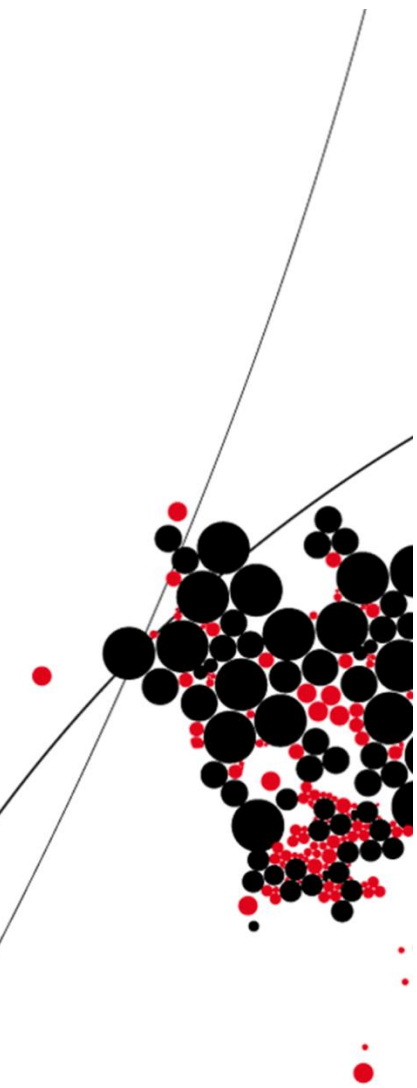




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Selection criteria and economic comparison models for evaluation of innovative and sustainable products



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Parts of this document have been altered or omitted before publication due to confidentiality of their content.

RESEARCH SUMMARY

Introduction

The issues with global sustainability are widely recognized and debated on by world leaders and the general public. Sustainability is considered a megatrend with the potential to alter the way businesses operate, comparable to other game changing trends, such as globalization, information technology, and mass production. Therefore, sustainability cannot be ignored by businesses and they should consider the environmental impact of their products. The African Agency for Sustainable Innovation (AASI) is an up-and-coming business development company whose main objective is to assist innovative and sustainable products to market. This research is aimed at assisting the company in the selection process of potential products.

Research Problem, Scope and Objectives

Adoption of innovative and sustainable products in Africa has a poor track record. Potential reasons for that are improper positioning of the products and unaffordable pricing. Western companies tend to face challenges when introducing new products in Africa arguably due to the limited understanding of the cultural and economic specifics of the market. This is partially due to lack of extensive and definitive research on product selection criteria in the African context. Furthermore, the majority of innovative and sustainable products introduced are unaffordable for the low socio-economic group, which includes the overwhelming majority of the consumers. Using data from five African countries, this study attempts to mitigate those issues by designing and implementing a multifactorial selection criteria and economic comparison models.

Research Approach

Firstly, the study looked into the existing literature on decision making, multi-criteria evaluation and sustainability measurement methods (Chapter 2). The data was gathered by an extensive search in academic literature. The research took the design approach in creating the selection criteria model and used interviews with relevant business professionals (Chapter 3) to derive and validate the criteria set (Chapter 4). In designing the economic comparison model, the study calculated the purchasing power of the consumers, both as individuals and households, and used existing literature to propose a feasible model for comparing affordability of products (Chapter 5). The study proceeds further with application of the two models on potential products and comparison of the products (Chapter 5). This aims to illustrate the use of the models in practice and clarify their application. The study concludes with a discussion of the findings and recommendations for the successful implementations of the models (Chapter 6).

Findings

This study researched and developed a selection criteria model for innovative and sustainable products, which can be used as an evaluation tool to assist the African Agency for Sustainable Innovation in its business operations. The model consist of the following set of criteria: *sustainable energy field relevance; sustainability score; affordability for the low-socio economics; ability to be continuously produced, delivered and maintained; durability; usability (ease of use); possibility for continuous customer involvement; and triple bottom line compatibility*. These criteria reflect AASI core competences and values, common practices of business professionals, and analysis of successful and unsuccessful innovative and sustainable products in the African market. Each criteria can be assigned with values ranging from 0 to 10 to allow comparison.

This research also developed an economic comparison model that measures the affordability of products. The model is considered confidential by the African Agency for Sustainable Innovation and therefore its design and application is not included in the publication.

The application of both the economic comparison and selection criteria models is illustrated by evaluating two products (referred to Product 1 and Product 2 in the publication). This allowed for a comparison of the products using a weighted sum model. The comparison results pointed out that Product 2 has higher potential. However, both products proved to be with a higher than the affordable price. Therefore, to improve their chances of success of in the African market the managers should either lower the price or look for methods to mitigate the financial tow on the consumers.

Conclusion

The selection criteria model is tailor made for the organization and is specifically applicable when considering innovative and sustainable product for the context of the African market. This model is suitable to use when the attributes of a potential product need to be quantified in order to get a better idea about the product or measure it against another one. The model can also be used as a blueprint when looking for potential products, and ensuring that they fit the predetermined criteria.

The economic comparison model can be used as part of the criteria model for assigning value to the affordability criterion or on its own to evaluate pricing of products. The model was designed for the purposes of measuring affordability, but it can also serve as a tool to measure returns on investment and payback periods. An important feature of the model is also that its complexity can be easily altered by adding relevant variable according to the desired depth and accuracy of the analysis.

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1. INTRODUCTION

There is a tendency that the overwhelming majority of innovative products introduced by European companies are unsuccessful in Africa in the long term. Successful and long term market penetration here is defined as the adoption of the product by the early and late majority based on the innovation adoption lifecycle of Rogers (1962) presented in figure 1.3. According to interviews with business professionals, the lack of success (poor diffusion of innovation), that European products have is due to the fact that from product inception, the economic and cultural specificities of the African market are not adequately assessed. Thus, impairing the commercialization of the products regardless of their sustainability aspects.

