology, they worked to understand other aspects of the business model such as *product offering and how they were going to earn money.* In the start the customers paid 30 rupees per month for six hours of lighting. HPS took the strategic choice of *not using any partners*, except vendors. They were doing everything from site selection, installation, operations, maintenance and rent collections to R&D themself, which gave them a *broad source of internal competences.* This made them able to learn and evolve as they adjusted to local conditions and they managed to operate the plant profitably.

*Marketing* was developed after the first village, and they learned that it was best done "word of mouth". The value proposition that the founders communicated was that they would save money, as it was cheaper than kerosene lamps.

Nine months after the first plant was running, the second plant was installed in June 2008, seven kilometers away from the first plant. The third plant was installed in October 2008. In 2009 they installed six plants and in 2010 they installed approximately six more plants. The founders developed the capability of transferring their knowledge to the local management and they founded the Barauni Training Center to efficiently manage the increasing numbers of operators who needed training.

### *Phase of exploitation*

Due to the fact that each plant needs four operators, which is difficult to manage as the number of plants grows, the founders understood that it would be difficult to grow the company by doing all operations themselves. Therefore when the company was ready to enter the exploitation phase and scale up, the founders *outsourced the daily operations* to local entrepreneurs who were in charge of local employment, power generation and distribution, and collection of revenue. The local entrepreneur was trained to operate the plant and adapted the local business model, which HPS had developed. In exchange, the entrepreneur paid a flat fee per month to HPS for the license to operate the plant. HPS installed approximately thirty plants like this during 2010 and 2011.

When the local banks saw that the local entrepreneurs were able to run the plant profitably, the banks felt confident to lend money to the local entrepreneur. The entrepreneur could then buy the plant from HPS. With this model, HPS is purchasing the components and building the systems, and is responsible for installation and necessary engineering maintenance of the plant, while the entrepreneur pays HPS upfront for the plant and is solely responsible for the daily operation and revenue collection. Until the day of the first interview in February 2012, HPS had set up twelve systems where a local entrepreneur both owned and operated the plant.

*"We are looking for entrepreneurs who are willing to take our business model, and set up their own plant, and running that as an independent unit." -Mr. Satish, Manager, HPS*

In the case of HPS, it was no remarkable shift when going from exploration to exploitation. The transformation from internal operation to external operation happened gradually and HPS still set up some few plants that they own, to keep themselves up to date on the technology and operation. However, by looking at their overall timeline, it is obvious they went from a learning phase where they installed fifteen plants in the first three years to an execution phase where they installed over forty plants in the next year and a half.

## Mera Gao Power

### *Phase of exploration*

When MGP set up their first *solar power system* in August 2010, they had a clear hypothesis that they should outsource the *construction and installation* to a contractor, *outsource distribution* to a local entrepreneur, and use a local NGO for *marketing*. They soon realized that this did not work. The contractor and the local NGO underperformed and the local entrepreneur had no power or was not willing to use any power to force his fellow villagers to pay.

The founders also had a clear hypothesis about the *product offering* and how they *where going to earn money*: they thought people would be willing to pay 100 rupees for two lights in nine hours. They quickly learned that when they did not provide phone charging, people came in a situation where they were willing to steal electricity to be able to charge their phones. This situation became a quality problem as well as a cultural problem as people got used to stealing which often resulted in a drop of voltage, which in the worst case could lead to the whole neighborhood losing power.

The second village came in November, three months after the first village and the founders had *changed their strategy regarding outsourcing*: the plant was solely run by the founders. They managed the marketing, installation, operation, money collection and maintenance themselves.

In the next half-year, they were looking into different *technological solutions* for how to allow phone charging and how they could *earn money* on it. Their solution was implemented in the newest system, which they set up in the third village July 2011. The founders looked at the first three plants as pilots and they decided to uninstall those systems and start their commercial operations in a new district in December 2011, where the local people where not influenced by the mistakes the founders had been doing at the beginning.

Prior to commercial operation, they hired a third person with background from micro-financing to further develop replicable procedures related to installation, revenue collection and maintenance. As of February 8th 2012, they had extended their network to five villages. In the next two months they tested if they had a replicable model by installing in another ten villages.

### *Phase of exploitation*

In March 2012, after installing a total of fifteen systems, they had optimized their business model and were ready to scale up. With a newly received grant from USAID of $300 000, they had the funding to provide 2400 households with electricity until they secured equity financing in February 2013. Since the beginning of exploitation phase, they have been doing the same model, which has enabled installation of up to fifteen systems per day. There were no structural changes in MGP's business model when they entered the exploitation phase, as MGP still owned the systems and conducted all operations themselves by employing local operators and collectors. The only shift laid in the change of focus from learning to execution, which has increased their speed of installation. As of February 20th 2014, they have provided electricity to 18000 households with a staff of about eighty.

## 4.2 The process of developing an Arrow Core

The process of developing the Arrow Core goes from the creation of templates to creation of hypothesis about the Arrow Core, which ends in a transformation of the business model from foundation and proprietary level toward the rule level.

The author has extracted the processes for the different business model components and highlighted them in Table 4.1 and 4.2 for HPS and MGP respectively, where the third column "Rule" is the output of the Arrow Core development process and constitutes the rule level of the local business model as defined by Morris et al. (2005). Below is an explanation for the first point in Table 4.1 to give a better understanding of the structure in Table 4.1 and 4.2.

HPS first plant was installed after the founders had been speaking with some households in a random village, which immediately liked the idea and welcomed them to start immediately. When the first plant was in operation, people from nearby villages were inspired after hearing that people saved money and they could see the lighting in people's homes in the evening. After the founders' experience with seeing how easy it was to convince people and hearing how people asked for a system in their village as well, they came up with the *hypothesis* that "marketing is done word of mouth" is replicable to every village. Their experiences from the first village serves here as the *template*. After trying this out in some other villages, they understood that the most cost-effective way to convince people was to let them hear it from others and let them come and ask for it. This knowledge got translated to the *rule* "don't go to the village for marketing before at least some from the village comes and ask you to set up a system". This way, HPS was able to transfer some of the work to some of the interested people, which helped to find a sufficient number of people who wanted the service in a village.