Common mishaps in assessment include overgeneralization of the market and assuming that a product will reap success simply because it was successful in other markets. Furthermore, even with the current economic growth, the majority of the population in Africa lives in poverty. Therefore, proper pricing is the key factor to achieve wide market penetration. Taking a look at an existing product (referred to as Product A in this publication), a solar lamp produce by a Dutch-based company, can illustrate how high pricing can hinder with the adoption of an even clearly superior product in its market segment (see Section 3.2). This allowed much less sustainable, durable and efficient solar lamps than Product A to dominate the lighting market in Africa.

The goal of this research is to develop an approach for evaluation of potential innovative and sustainable products for the African market, while at the same time keeping it general enough to serve as a basis for a broader product potential evaluation with the vision of making the approach helpful to the business (investment) world. Benefits of using such a systematic set of criteria are that the product selection process reflects the complexities of the real business environments better, and the decisions can be better explained and defended.

Moreover, the research is also expected to design an economic comparison model that takes into account the low socioeconomic groups in Africa. The current positioning approach for sustainable products in the African market targets the middle and higher class people, while failing to make the products affordable for the low income citizens. Therefore, the development of an economic model that considers both price and sustainability is a crucial step toward ensuring successful market penetration.

The process of this study is visualized in figure 1.1, starting by designing the selection criteria model, continuing by applying the model in the selection of a product and ending with the economic model, while using the African market as a context.

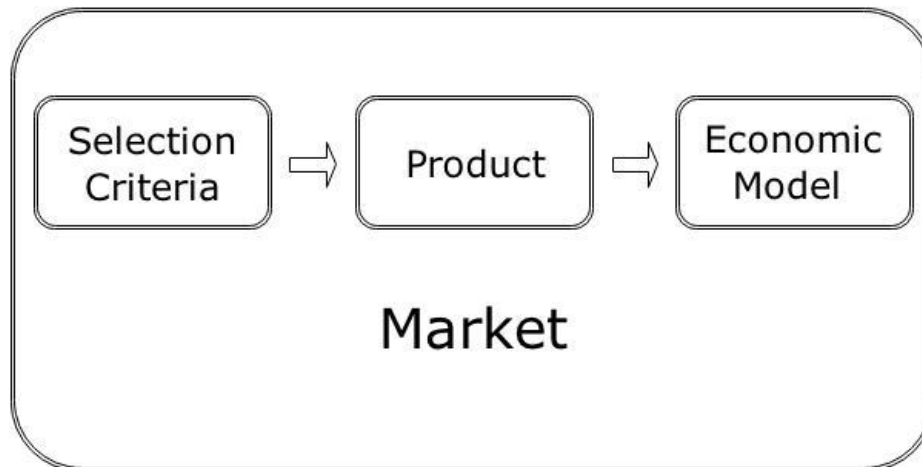


Figure 1.1: Depicts the process of determining a market-specific criteria model, followed by a product selection and an economic model for effective introduction to the market.

Sections 1.1 and 1.2 introduce the organization for which this research is conducted. Sections 1.3 and 1.5 discuss sustainability and innovation and their effects on the low socio-economic groups in Africa. Section 1.4 defines the countries examined in this research and section 1.6 outlines the research strategy and approach.

1.1 COMPANY INTRODUCTION

The African Agency for Sustainable Innovation (AASI) is a business development company that brings innovative products to market. The company originates as a spin-off enterprise from the University of Twente, the Netherlands. AASI is a knowledge intensive company that combines research methods and best practices to seek out and assist highly innovative products. The primary purpose of the organization is to identify and introduce innovative and sustainable products and services to the African market.

1.2 AFRICAN AGENCY FOR SUSTAINABLE INNOVATION'S VISION AND MISSION

AASI works towards assuring sustainable future by promoting entrepreneurship and sustainable development in Africa. The organization strives to ensure that the creativity of the African entrepreneurs is utilized by providing them with support in the product and business development.

1.3 SUSTAINABLE INNOVATION

Sustainable innovation is shaping as a promising and essential driver of change in both business and society. The transformative potential it has for technology, products, and markets highlights an area of tremendous entrepreneurial opportunity and a force for “creative destruction”. The economist Joseph Schumpeter (1934) uses the term “creative destruction” to refer to a process that ceaselessly reforms the economic structure, by creating a new one while making the old one obsolete (Larson, 2000).

1.3.1 Innovation

There is absence of a clear definition of what is meant by innovation in the empirical work on the subject, which makes it hard to generalize and compare outcomes (Hauschildt, 2004). The origin of the word “innovation” comes from the Latin “novare” which means renewing and it is used to designate the appearance of something that did not exist prior to that moment. In that line of thinking the outcome of a new product development process, but also new product features or just the replacement of the materials the product consist of, are to be considered as innovations (Schiele, 2006). In their research on innovation in the marketing science, Hauser, Tellis and Griffin (2006) define innovation as the process of taking new products and services to market.

While discussing the theory of diffusion of innovation, Rogers (1962) talks about innovation as an idea, behavior, or object that is viewed as new by individuals. The theory tries to shed light on the way, the reason, and the rate at which new ideas, and technology in particular, are spread through cultures. According to Rogers (2003), diffusion is the process by which an innovation is communicated through particular channels over a period of time among the members of a social system. Therefore, four main elements; the innovation itself, communication channels, time, and social system can be identified as the factors influencing the spread of innovation. Furthermore, Rogers (1962) emphasizes the importance of mass adoption of the innovation in order for it to sustain. He refers to the term critical mass, defined as the necessary amount of adopters of an

innovation in a social system that allows the rate of adoption to become self-sustaining and spurs further growth. When it comes to customers, the diffusion of innovation theory divides them into innovators, majority and laggards and the adoption usually follows an S-shaped curve as shown in figure 1.3.

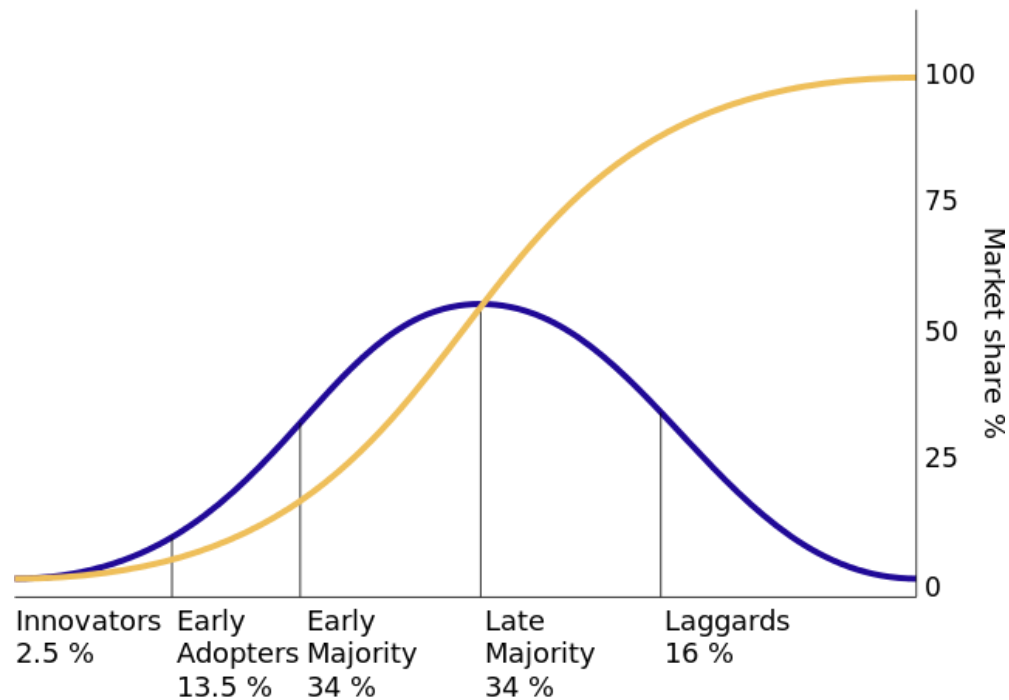


Figure 1.3: Represents the diffusion of innovation according to Rogers. The blue line shows the diffusion curve, broken down into sections of adopters. The yellow line shows the market share curve.

1.3.2 Sustainability

The issues with global sustainability are widely recognized and debated on by world leaders, scientists, journalists and the general population (Adams, 2006). Sustainability is defined by Brundtland report (WCED, 1987) as ‘meeting the needs of present without compromising the ability of future generations to meet their own needs’. Although broad, this definition highlights the main aspects of the problem; the environmental damage that often comes with economic growth versus the need for economic growth to mitigate poverty (Adams, 2006). There is a tendency for increasing awareness of the importance of achieving economic growth without environmental damage. A common decomposition of sustainability is in three dimensions, environmental, social and economic sustainability as seen in figure 1.2.

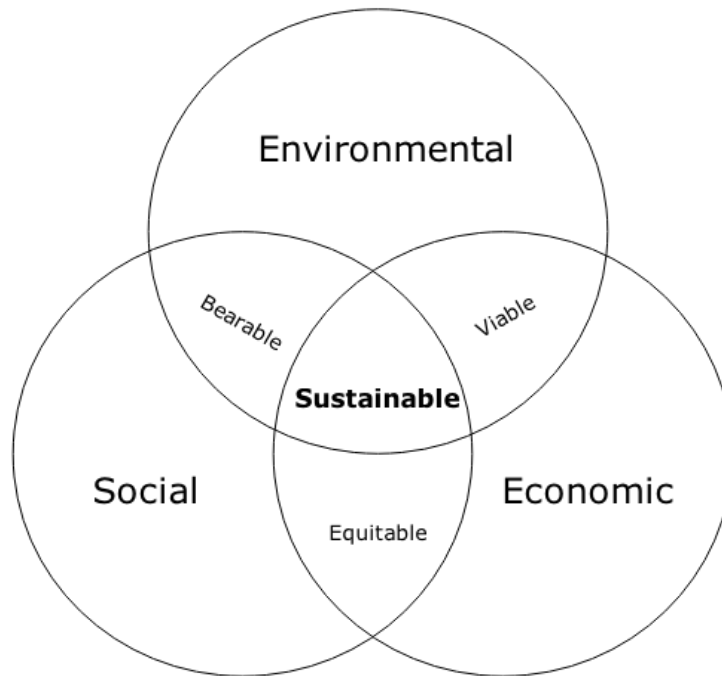


Figure 1.2: Venn diagram of sustainable development, where sustainability is at the convergence of the social, environmental and economic dimensions.

A growing body of studies paints sustainability as an emerging megatrend, with scale comparable to previous game changing trends such as globalization, information technology and mass production. Throughout the course of the last decade environmental problems and the growing awareness about those issues have increasingly disturbed the ability of businesses to generate value. Key drivers of the sustainability megatrend are also the competition for the depleting natural resources and the growing concerns of people and communities about the carbon dioxide's effect on the climate, the pollution of the underground water and oceans, as well as food security. The investment capital going towards sustainability in the last decade has been substantial, which further signifies the sustainability as a global trend. The private funds being invested in the clean technology sector amount for more than 200 billion dollars annually, with allocation not only in the Western world but also in developing countries. Furthermore, the G20 governments have reserved 400 billion dollars of stimulus funds for sustainability and clean technology initiatives. Being such a megatrend means that sustainability cannot be ignored, and businesses will have to innovate and adopt it or become uncompetitive (Lubin & Esty, 2010).