**Table 4.1: Process of developing the Arrow Core for Husk Power System**

| Template | Hypothesis | Rule | Component |
|---|---|---|---|
| The first plant was installed after speaking with some households in that village | Marketing is best done word of mouth | Don't go to the village for marketing before at least someone from the village comes and ask you to set up a system | Internal capability factor: marketing |
| After installing some few plants they were able to understand how a village should look like to be able to serve it profitably | A preliminary survey is necessary to find the right villages | Only install a plant if they pass the preliminary survey | Internal capability factor: operation procedure |
| After entering some villages, HPS learned what kind of person they needed for the job as a local manager. With this knowledge, they created a psychometric test, which gave a personal profile of the candidate | It is possible to find a person with x, y and z set of skills | Only install a plant if the potential local manager passes the psychometric test | Internal capability factor: operation procedure |
| During operation of the first plant the founders saw the necessity of training a local manager and operators | Most of the operators hves no past experience and they all have to go through the same training | Every manager has to pass the training program at Barauni Training Center/ HUSK University | Internal capability factor: Human resources |
| As a part of their vision the founders wanted the ability to serve more than basic lighting. Based on the technology-choice, they understood that it would be possible to serve a customizable product | With the chosen technology, it will be possible to provide a customizable product to every village | Regardless of chosen product, charge the customer for maximum potential load in each connection, up-front | Factor related to offering: Product/service offering |
| Through the founders work in the first few villages they understood when it was easiest to collect | Everyone is out in the field during the day, so the collection should happen in the morning | Collection should happen before 10am | Internal capability factor: operation procedure |
| They also got a sense of how to follow up households, which did not pay | Most people need regular follow-up | Come back every four days until they pay if the villagers are not able to pay during the first visit in the month | Internal capability factor: operation procedure |
| After working with the technology for some time they understood how to keep low maintenance cost | As long as the technology is the same we can have same maintenance procedures everywhere | Maintain gasifier daily to prevent costly breakdown | Internal capability factor: operation procedure |
| During the development of the system in the first villages they understood that there might be a problem for local entrepreneurs to support costly change of spare parts | Most plants will not bear the cost of spare parts above the price of X rupees | No single part should cost more than 25000 rupees when building the system | Internal capability factor: operation procedure |
| Through their early experiences they saw that the quality affected the customers probability to pay | The likelihood that the customer will pay proportionally with the quality of the service for all villages | The maintenance engineer should go through the customer complaints book during his periodical visit | Competitive strategy factor: Customer relationship |
| In general through their first fifteen templates | Not applicable. See comment below the table | All new gasification plants should be operated by a distributor which should be responsible for managing the local operators | Factors related to offering: direct distribution/ indirect distribution |

**Table 4.2: Process of developing the Arrow Core for Mera Gao Power**

| Template | Hypothesis | Rule | Component |
|---|---|---|---|
| After serving the first four villages in three different districts, they saw what kind of product villagers were eager about | A product of two lights and a mobile phone charger is what most households are willing to pay a premium for | Charge the customer for the fixed product of two lights and a mobile phone charger for seven hours per day | Factor related to offering: Product/service offering |
| Not applicable. See comment below the table | Not applicable. See comment below the table | Only sell to households and shops that only need the specific product | Market factors: b-to-c |
| After failing by using local partners for marketing and revenue collection in the first village they understood in the next villages that it is necessary to do all activities in-house | Every rural settlement will pay you if you provide something with a high value proposition. You do not need local partners to create a good relationship | Don't use any partners for marketing, operation or collection of revenue | Factor related to offering: Direct distribution |
| When Mr. Pandey was hired, he used his past experience from micro financing and his experience from the next few villages to create a procedure for how marketing should happen | An hour marketing session, which includes the value proposition, the rules for the customer and payment of a connection fee, is sufficient before installing a system | Do not install a plant before ten people have paid a connection fee of 50 rupees up-front in the end of the marketing session | Internal capability factor: marketing |
| They had a clear hypothesis that the revenue collection was best conducted by a local entrepreneur, which worked commission-based. They saw quickly that the entrepreneur could not managed to be strict upon fellow villagers who could not pay.<br><br>Through their experience with collection in the next few villages, they understood how revenue was collected most efficiently | Revenue collection is best conducted once a week by a person not living in the village | Collect revenue weekly in a defined location and time in the village. The collector should not collect in his home-village | Internal capability factor: operation procedure |
| Through their operation in the first village, where people stole electricity when they left in the evening, made them understand how to deal with electricity theft | To threaten to uninstall the system is the most efficient way to keep people from steeling | Disconnect the customer if he/she tries to steal | Internal capability factor: operation procedure |
| When they left the village after the plant was installed they understood how they best had a good communication with the customer | The best way to keep a good relationship with the customers is to give them the opportunity to call in case of faults | Every branch should have a phone, which the customer can call in case of fault with the product | Competitive strategy factor: Customer relationship |
| After serving the first villages they saw that the price of 100 rupees was lower than what most people used on kerosene and mobile charging combined | There is sufficient number of villages where people are willing to pay 100 rupees | The price of the product is 100 rupees and should be equal to all villages to obtain easy replication of collection procedures | Economic factors: Product pricing |

Both companies has gone trough an extensive Arrow Core development process as summarized in the tables above. Except MGP's rule about what kind of customer to serve and HPS rule about indirect distribution, all the rules is a result of an Arrow Core development process: The founder first has a template, which is the root for creating an idea if a component is replicable or not, which is then tested in the creation of new outlets. MGP's rule "only sell to households and shops that only need the specific product" is a direct effect of their ambition (business model component six by Morris et al. 2005) of being a high-growth firm that only wants to provide lighting. It does not therefore originate from a hypothesis of its replicable character. HPS's rule "all new gasification plants should be operated by a distributor" evolved after setting up new outlets, which increased their understanding that it would be difficult to manage the increased number of employees.

## 4.3 Identification of the Arrow Core

As a natural transition from exploration to exploitation, the end of the Arrow Core development process, when most of the rules are created, happens at the time the company is ready to step into the exploitation phase. At this point in time, the author has taken a snapshot of the business model to identify the companies' overall Arrow Core. This snapshot is essentially equal to the template that the firm will use for high-scale replication and is taken to understand the business logic by a static approach (Nadler et al., 1997). The results are summarized in Table 4.3 and 4.4 for Husk power System and Mera Gao Power respectively. As the rules developed in previous section are the ones that will be used for replication, the rules that constitute the replicable components in the tables below is identical to the rules in Table 4.1 and 4.1.

As written above, most but not all rules are fully developed. This is because speed of replication is critical in both a competitive setting and in general for being profitable (Winter and Szulanski, 2001). The entrepreneur must balance the effort in uncovering and developing the best business model against the affordability to delay the transition to the exploitation phase. Therefore, some components are intended for replication, but are not yet fully developed. One example of this is found in Table 4.3- "Operation procedure: prevention of theft". The intention is clearly to develop standard procedures and to develop rules for how to best deal with theft, but until they have managed this, the strategy is to deal with it locally. HPS are continuing to experiment to find the "best" solution against theft and are planning to replicate it when it is ready. Example of this progress is the development of "smartmeters" (Table 4.3- Technology) that are meant to prevent theft and are replicated to each village.

**Table 4.3: The Arrow Core of Husk Power System**

| Component | Sub-factors | Replicable/ not replicable | Example | Rule |
|---|---|---|---|---|
| Factors related to offering | Product/ service offering | **Replicable:** HPS provides a customizable service. (The customer may choose how many connections and the maximum wattage per connection) | Customer A has 2x light whereas Customer B has 1x light, 1x phone charger and 1x fan | - Charge the customer by maximum potential load, not by chosen product mix |
| | Hours of supply | **Not replicable:** In addition to changing the price, HPS has offset the differences between the affordability among villages by changing the numbers of hours of electricity supply per day. This is determined locally | Some villages have electricity for 6 hours per day while other has 7 hours and some also 12 hours per day | |
| | Direct distribution/ indirect distribution | **Replicable**: They saw that direct distribution would give some constrains in the long run, such as management issues with growing number of employees. They have therefore chosen to use indirect distribution on every new gasification plants | | - All new gasification plants should be operated by a distributor which should be responsible for managing the local operators |
| Market factors | b-to-c or also b-to-b | **Not replicable**: The kind of end-customer is changing from being only consumers to being consumers and enterprises between the different villages. This affects the necessary load and is dealt with locally | One consumer wants to run two lights on 15W connection while a enterprise customer wants to run a pump at 200W | |
| | Transactional/ relational | **Replicable:** HPS need to establish a relation-based relation to its customers to make sure the customer get the necessary maintenance and quality of the service. This is important to make sure they pay | See Competitive strategy factor: customer relationship | |
| Internal capability factors | Marketing | **Replicable:** Marketing is best done by word of mouth. It is the villagers who create the initial contact with HPS | When a plant is installed, villagers from nearby villages come to check out the system and ask if they can also have one | - Don't go to the village for marketing before at least someone from the village comes and ask you to set up a system |
| | Operation procedure: Conduction of preliminary survey before installation | **Replicable:** HPS has to a great extent a good knowledge about how a village should look like to be able to serve them profitably. Therefore, they have created a preliminary survey, which they use on every village before installing any plant to check if they pass HPS's requirements.<br><br>They have also learned which characteristics the local managers should have for successful operations. As a part of the preliminary survey, they are using a psychometric test to screen the potential candidates quickly. They can then hire the one that best match ideal profile. With this test, they can replicate the "correct" characteristics of the manager | Preliminary survey:<br>- Several villages to reach the minimum of 15 kW?<br>- If yes, is the distance to the other villages less than 2 km in radius?<br>- Are the customers that constitute the consumption of 15 kW capable to pay a non-refundable installation fee up-front?<br>- Is there a potential local manager in the village?<br>- Is there sufficient amount of husk available in the area?<br>- What do they pay for substituting solutions? | - Only install a plant if they pass the preliminary survey<br>- Only install a plant if the potential local manager passes the psychometric test |
| | Human resources: training of local management | **Replicable:** To sustain a low cost strategy they have to hire an unskilled workforce for the local operations and train them internally. They have developed a training program, which is replicable to all villages | Two months of training where the operators learn all necessary sides of operation | - Every manager has to pass the training program at Barauni Training Center/ HUSK University |
| | Operation procedure: Collection procedure | **Replicable**: An important part of the local operations is the collection of revenue. HPS has developed replicable guidelines of how to conduct the collection and how to follow up people who do not pay | | - Collection should happen in the morning before 10am<br>- Come back every four days until they pay if the households are not able to pay during the first visit in the month |

| | | | | |
|---|---|---|---|---|
| | Operation procedure: Prevention of theft | **Not replicable:** Even if HPS manages to collect revenue from most customers, they are struggling with theft. Large parts of their customers' use more electricity than they pay for. HPS does work as a central organization, which distributes some technology to prevent theft, but as the amount of theft and the way electricity is stolen is changing from village to village, this is something that is handled locally | It happens that people use 200-300W while they only pay for 50W<br><br>HPS has developed "smartmeters" to prevent theft but they have understood how to bypass it | |
| | Technology, operation system, | **Replicable:** HPS's biomass gasification system is replicable to all villages as long as they are able to sell an amount of electricity that is over the minimum production capacity. This is determined by the preliminary survey.<br><br>HPS develops continuously other technologies to help with collection and prevention of theft. This is replicable to every village | Biomass gasification systems produce minimum 15 kW.<br><br>Other technologies:<br>- "Smartmeter"<br>- 3V LED Lamps<br>- Two core wires | - Only install a plant if the consumption will be over 15kW (a part of the preliminary survey)<br><br>- Offer all newly developed technology to the villages |
| | Local supply chain | **Not replicable:** The lack of fulfillment of legal contracts is a challenge in rural India. Negotiating of the husk price, which changes over time and season is therefore handled locally and is not replicable.<br><br>To help staying profitable, HPS has developed a rule that the "cost of husk should not be more than 1.5 rupees per kg in average" which works as a guideline for the local manager. The local manager then needs to use different techniques to hold the price down | To keep a lower price in times when rice husk cost more than 1.5 rupees per kg, the local manger should substitute some of the rice husk with other biomass sources | |
| Competitive strategy factor | Cost leadership | **Replicable:** HPS low cost leadership strategy is replicable to every village. They have developed rules to keep maintenance costs down, enable local distributors to purchase spare parts cheaply during emergency breakdowns, and give a competitive price for the customers | | - Maintenance gasifier daily to prevent costly breakdown.<br>- The system should be built, so that no single part should cost more than 25000 rupees<br>- Price on load is determined during the preliminary survey |
| | Customer relationship | **Replicable**: HPS needs a close relationship to the customer to take care of customer safety (regarding electricity) and to make sure that they pay. HPS has therefore developed replicable procedures for how they should give support to customers and how to take care of customers' safety | - Every plant has a book where the operator writes down customer complains<br>- Local managers and distributors call directly if the plant needs engineering maintenance<br>- Customer safety is taken care of by following up safety rules, safety drills and safety check-ups | - The maintenance engineer should go through the customer complaint book during his periodical visit, then visit the customers to help them with their problem.<br>- Conduct monthly safety audits at the plant |
| Economic factors | Product pricing | **Not replicable:** HPS has found out that the affordability is very different between the different villages. They are therefore charging a local price that is cheaper than kerosene/ diesel but as high a price as possible to maximize the profit | A 15 W connection costs 50 rupees in village A, while it costs 100 rupees in village B | |
| | Revenue sources | **Replicable:** HPS has revenue collection from customers in all villages | | Not applicable |