1.4 DEFINING THE AFRICAN MARKET

This study focuses on the sub-Saharan part of Africa and in particular the following countries: Nigeria, Ghana, Kenya, Ethiopia and South Africa. For the sake of simplification, those countries are collectively referred to as 'African countries' and/or 'African market'. This research places the above mentioned countries under one common denominator based on their cultural similarities as identified under the cultural dimension theory of Geert Hofstede (Hofstede, 2001). The theory is a systematic framework that distinguishes five cultural dimensions, namely; power distance, individualism, masculinity, uncertainty avoidance, and long-term orientation.

The power distance dimension examines the perception of inequality within a society. It measures the degree to which people in a given society anticipate and agree with the unequal distribution of power. The bigger the power distance index the more the people in the particular culture are comfortable with acceptance of a hierarchical authority. The selected countries all show scores that put them into the high power distance bracket on this dimension (see figure 1.4), which means that people there consent to a hierarchical order in which everybody has a place without any further justification. In organizations and institutions with hierarchical structure, higher ranked individual have absolute authority over lower ranked ones, with the underlings expecting to be told what to do.

The extent to which individuals in the society view themselves as independent entities is measured by their individualism score. In individualistic societies the focus is on the individuals' success, and they are expected to uphold themselves and their immediate family only. The predominant scores of the countries here are low, with the exception of South Africa, meaning that members of society there have more collectivistic mindset, and do feel obligated and responsible if they do not comply with the norms within the larger society.

The masculinity dimension assesses the behavioral drivers in the culture. For masculine societies the leading drivers are success, competitiveness, and aspiration for power, as oppose to feminine societies where the focus lie on balanced life and fruitful relationships. In masculine societies extreme achievement are celebrated and encouraged while feminine ones strive for equality. Four of the five countries that are examined fall under the predominantly masculine society category with rather similar scores ranging between 60 and 65, with the exception of Ghana that scores 40.

The uncertainty avoidance deals with the unpredictability of the future and how members of society react to it. Low score here tends to represent a high degree of ignorance towards that fact, while societies with higher uncertainty avoidance scores tend to take measure to bootstrap against potential undesirable circumstances. The scores of all countries in this dimension are relatively similar with values ranging from 49 (South Africa) to 65 (Ghana). However, South Africa is considered to be leaning towards the low and Ghana towards the high uncertainty avoidance category, while Nigeria, Ghana and Ethiopia score intermediately, with no clear preference for either.

When it comes to long term orientation, defined as the degree to which members of a society are willing to overlook immediate gratification in order to achieve greater future goals, scores are in the lower bracket. Nigeria and Ghana's scores are extremely low, with South Africa being slightly higher in comparison, but still low. These results are related to strictly normative societies with respect for customs, reluctance to accept change and little inducement to prepare for the future. There is no data available on Kenya and Ethiopia's long term orientation score.¹

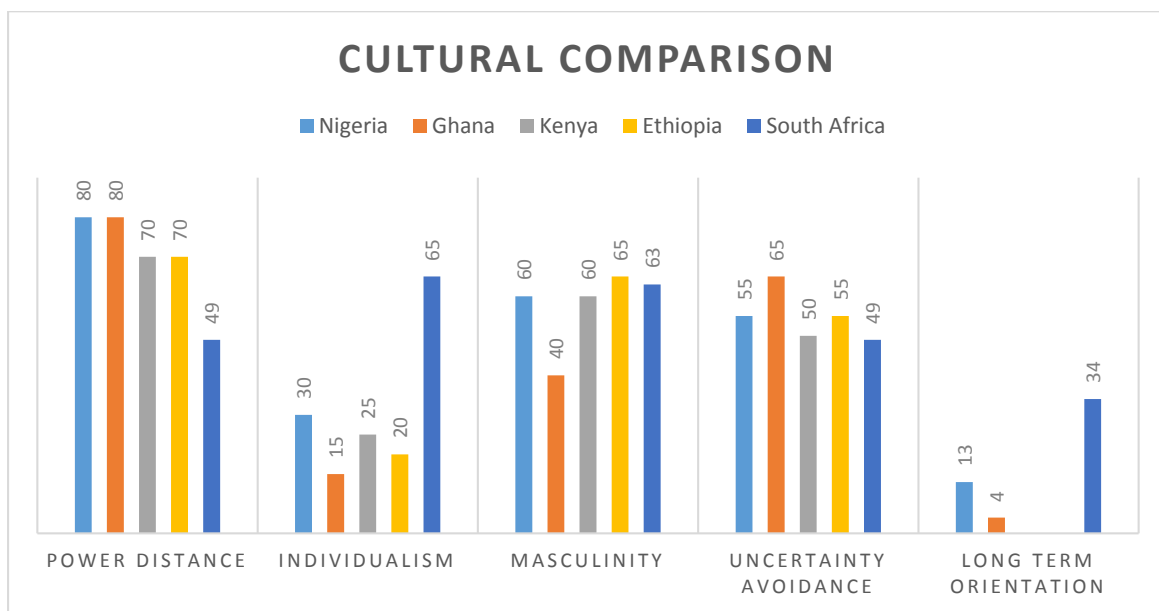


Figure 1.4: The chart compares the African counties across the five cultural dimension. Scores range between 0 and 100, with 100 being the highest possible score.

¹ Data collected from <http://geert-hofstede.com/countries.html> (retrieved on 6th of May 2015)

1.5 SUSTAINABLE INNOVATION IN AFRICA AND ITS EFFECT ON THE LOW SOCIO-ECONOMIC GROUPS

The total population of Africa, estimated in 2013, is approximately 1.1 billion people with a gross domestic product of \$2.39 trillion. A 2014 Financial Times article foresees an average of 5% economic growth a year quoting the International Monetary Fund, while some surveys estimated the number of middle-class consumers in Africa to be above 300 million. According to research group Euromonitor, the amount of total customer spending in sub-Saharan Africa is to reach \$1 trillion by the year 2020, a raise from \$600 million in 2010.