**Table 4.4: The Arrow Core of Mera Gao Power**

| Component | Sub-factors | Replicable/ not replicable | Rule |
|---|---|---|---|
| Factors related to offering | Product/ service offering and hours of supply | **Replicable**: MGP offers only a single fixed product of two lights and one phone charger for seven hours per day | - Charge the customer for the fixed product of two lights and a mobile phone charger for seven hours per day |
| | Direct / indirect distribution | **Replicable:** MGP has chosen direct distribution. They have not faced the challenge of trust issues with their customers and have therefore not had the need for local partners | - Don't use any partners for marketing, operation or collection of revenue |
| Market factors | b-to-c or also b-to-b | **Replicable**: The fact that MGP only wanted to sell one product has set limitations in the customer segment it can reach: households and shops that require the same product | - Only sell to households and shops that only need the specified product |
| | Transactional/ relational | **Replicable:** MGP needs to establish a relation-based relation to its customers to make sure the customer gets the necessary maintenance and quality of the service. This is important to make sure they pay. This relationship is equal in all villages | - See Competitive strategy factor: customer relationship |
| Internal capability factors | Marketing | **Replicable:** As MGP only needed ten households with a reliable income to be able to start serving a village they managed to develop a combined marketing and evaluation procedure before installing any plant. | - Do not install a plant before ten people have paid a connection fee of 50 rupees up-front in the end of the marketing session |
| | Operation procedure: Conduction of preliminary survey | | |
| | Operation procedure: Collection procedure | **Replicable**: MGP has developed clear rules of how collection should happen | - Collect revenue weekly in a defined location and time in the village<br>- The collecting person is employed by MGP and should not come from the village where collection is conducted |
| | Operation procedure: Prevention of theft | **Replicable**: By having a small system, they can easily disconnect the user and uninstall the system if people try to steal. Therefore, they have created rules, which is communicated during the one-hour marketing session | - Disconnect the customer if he/ she tries to steal |
| | Technology, operation system, operation procedures | **Replicable:** Their choice of solar panels was easily replicable to every village and its module-based systems made it also possible to serve much smaller villages.<br><br>The solar panels don't require daily maintenance and MGP has seen it sufficient with a more central branch that handles all sides of operations. One branch has 25-30 employees and handles 250 villages. To obtain high quality service, MGP have set some rules regarding the distances | - Every village should be within a radius of 10-15 km from the branch office |
| | Local supply chain | **Not applicable:** Their choice of solar energy eliminates the need for a local supply chain | Not applicable |
| Competitive strategy factor | Positioning strategy | **Replicable**: As MGP offers a premium product at a lower price than what most households use on substituting solutions (kerosene lamps and remote phone charging), their positioning strategy is replicable to sufficient number of villages | - Do not change the positioning strategy by taking local demand conditions into account |
| | Customer relationship | **Replicable:** MGP is dependent of high uptime to be paid for the product. Therefore, they have clear procedures of how to follow up customers that have problems. If the customer calls during the day, an electrician visits the customer the same day. If he calls in the evening, the electrician goes there the day after | - Every branch should have a phone, which the customer can call in case of fault with the product |
| Economic factors | Product pricing | **Replicable**: The price of 100 rupees was lower than what most people used on kerosene and mobile charging combined and is therefore replicable to most villages. See competitive strategy factor: positioning strategy | - The price of the product is 100 rupees and should be equal to all villages to obtain easy replication of collection procedures |
| | Revenue sources | **Replicable**: Only revenue from customers | Not applicable |

Both companies have found what is replicable, what is not replicable and where the local business creates satisfying value in their respective cases. As seen from Table 4.3, HPS has built a strong Arrow Core, which they have leveraged through replication of the replicable components in the exploitation phase. HPS needed to experiment in approximately fifteen villages before it had a clear Arrow Core.

MGP has developed the same kind of knowledge about the Arrow Core. Meanwhile, instead of acknowledging that some components have to be flexible and need to be dealt with locally, they have followed a strategy saying "if it is not replicable, don't implement it". By following such a strategy they have developed a business model where all components are replicable to most villages.

*"The important thing was that we were going to have a model that we could scale up rather rapidly to other villages. So we didn't want to have a solution that was only appropriate for one village. We were trying to understand a solution that would have broad interest from a lot of off-grid villages" - Nikhil Jaisinghani, Founder HPS*

This reflects the company's ambitions, which is the sixth component of Morris et al. (2005) business model framework. In a simplified way, they are more focused on having a good solution for a lot of people rather than a perfect for solution for fewer people. MGP did several experiments in the first few villages to find the Arrow Core. These were further refined and tested in the next ten villages over a short time interval of December 2011 to March 2012 to prove its true scalability. The founders used in total of 18 months to get through the exploration phase and the development of a coherent Arrow Core.

# 5 Discussion

## 5.1 The framework consistency with reality

As shown in the previous section, there is a strong consistency between the theoretical framework and how HPS and MGP have developed a replicable model. There is however some differences that the author wants to highlight, to develop the framework further:

### MGP- business model development process

In the theoretical framework, the author proposes that the company develops a profitable business model in the first village before entering the second village. In the case of MGP, this did not happen. As they continued to develop their business model when entering the next villages, they managed to develop part of their Arrow Core simultaneously. As a result, they had a good understanding about parts of their Arrow Core at the time they were supposed to enter the second step in the theoretical framework. The fact that the firms can fail in the first villages and therefore can develop part of their Arrow Core before having a profitable business model is not taken into account in the theoretical framework.

In such cases when the entrepreneurs installs systems in new villages with the focus to develop its business model rather than to develop its Arrow Core, the hypothesis that underlies BM experimentation can coincide with the hypothesis that underlies Arrow Core development.

### HPS- company building step

In the theoretical framework, the author has linked the Arrow Core development process to the second step of Blank (2013) Customer Development Model framework. In this second step, Blank suggests to bring in the different distribution partners to be able to prove that the chosen business model is scalable.

HPS on the other hand, started to use distributors (local entrepreneurs that operated after their local business model) in the fourth step: "company building step". This enabled them to run all operations, which helped them to learn all aspects of operations themselves (Itami and Nishino, 2010), in the exploration phase. This also helped them to keep a lower cost while learning to replicate, as they did not need to bother about design and quality of machinery in the exploration phase.

*"The one we sell to entrepreneurs will be a more expensive machine, cause it is going in someone else's hands. When I operate it, it is my thing, I will do with bare minimum, and I will live with my patching and the other approach. I don't care, I don't want my plants to look pretty." – Mr. Gyanesh, Founder HPS*

Using cheaper machineries can be tied up to Ries (2011), who states that only resources that provide valuable feedback to the learning phase should be used and is compliant with Thompson and MacMillan (2010) use of a pilot to reduce the risk and cost of failing.

Not including distributors in the explorations phase also has its downsides. In retrospect they have seen that the local entrepreneur is able to get much higher revenue, in some cases double

the revenue, due to better prevention of theft and higher prices. If HPS had included these entrepreneurs in an earlier stage, they might have been able to serve villages that they saw as non-profitable.

*"It is because they have much more watches on the customer, no-one bypasses their system. Every customer uses only that much wattage which has been allotted to them. But in our system some of the customers are just bypassing our system – they are using much more electricity than they are buying from us. For example some of customers, just buying 50 watt but using 200-300 watts" -Field Engineer, Bettiah region*

However, introduction of distributors would interfere the process of developing the Arrow Core. It would have been difficult for the founders to create a hypothesis about the Arrow Core, as the founders would be more distant from the templates, as shown below:

*"From our distributors nobody can get the numbers, they want to tell you the numbers. That's the nature of it. They live in fear that if that other guy knew... that there is some comparison going, they start to look at this as a personal thing coming into play. Things like that" -Mr. Gyanesh, Founder HPS*

## 5.2 The effect of the differences between HPS & MGP's business model on the Arrow Core development

To understand the similarities and differences in the replication process for the case companies, the author has done a cross-case analysis of the two case companies' business model. To describe it through the lens of a business model is the favorable way as a business model is built up on multiple theoretical perspectives, and that no single theory can explain the value creation potential of a venture (Amit and Zott, 2001).

The main differences in HPS and MGP's business models during the exploration phase are highlighted in Table 5.1. The impact the main differences have on the Arrow Core development is then described in more detail.

**Table 5.1: Main differences in HPS and MGP's business model in the exploration phase.**

| | Foundation level | | Proprietary level | | Rules | |
|---|---|---|---|---|---|---|
| | **HPS** | MGP | **HPS** | MGP | **HPS** | MGP |
| **Component 1: Factors related to offering** | Customizable service | Standardized product | Flexible product/ market fit. | Rigid product/ market fit | | Only 2 light bulbs and 1 mobile charger per household |
| **Component 2: Market factors** | Sell to households and enterprises | Sell to households | Detailed analysis before installation | Quick analysis before installation | No installment prior to received non-refundable connection fee from households and businesses that correspond to 15 kW | No installment before 10 household pays a connection fee of 50 rupees |
| **Component 3: Internal capability factors** | Resource intensive local operation (in-house) | Uncomplicated local operation (in-house) | Highly selective hiring of local managers by personality tests | | Hire one manager and 3-4 local operators per plant | Team of 25-30 oversees operation in 250 villages |
| | | | Private learning center for employees | | All local managers need two months of training. | |
| | Outsourced manufacturing of gasification systems | Purchase of standardized solar panel system | Procurement of components from different vendors. | Procurement from a us-based solar panel manufacturer | Always buy from the vendor with the lowest prices | |
| **Component 4: Competitive strategy factor** | Cost leadership | Positioning | Biomass gasifier system (serves 3-400 households) | Solar panel system ( serves 12-20 households) | Get the cheapest and simplest thing out there regardless of efficiency | Only sell premium products which can support low maintenance solution |
| | | | | | No single part should cost more than 25000 rupees | |
| **Component 5: Economic factors** | Price dependent on wattage and number of connections | Fixed price and fixed product | Price may change from village to village | Fixed price for all villages | Charge a price lower than what most households use on kerosene | 100 rupees/ month |
| | High investment cost per system (low per kwh) | Low investment cost per system (high per kwh) | | | | Revenue collector does not live the village where collection is conducted |
| | High volume and low margins per plant | Low volume and high margins per plant | | | Collect revenue monthly at each house | Collect revenue weekly in a central place in the village |
| **Component 6: Personal factors** | Growth model | Growth model | | | Measure growth by revenue by number of watts sold | Measure growth be revenue by number of villages with lighting |

### The purpose of the venture

As each business model component affects and is affected by other components, consistency between the components is important for firm performance (Demil and Lecocq, 2010, Zott and Amit, 2007). As the founders had clear thought of their ambitions before they started, the author will first discuss component 6: personal factors and the founder's ambitions to explain the differences in the other components.

At the proprietary level both the founders at each company had the ambitions of developing offerings that could enable high-growth. MGP has been very clear that the financial return is very important and they have therefore only developed a solution for those two services (component 1) that could generate a sufficient return.

*"We have got a great financial return and a clear market. For me that is a strong foundation. If we can figure out a way to provide fans, and televisions and media and something else, and still get that same kind of return then that is great. We got to have that same kind of return. The reason we focused on these two services was that these were the only two services that could generate that kind of return. As you provide more power people are also willing to pay less for it, and therefor your returns diminish very quickly." – Mr. Jaisinghani, Founder MGP*

For HPS the ambitions go beyond being a high growth firm with high profits. HPS's ambition is to provide a broad set of electric services to enable economic development.

*"Our mission is about empowering people using power." – Mr. Gyanesh, Founder HPS*

From a perspective on organizational purpose, these statements shows how MGP goes into the perspective of "shareholder value" while HPS purpose goes more into a "stakeholders value" perspective (Freeman and Reed, 1983). These purposes gives direction to the decision of who will be the main beneficiary of the value-creation activities of the firm, and it plays an important role in determining the strategic choice of which business model to choose (Casadesus-Masanell and Ricart, 2010, Wit and Meyer, 2010).

### Cost leadership versus differentiation strategy

The differences in the learning phase can to a large degree be explained by the extent the firms have positioned themselves and focused on its offerings. Porter (1985) describes how a firm can choose between three generic competitive strategies: cost leadership, differentiation and cost focus- or differentiation focus.

In a differentiation strategy, a firm selects one or more attributes that many buyers in an industry perceive as important, and uniquely position itself to meet those needs. The company will then be rewarded for its uniqueness with a premium price (1bid). With a defined product of two lights and one mobile charger, MGP can be described to follow a differentiation strategy. By not "selling everything to everyone", MGP has a rigid product/ market fit and in their situation, it is more important to find the villagers that match their offering. *This has reduced their need to take local conditions regarding the product offering into account.*

HPS on the other hand has taken the generic strategy of being cost leader. The cost leader seeks out to become the low-cost producer in its industry, and the sources of cost advantage lays in having a broad scope and serve several industry segments. To be able to serve a broad

set of customers they are offering a broader set of services. In the context of rural electrification, *this increases their need to take local conditions into account.*

*"I would say it has never been about technology, it has always been about solution. Technology would be determined by the community we are operating in. How much can the pay, what is beneficial to them. How can it be made sustainable." – Mr. Gyanesh, Founder HPS*

### Operation intensiveness

Their strategic choice of cost leadership versus positioning has affected the company's operation intensiveness. In the search of finding a cheap and simple solution to provide a low cost service to customers to enhance their consumption, HPS has invested in large biomass gasification systems. This has a low installation cost per wattage but the system is resource-intensive in operation: it requires several people to operate a single plant, requires daily maintenance, and local procurement of husk. *These are all parameters that need to be dealt with locally*.