Up until the economic crisis of 2008 the African economies experienced a decade of high growth (upwards of 6% on average), one of the longest uninterrupted episodes ever recorded. According to a briefing note from the African Development Bank, sustainable innovation and entrepreneurship must be a part of a pioneering approach to stimulate the economy and increase employment rates. In a number of African states the innovation and entrepreneurship have been hindered by lack of sufficient finance, poor infrastructure and inadequate regulations (AfDB, 2012).

The micro, small and medium-sized enterprises (MSMEs) support the youth employment and low income households, a total of 90% of the off-farm employment (occupations other than farming) in Africa. Therefore to make a sensible and sustainable change the support should be aimed towards that sector. Even though the governments of many African countries have attempted to design key policies emphasizing on the importance of the development of the private sector, the progress of innovation and entrepreneurship has been hampered by the continent's business climate. Factors such as hostile governance and regulatory framework, lack of research and development, poor infrastructure and low access to financing are still among the main blockers of sustainable innovation in the Africa. According to the African Development Bank, to tackle the poverty and regional disparities, and avoid social and economic cataclysms a new period of high growth is needed. The ignition of which should come from the lower levels of market structure, the MSMEs, that produce mostly for the low-income class (AfDB, 2012).

1.6 RESEARCH STRATEGY

1.6.1 Problem Description

There has not been an extensive and definitive research on product selection decision making criteria in general and especially when it comes to products in the context of the African market. The absence of a model for selection makes the decision to select certain products ambiguous, challenging to explain and defend, as well as unable to be replicated. Furthermore, in reality most products deemed sustainable in Africa are affordable exclusively to the middle to high class citizens and thus, failing to reach the low socio-economic group of Africans and retain market share. At this moment the African Agency for Sustainable Innovation does not have an empirically supported method for examining potential products and a model for taking products to market. This study attempts to mitigate the problems that the company might encounter by designing multifactorial decision making tool for product selection and a feasible economic comparison model for measuring affordability.

1.6.2 Research Objectives

This study developed a criteria model that supports the selection of innovative sustainable products appropriate for the African market. This model will aid the African Agency for Sustainable Innovation in its product selection procedures and provide scientifically backed decision making tool. The findings of this research are also expected to serve as a basis for product selection criteria research in other markets. Moreover, the study developed an economic model that ensures that sustainable products are reasonably priced for the low-socioeconomic groups in the African market and in doing so increases the probability of successful mass-market product adoption and creating a competitive advantage for AASI.

1.6.3 Research Deliverables

This paper delivered the following results:

- Set of criteria to select innovative and sustainable products for the African market.
- A model to measure affordability of an innovative and sustainable product for the African market.

1.6.4 Research Set-up and Scope

This research reviews the literature on business selection criteria. It makes use of a selected class of multi-criteria decision analysis (MCDA), convenient in choosing the best alternative out of several potential options, paired with testimonials from related professionals in the business development field in Africa. The interviewed professionals operate or have prior experience operating in at least one of the following countries; Nigeria, Ghana, Kenya, Ethiopia and South Africa. It is intended that involving the decision makers in the analysis will allow for a closer to business reality evaluation and possible reevaluation of previously assessed preferences. The economic comparison model is developed for the promising products based on the criteria model and available data and literature.

1.6.5 Research Questions and Outline

The outline of the study is presented along with questions formulated to explore the research problem and objectives. The two major questions that this study attempts to answer are:

RQ1 (Major): *What are suitable criteria for the selection of innovative and sustainable products for the African market?*

RQ2 (Major): *What economic model can measure product affordability for the African market?*

In Chapter 2, the study examines the multi-criteria decision methods in literature as well as approaches to measure sustainability:

RQ3: *What multi-criteria decision methods are currently used worldwide for innovative and sustainable product selection?*

RQ4: *What is/are widely accepted method/s of measuring sustainability of a product?*

In answering those questions the study looked into the existing literature on decision making and multi-criteria evaluation and comparison models as well as methods for measuring sustainability. Data was collected after an extensive search in academic databases and evaluation of the most cited and widely accepted tools. The approaches and models that proved both promising and

suitable for the purposes of this study were selected and outlined in the chapter. This gave the study the necessary approach and tools to guide the required product comparison and decision making processes.

The already existing innovative and sustainable products found in the African market and practical experience in selecting such products are examined in Chapter 3:

RQ5: What are measures used by professionals to determine whether a product is suitable for the African market?

RQ6: What environment specific factors can affect the selection criteria?

RQ7: What methods are used to measure sustainability of a product by professional?

To answer these questions, the study looked into the results from a number of interviews conducted with business professionals and investors who have experience within the context of the African market. The complete set of interview questions that were addressed can be found in appendix 1. The interviewees were entrepreneurs, professionals and investors directly or indirectly responsible for new product development and introduction. There were interviewees from all counties within the scope of this research. Furthermore, products that were pointed out as examples during the interviews were analyzed to determine what could be possible reasons for their success or failure. This provides the study with insights about the current reality and serves as a foundation of the selection criteria model design in chapter 4.

The AASI's selection criteria model is designed in Chapter 4 by answering the following research questions:

RQ8: What are suitable selection criteria for the African Agency for Sustainable Innovation?

RQ9: How to quantify and measure those criteria?

In designing the criteria model for the African Agency for Sustainable Innovation this research looked into a number of different sources. Firstly, the study considers data provided by the company as to what are its core values, expertise and affinities. This data is crucial as it is

imperative to have a model in line with the organizational values and capabilities for which it is created. Secondly, the most commonly used criteria for evaluation of innovative and sustainable products are derived from interviews with specialists. The existing body of knowledge that these seasoned professionals provide is invaluable for the backbone of the selection criteria model. Thirdly, the analysis of existing products is used as a source of qualities that are to be insisted on when selecting a potential product. Using diverse sources provides additional validation to the criteria. This is especially true in the cases where the same criterion was indicated by more than one source. To measure the criteria, the study proposes approaches based on literature and common practices depending on the individual criteria and suggest a scale for assigning values.

Chapter 5 addresses the largest number of research questions. They are as follows:

RQ10: What is the purchasing power of the low socio-economic groups in Africa?

RQ11: What are the specifics of the purchasing behavior in Africa?

RQ12: What aspects have been used in the past to design an economic model?

RQ13: What aspects are relevant for the African market environment?

RQ14: What is a suitable price point to allow affordability of the product to the low socio-economic groups?

RQ15: What is a suitable economic model to measure affordability in Africa?

The purchasing power is calculated with data derived from the official gross domestic product (GDP) statistics of each of the countries examined, as reported by the US Central Intelligence Agency. Taking the GDP of a country is considered a reliable way to evaluate the purchasing power of its citizens. The specifics of customer behavior are arguably influenced by the culture of the country (De Mooij, 2011). The current research examined how the purchasing behavior is affected by the cultural peculiarities of the African consumers to aid AASI's understanding on the matter. Furthermore, this study utilizes available literature on economic models to define them and provide an insight about their design specifics. By doing that, this research singles out the most relevant characteristics and designs and economic model for its purposes. The model is

presented in depth in chapter 5. The so called economic comparison model is expected to serve as a tool to measure affordability of a product.

The research later proceeds with application of the selection criteria model for two innovative products to examine their potential and utilization of the economic comparison model to get an idea about the affordability of the products. This is an important part of the research as it shows the practical application of the two models. This illustration serves as validation of the models and provides the management of the African Agency for Sustainable Innovation with insights for their practical application. Furthermore, the two products are compared to each other using a multi-criteria decision making tool. The research is conclude with a discussion about the findings and results as well as recommendations for the management team of the company for which the study was conducted.

2. ANALYSIS OF CURRENT PRODUCT SELECTION METHODS

The most widely accepted decision making and selection models as well as best practices are reviewed in the following chapter. The focus starts with the examination of general selection methods and narrows down to product assessment. This chapter consists of two sub-chapters, the first one discusses the literature on decision making and the second reviews common assessment practices.

2.1 THEORETICAL FRAMEWORK

The aspiring international entrepreneur/manager must begin his analysis with evaluating the prospect of the target market/environment by using a number of different criteria (Beim & Levesque, 2005). The professional then, has to draw out various possible outcomes from diverse points of view. The study of (Beim & Levesque, 2005) proved that multi-criteria decision analysis (MCDA) can be more beneficial for a reliable country selection analysis than the frequently used ad hoc decision approach. However, formal multi-criteria methodologies are often overlooked by business professionals. A possible explanation for that could be that the MCDA theory has the tendency to oversimplify the real world decision making process (Kasanen, Wallenius, Wallenius, & Zionts, 2000). Nevertheless, MCDA is beneficial in outlining and weighing predetermined criteria for a more comprehensive and defensible decisions (Beim & Levesque, 2005).

A key challenge that entrepreneurs and managers come across while trying to prioritize business opportunities (choosing product or service worthy of investing their resources) is figuring out a dependable model for ranking their options. It is not rare that managers face contradicting criteria in their decision making process (Ahmed, Bwisa, & Otieno, 2012). Therefore, a model that assists business selection is advisable. The literature study, conducted for this research, showed that there is no extensive study on the matter. Most frequent suggestions given by authors are heuristic or set of guiding questions, but does not go as far as creating a model for business selection.

2.1.1 MCDA Road Map

A common starting point of the MCDA is the design of a road map. The study of Beim and Levesque (2005) presented a MCDA modeler's road map that consisted of six steps:

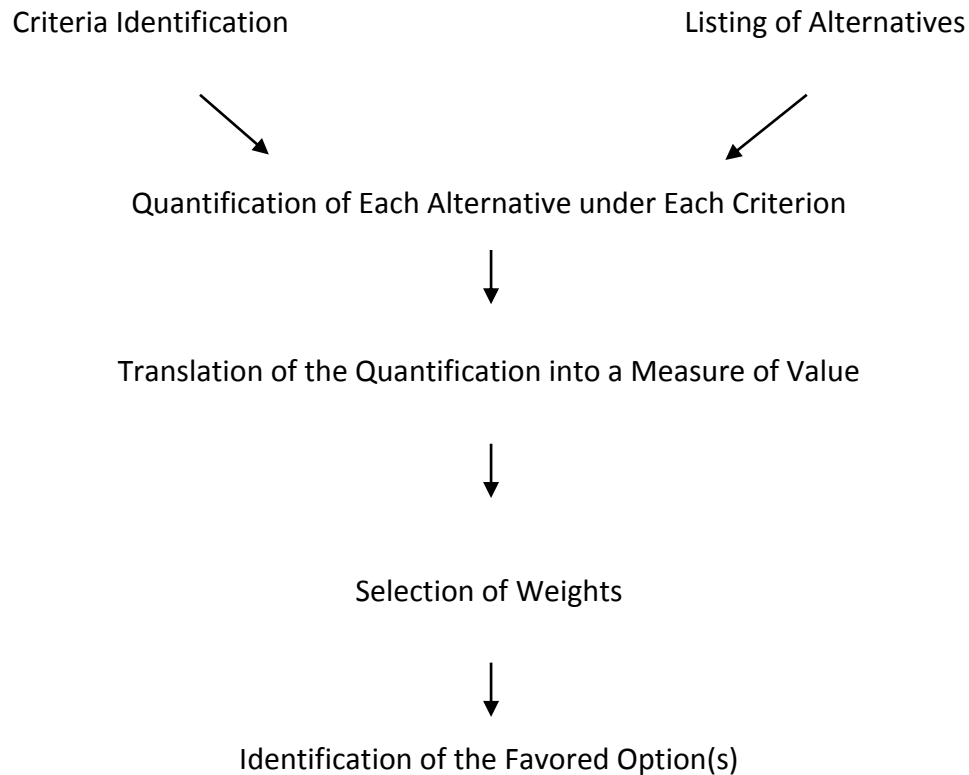


Figure 2.1: Six step MCDA road map flowchart.