To bear the cost of resource-intensive operations in an effective manner, HPS is dependent of employing local people with a low educational level. These people can work on a lower salary than educated people, but requires approximately two months of staff training before they can operate the gasification system. *This gives a natural limit in the speed of learning and Arrow Core development,* as they cannot open a new plant before some people know how to operate it.

On the other side of the scale you have MGP. As MGP has positioned itself in such a manner that the customers are willing to pay a premium price, it has allowed them to invest in solar panel technology. Solar panel technology is expensive per installed wattage but it has the advantage of low maintenance requirements and it runs stable which gives a more reliable quality for the customer. This has the benefit of *less local effort to operate and collect revenue*. The operation is less resource intensive.

Even if MGP are facing the same challenge as HPS of finding a skilled local workforce, MGP will be able to put several solar systems in operation in the time it takes to get one gasification system operational, due to the amount of time it takes to train staff and the amount of people needed.

In addition, the cost of installing one gasification system is the same as multiple solar cell systems. This combined with the fact that MGP has a payment schedule of once per week, instead of once per month, have made it possible for MGP to learn rapidly, which is in compliance with (Ries, 2011) theory.

### Economic factors

When a company enters a new village the firm will meet an uncertainty in the customer's price sensitivities. The main factor to this is the amount of money the households use on substituting solutions like kerosene and diesel as this changes from village to village. For settlements in rural areas, cost saving is the main reason to change.

At a strategic level, since HPS strategy is cost leadership, the prices for electricity has to be lower than what the customers use on substituting solutions. By taking the decision on a local level, they are able to profit on the differences in the local price conditions without loosing

their cost leadership and therefore be able to serve a broad market. *This implies that HPS has to do extra work during the preliminary survey to understand the customers' price sensitivity.*

As MGP have taken a positioning strategy, they have been able set a fixed price on their product. MGP are therefore not so dependent on a detailed preliminary survey and can start to serve the village with once MGP know that the customer can afford their product.

### Risk factors

The necessary local work prior to installation is also linked to the choice of technology and the differences in the company's risk of failing.

Since the smallest system HPS has is 15 kW, their minimum investment cost is high. To bear the risk of not being profitable, HPS needs a sufficient number of customers to sign up before taking the decision of installing a plant. This turns out to be around 30-40% of the households in several nearby villages.

Because MGP operates much smaller systems that only require a minimum of ten customers *makes it easier to find sufficient number of customers* in a village that are necessary to be profitable, *without encountering the challenge of getting customers who are not able or willing to pay.* As MGP's solar system is modular, they are able to decide on the final production capacity after initial installation.

## 5.3 Improvement of the framework

The contribution from the discussion above is twofold: first, the data analysis shows that both companies have followed more or less the same process as presented by the theoretical framework first constructed. However, there are some interesting differences between the theoretical framework and what the entrepreneurs have been doing in their commercialization process. This is highlighted in the discussions above and will be taken into account during the improvement of the framework below. Second, the cross-case analysis gives an explanation for the differences between the replication processes for the two companies. The author shows how their strategic choice of which business model to compete through, is the reason for the differences in the way the companies has organized the business model innovation process, which enable replication. This implies that the framework can be used as a guideline for the entrepreneur, regardless of the chosen business model.

### Inclusion of all necessary villages to find a profitable business model

In the revised framework, the author expands the first step "Business Model Discovery" to contain not only the first village, but all necessary villages where the founders have been operating in the search for a profitable business model. This makes the framework applicable to a broader set of companies, without having an impact on the strength of the framework, as described below.

At the time the founders have found the profitable local business model, which they want to replicate, they are entering the second step "Arrow Core Development", as shown in Figure 5.1.

If the founders have been operating in several villages in the first step, they might have started on the process of developing the Arrow Core (i.e. started the process of hypothesis what is

replicable and not on a foundational and proprietary level). As the rules are meant to help the local manager or distributor to execute the replicable components of the profitable local business model, these rules can only be developed in the second step, after the first local viable business model is found. Therefore, the most important step in the Arrow Core development process, the process to go from hypothesis to rules, will always happen in the second step.

If the entrepreneur has found a profitable business model in the first village and has never operated in more than one village, the whole Arrow Core development process will happen during the second step.

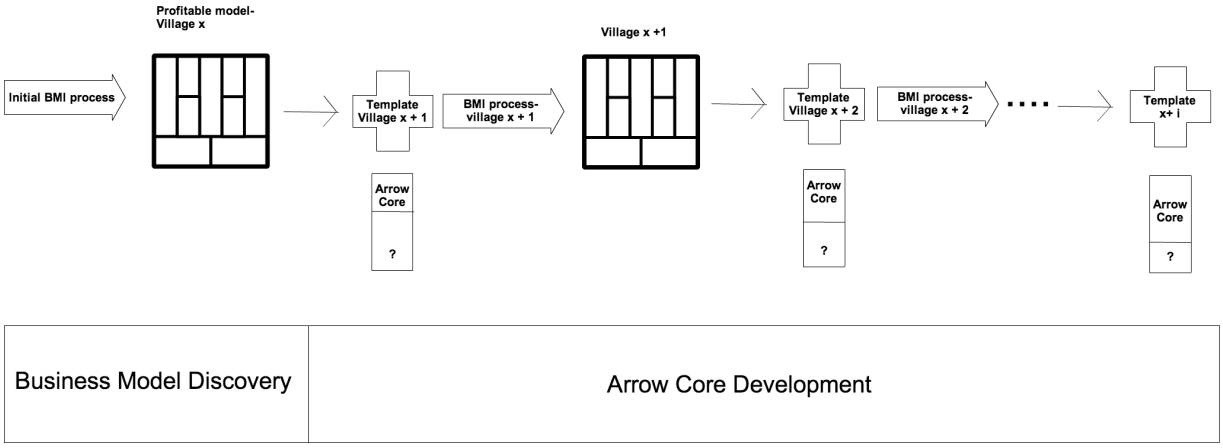


**Figure 5.1: Inclusion of all villages in the development of a viable business model. Source: Author**

### Clearer distinction between the entrepreneur's role and partner's role

As the exploration phase is about learning, and it is the company that does the learning that will learn, the author will go away from Blank's (2013) recommendation of including the distributors and local partners in the second step. In Customer Development Model, this is necessary since the entrepreneur is trying to validate the company's overall business model. As the focus of this paper is on replication strategy, it is more important to validate that the local business model is viable rather that the company's overall business model. The author makes a clearer distinction between the entrepreneur's role and the partner's role, by saying that it is the company's role to learn, while it is the partner's role to support company growth in the exploitation phase. Therefore, the author suggests bringing in the different partners in the exploration phase, when the company decides how it will structure its overall business model.