The road map begins with identification and hierarchical alignment of the criteria. The ranking could be produced by assigning either numerical or categorical values to each criterion. The set must adequately reflect the relevant criteria, while at the same time being simple and concise. Researchers debate between two approaches for the design of the set of criteria; bottom up and top down. The bottom up approach focuses mostly on the alternatives by weighing their positives and negatives. In contrast the top down approach starts by identifying an overarching goal, then proceeds to decomposing it into sub-goals, which are further separated into more detailed sub-criteria until a measurable criterion is identified (Beim & Levesque, 2005).

It could be the case that the decision maker is faced with partially overlapping, incomprehensive or simply too large to cope with alternatives. Therefore, the listing of the alternative helps the decision makers to remove clearly inferior alternative in the very beginning of the overall process. The quantification of the alternatives within each criterion is essentially the evaluation of the performance, presented either by a quantitative or qualitative measure. In case the performance of the alternative is represented by a subjective description, the description has to be translated into a numerical value, complying with the specific reference point. Furthermore, the usage of common units allows the aggregation of the value functions of each criterion into the overall

value function, hence the translation of the quantification into a measure of value (Beim & Levesque, 2005).

The selection of weights is an important and rather controversial step. The approach of the managers in assigning the weight to the different criteria is a debated topic among scholars. The different MCDA methods have different mathematical flaws when it comes to the weighting of the criteria, which makes a method of elicitation that is accurately weighting the criteria in one instance yield an inaccurate result in another. Additionally, some studies observe a mismatch between what managers initially perceive to be an accurate expression of the weights and what the weight turn out to be in the process of decision making. This effect could be mitigated by using the swing-weight approach, where the managers assess the potential improvement of one criterion and compare it against all others (Stewart, 1992). Ideally, when adequately elicited the resulting weights are accurate and representative of the tradeoffs that managers are prepared to make. The identification of the preferred option is then done by totaling the values of the weights, most commonly by using weighted sum of value functions (Beim & Levesque, 2005).

2.1.2 Weighted Sum Model

In their study on multi-criteria decision analysis methods (Ahmed et al., 2012) encompass the manager/investor as the single decision maker. They make use of three deterministic model: the Weighted Sum Model (WSM), Weighted Product Model (WPM), and the Analytic Hierarchy Process (AHP). The WSM (Fishburn, 1967) is the most widely used one due to its simplicity mainly in terms of amount of decision criteria. Imperative for this model is that the comparable data is in the same unit of measurement, otherwise the results are incomparable. An equation used to weight the total importance of an alternative (A_i , denoted as $A_i^{\text{WSM-score}}$) considering all values at the same time is as follows:

$$A_i^{\text{WSM-score}} = \sum_{j=1}^n w_j a_{ij}, \text{ for } i = 1, 2, 3, \dots, m.$$

Where there are m alternatives and n decision criteria. The w_j signifies the relative weight of importance of criterion and a_{ij} is the performance value of alternative A_i when evaluated in against the same criterion (Triantaphyllou, 2000).

2.1.3 Weighted Product Model

The WPM is also a widely used model for multi-criteria decision making. This model resembles the WSM but differs in the use of multiplication as oppose to addition in the main mathematical

operation. In the WPM the decisions alternatives are compared, by raising the decision criterion ratios to the power corresponding to the relative weight, and then multiplying the ratios. If one is to compare two alternatives, using similar notation as for the WSM, where A_K and A_L ($m \geq K, L \geq 1$) the following output can be produced:

$$P(A_K/A_L) = \prod_{j=1}^n (a_{Kj}/a_{Lj})^{w_j}, \text{ for } K, L = 1, 2, 3, \dots, m.$$

Based on the end result for $P(A_K/A_L)$ one can determine the most desirable alternative. If the value is higher or equal to one then alternative A_K is preferred over alternative A_L . In case one compares more than two alternatives, then the most desirable one is the one with the highest value (Ahmed et al., 2012). A distinct advantage of the WPM is that its mathematical structure disregards the units of measure, making it suitable for MCDA problems in which the alternatives are expressed in diverse measurement units.

2.1.4 Analytic Hierarchy Process

The analytic hierarchy process (AHP) introduced by (Saaty, 1980) is a technique for the breakdown of a multifaceted decision making problems into a system of hierarchies. The AHP delivers a framework that structures the problem, showcases and quantifies its components and their relation to the overarching goal (see figure 2.2). This process assists the problem owners to examine the most suitable solution in regards to their goal and comprehension of the issue, rather than simply yielding a singular “best” decision. The application of the AHP starts with the decomposition of the decision problem into a hierarchically organized sub-problems. This allow for a more comprehensive analysis due to the reduce complexity. The components of this hierarchical alignment can consist of everything relevant to the decision problem. After constructing the hierarchy, the decision maker, systematically compares the elements to each other in pairs, with respect to their effect on the higher standing elements in the ranking structure. A key feature of the AHP is that, even though concrete data can be used, it also allows decision maker to use human judgment about the significance of the elements (Saaty, 2008). Each element is assigned with numerical weight, which permits wide and consistent comparability between the elements across the full range of the problem. To finalize the AHP, the decision maker computes the numerical priorities for each of the decision alternatives. These figures show the relative capability of the alternatives to reach the decision aim, which enables clear examination of the available courses of action.