### Updated framework to explain the replication process

The framework has evolved away from Blank's (2013) CDM-framework when it comes to the structural aspects in the exploration phase. Therefore, the author proposes a more coherent framework to guide the replication process in the context of rural electrification, see Figure 5.2. The author sees several prevailing principles from CDM, which are included in the framework.

| Exploration | | Exploitation | |
|---|---|---|---|
| Business Model Discovery | Arrow Core Development | Market Creation | Company building |
| Execute the business model innovation process until the entrepreneur has found a viable business model, which can serve as the initial template for replication. | Execute the process of finding and validating what is replicable and what is not replicable together with the creation of knowledge about the characteristics of the environment where the model provides satisfying value.<br><br>Develop the rules that is replicable to all villages<br><br>Do not include distributors and partners | Do not rely on that partners will market the product in your behalf you. Therefore, the entrepreneur will be responsible for creating and deriving end user demand. | Move the organization's focus from informal learning and discovery to mission-centric structure with formal departments capable of exploiting the company's early market success<br><br>Decide the structure of the company regarding partners and distributors. |

**Figure 5.2: Framework explaining the replication process in the context of rural electrification by mini-utilities.**

While Blank (2013) focuses on understanding the customers' problems and needs to evaluate that there is a market for the product, the author goes further and says that the entrepreneur should find a viable business model in this step, which involves all business model components at a foundation level that are necessary to provide the service to the customer.

In Blank's second step, the focus is to validate that the entrepreneur's beliefs about how to do marketing, production and how to sell the product/service is right. This is done by selling to a group of early customers. By doing this, the entrepreneur will verify the existence of customers and that the perceived value, the pricing and distribution channel is appropriate. To enable high-growth, the entrepreneur should develop a replicable sales process that would do the sale process equal to all potential customers.

The same principle goes again in the author's framework, but the focus is to identify and validate that some business model components are replicable by selling to some few villages. By doing this, the entrepreneur develops the firm's Arrow Core and creates rules that are replicable to each village to enable high-growth.

Other principles like the importance of sufficient success at each step before going to the next step is still applicable, as it will prevent premature scaling and high cash burn-rate. The iterative character of CDM is still applicable, as it will be difficult to enable high-growth if the firm can not see a pattern in what is replicable or not and develop the corresponding rules. If the firm can not find a pattern, the firm will need to use more resources to find the appropriate villages or go back to the first step and re-evaluate its initial business model.

As the focus of this paper is on the exploration phase, the author has re-used the broad principles from Blank (2013) CDM in the exploitation phase. The author finds these principles appropriate to use in the context of rural electrification based on the analysis of the case companies' transition from the exploration to exploitation.

## 5.4 Critics and further research

Some critics can be directed to this study. First, some researchers would argue that two-case analysis is not sufficient in grounded theory development, and that more cases should be used when following a literal replication design. Second, as both firms operate in northern India it can be said that they are operating in similar external environments and therefore similar results are expected. The author has tried to overcome this by choosing companies, which has managed to scale with two different business models that both fit the external environment. However, the author recommends testing the framework on more cases in multiple external environments for further research.

Further the author say that the use of local partners will affect the learning phase and should happen in the Company Building phase. However, the author does not discuss what the company should do if it has already established a successful partnership in the first Business Model Discovery phase. Therefore, further research should also take this issue into account. The author proposes to do a study regarding the use of partnership impact on the firm performance in replication.

Last, the author should ideally have described how the Arrow Core evolved step by step from village to village instead of summarizing the Arrow Core as it is at the end of the exploration phase, which is done in Table 4.3 and 4.4. This has not been possible, as the interviews have been conducted in a retrospective manner and the interviewed objectives could not describe the process in such a detailed view. This is as expected from such a study, as the main disadvantages lays in that the current situation overlaps with earlier situations and that the informants have forgotten details that might be of importance for the findings (Eisenhardt, 1989).

# 6 Conclusion

This paper has developed a framework for experimental learning, which clarifies the business model innovation process by which entrepreneurs can ascertain which components of a (local sustainable) business model can be kept constant and which components have to be modified when going from an established business model in one rural area to new areas for replication in the context of rural electrification by community-level mini-utilities. Divided into two phases, the framework first describes the learning process and how the process of accumulating knowledge about the Arrow Core and developing rules is best conducted. It recommends a linear but iterative process where the firm enters one village at a time and develops the needed sustainable local business model for each specific village. In doing so it accumulates knowledge both about the business model and the context, which can then be exploited to build a larger organization through replication. It emphasizes the importance of having enough knowledge at each step in the framework to keep a low cash burn rate through the learning phase.

The paucity of examples of mini-utility companies that have successfully expanded to multiple sites suggests that it has been a challenge to find a replicable business model in rural electrification. In addition to the many challenges regarding the context, the author posits that this may be because of a static approach to business model development. By developing a dynamic tool, the author suggests a more dynamic approach than the existing business model innovation literature. In addition to the theoretical contribution, the model also has practical implications for entrepreneurs, describing a process they can use in their own commercialization efforts.

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# Appendix A

**Table A.1: The first and final set of categories that were used to analysis the cases by thematic coding.**

| First set of categories | Second set of categories |
|---|---|
| Business model | Firm boundaries |
| | Product offering |
| | Market factors |
| | Internal source of competences |
| | Strategic positioning |
| | Revenue streams |
| | Ambitions |
| Search for viable local business model | Search for viable local business model |
| Trial- and- error | Trial- and- error |
| Purposeful experimentation | Identify decisions |
| | Build hypothesis |
| | Test hypothesis |
| | Measure outcomes |
| Fidelity | Fidelity |
| | Cost |
| | Time |
| Benefits from past experiences | Benefits from past experiences |
| Learning process | Learning process |
| Exploration | Exploration |
| Arrow Core and the traits | Arrow Core and the traits |
| Hypothesis about Arrow Core | Hypothesis about Arrow Core |
| Creation of new outlets | Creation of new outlets |
| Search for market that fit the BM | Search for market that fit the BM |
| Replication | Replication |
| Replicable sales road map | Replicable sales road map |
| Constant components | Constant components |
| Stabilize business model | Stabilize business model |
| Sufficient knowledge at each step | Sufficient knowledge at each step |

## Appendix B

**Table B.1: Morris et al. (2005) six-component framework, which ask the strategic questions that underlie the business model.**

| | |
|---|---|
| Component 1 (factors related to the offering): How do we create value? (select from each set) | primarily products/primarily services/heavy mix |
| | standardized/some customization/high customization |
| | broad line/medium breadth/narrow line |
| | deep lines/medium depth/shallow lines |
| | access to product/ product itself/ product bundled with other firm's product |
| | internal manufacturing or service delivery/ outsourcing/ licensing/ reselling/ value added reselling |
| | offering: direct distribution/indirect distribution (if indirect: single or multichannel) |
| Component 2 (market factors): Who do we create value for? (select from each set) | type of organization: b-to-b/b-to-c/ both |
| | local/regional/national/international |
| | where customer is in value chain: upstream supplier/ downstream supplier/ government/ institutional/ wholesaler/ retailer/ service provider/ final consumer |
| | broad or general market/multiple segment/niche market |
| | transactional/relational |
| Component 3 (internal capability factors): What is our source of competence? (select one or more) | production/operating systems |
| | selling/marketing |
| | information management/mining/packaging |
| | technology/R&D/creative or innovative capability/intellectual |
| | financial transactions/arbitrage |
| | supply chain management |
| | networking/resource leveraging |
| Component 4 (competitive strategy factors): How do we competitively position ourselves? (select one or more) | image of operational excellence/consistency/dependability/speed |
| | product or service quality/selection/features/availability |
| | innovation leadership |
| | low cost/efficiency |
| | intimate customer relationship/experience |
| Component 5 (economic factors): How we make money? (select from each set) | pricing and revenue sources: fixed/mixed/flexible |
| | operating leverage: high/medium/low |
| | volumes: high/medium/low |
| | margins: high/medium/low |
| Component 6 (personal/investor factors): What are our time, scope, and size ambitions? (select one) | subsistence model |
| | income model |
| | growth model |
| | speculative model |

## Appendix C

Appendix C shows which components that most likely will be affected- and how, if there is a change in the conditions affiliated to the four lenses described by (Schillebeeckx, Parikh et al. 2012)

**Table C.1: How changing conditions might impact on the components of the business model**

| Four lenses | Condition | Component | How |
|---|---|---|---|
| Technology | Local availability of natural resources | - Choice of technology<br>- Cost structure<br>- Suppliers<br>- Human resources | Some technologies are highly dependent on the available local natural resources such as rice husk. If there is a low amount of resources available this will affect the variable costs and also the suppliers used to provide the resources. The chosen technology highly affects the needed human resources that are needed to operate and maintain the plant. |
| | Available infrastructure | - Choice of technology<br>- Cost structure<br>- Suppliers<br>- Customer segments | The quality of the infrastructure will affect the cost of implementation, and it might also affect the transportation of input resources (Schillebeeckx et al., 2012)<br>The nearness to other kind of infrastructure such as regional electricity lines and mobile phone base stations might affect the opportunity to serve other customer segments (International Finance Corporation, 2012) |
| User | Users affordability | - Revenue structure<br>- Choice of technology<br>- Partners | Due to the low disposable income and the fact that the income can vary significant by season and availability of work (Schillebeeckx et al., 2012), this will have clear impacts on the revenue model in terms of payments schedule, the maximum price which can be charged and if the product should be sold or rented.<br><br>The affordability will as well affect the chosen technology in terms of weighting the upfront cost with the running costs. The affordability will also affect the choice of partners such as commercial lenders and organizations providing subsidies (Raffaella and Garside, 2013). |
| | Single potential customers decision to connect | - Value proposition<br>- Human resources<br>- Partners<br>- Cost<br>- Technology | If people decide to not buy the product, it is a perceptional misfit between the perceived value proposition and price seen by the customer (Blank, 2013). It may come from customers' awareness, expectations and social recognition (International Finance Corporation, 2012) and it might affect the need for more salespeople/ information-providers by increasing the numbers of human resources or new partners, see condition "local awereness and competences". If the number of users that choose to not connect will affect the price and costs, depends on the simplicity to change the size of the plant after the demand. |
| | Users consumption of electricity | - Price | A higher consumption per customer of electricity will most likely make it possible to reduce the price per unit of consumed energy due to the fixed installation costs. |
| | Willingness to pay | - Distribution channels<br>- Technology<br>- Revenue structure<br>- Customer relationships<br>- Costs<br>- Value proposition | A changing "willingness to pay" mindset might change the need for technologies and systems that make it necessary to pay up-front to get access to electricity.<br>This will change the revenue structure and customer relationships but new technology might also add costs (Schmidt et al., 2013). These kinds of mechanism may also change the perceived value proposition. |

| | | | |
|---|---|---|---|
| | Local awareness and competences | - Partners<br>- Human resources<br>- Customer relationships<br>- Maintenance costs | The local awareness of the positive social impact of electricity will affect the need for people and partners in the field to educate and inform potential customers (Chaurey et al., 2012). The users need also to be educated in how to operate the system safely and correct, to reduce the maintenance costs. |
| Viability | Density in population | - Costs structure<br>- Revenue structure<br>- Partners | The density of the population will affect the implementation costs of setting up the needed infrastructure (e.g. power lines) (Zerriffi, 2010). This investment cost is a fixed cost that might affect the way the firm charges its customers (amount of costs that has to be paid upfront vs. fixed over time). Combined with the affordability, this will affect the choice of partners, to be able to realize the investments, being it a subsidizing organization, an direct investor/ lender to the company, or an organization lending money to the customer (Raffaella and Garside, 2013). |
| | Subsidies and favor of technology | - Price<br>- Value proposition<br>- Technology | If every household has access to the same subsidies, it might stop customers who can afford and have the willingness to pay, from paying a commercial price. This will again affect the price structure and the value proposition the firm can provide (International Finance Corporation, 2012). It might also encourage companies to manufacture to specifications that are not wanted by the market (International Finance Corporation, 2012, Zerriffi, 2010). |
| Institutional | Existent and transparent energy policy, corruption | - Partners | Opponents that will be affected by project success can try to resist or delay its execution (Thompson and MacMillan, 2010). It might then be necessary to mobilize to get support by beneficiaries and allies such as a influential member of governance authorities to neutralize and block opponents (ibid). |
| | Illiteracy | - Key activities<br>- Costs | The degree of illiteracy in the communities may affect the needed actions to educate people to operate and maintain the equipment (Thompson and MacMillan, 2010, Raffaella and Garside, 2013). The lack of a skilled workforce may increase the costs of learning but also the maintenance costs if the equipment are poorly maintained (Schmidt et al., 2013). |
| | Availability of partners | - Several components | As most of this table shows, partners are a key components of the business model in rural electrification (Chaurey et al., 2012), and a misfit between the needed and available partners can negatively affect several core components of the business model, as they are all highly connected (Osterwalder et al., 2005), which again may affect the firm's overall performance (Zott and Amit, 2007). Local partners has often the necessary knowledge about the local customs that is needed to be able to enter the market and they often help in the local capabilities- building (Schillebeeckx et al., 2012). |