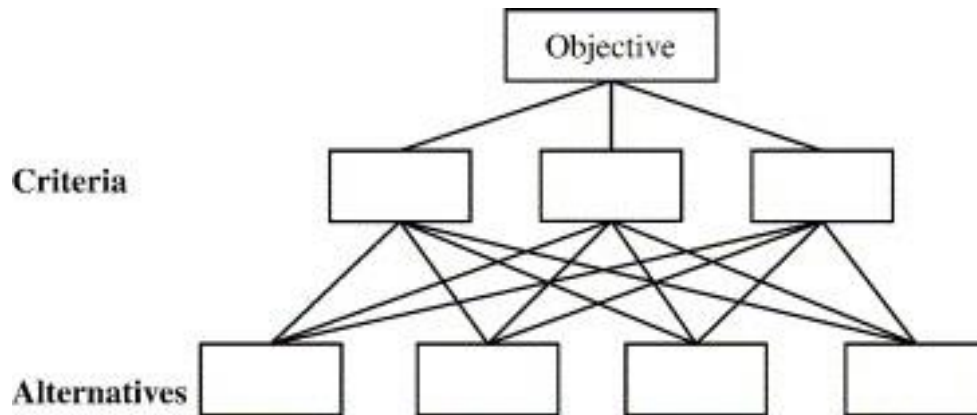


Figure 2.2 Hierarchical structure used in AHP for decision making.

2.2 MEASUREMENTS OF SUSTAINABILITY

The term “sustainability” was put forward specifically to spark the idea that industrial development and economic growth are possible without damaging the environment. There are no unified measurements of the extent of sustainability in the existing policy programs. According to (Adams, 2006) sustainable development and sustainability are merely ethical concepts that stress on the desirable results from social and commercial resolutions. Therefore the concepts are used broadly to show that certain policies are or have the desire to be friendly and sparing to the environment. However, more often than not, sustainable development is disregarded in practical decisions. Which concludes in overlooking the principle in the desire to set targets and measure progress (Adams, 2006).

A commonly used technique to weigh the environmental impact of products is the so-called Life Cycle Assessment (LCA) method. It is part of the ISO 14000 family of standards and assists in the creation of environmental management systems. The tool considers the environmental tow of the product in each stage of the product’s lifecycle from cradle to grave (see Figure 2.2). The LCA typically comprises of six to eight step, which could later be divided into smaller sub categories in order to receive more indebt understanding of the environmental impact or the product (Ljungberg, 2005). The main benefit of the method is that it quantifies every input and output of the material flow and evaluates what is its effect on the environment, therefore allowing benchmarking of the entire range of environmental effects associated with products and services. The major uses of this method in business are observed to be in for justification of company strategy, research and development, product/process design and labeling of goods (Cooper & Fava, 2006).

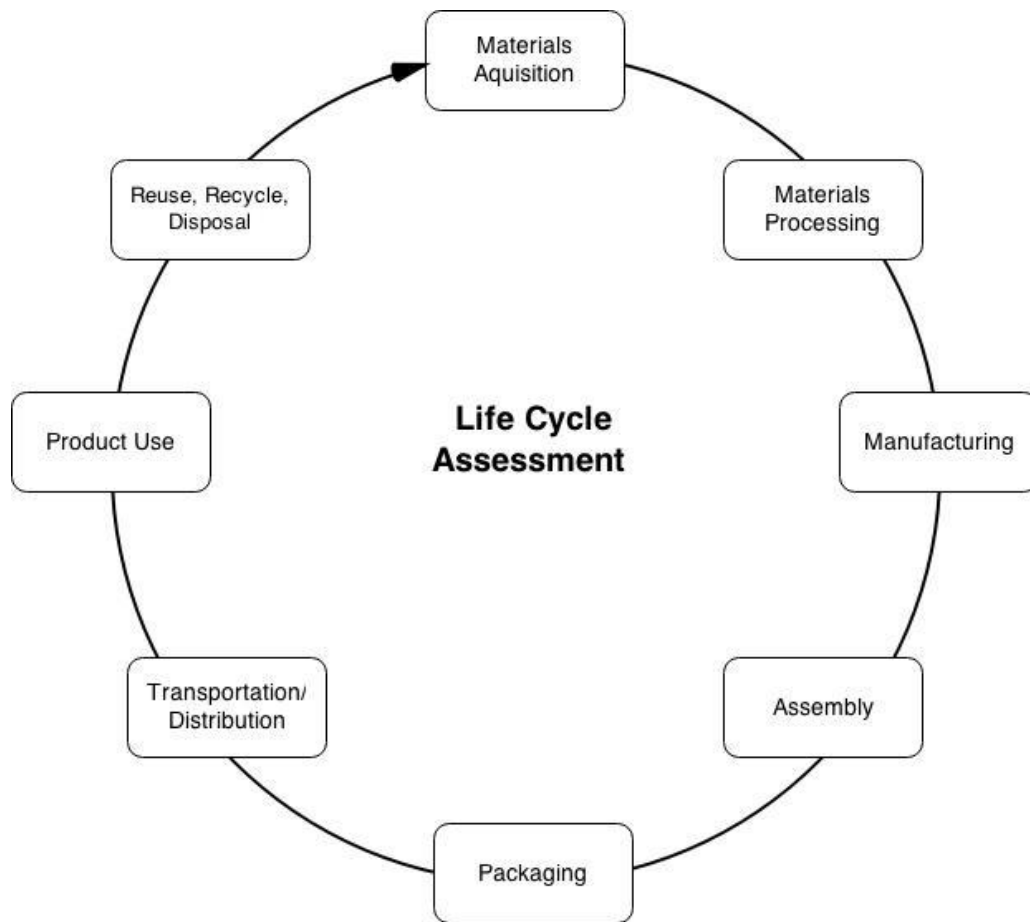


Figure 2.2: The main steps of product lifecycle assessment according to the LCA methodology.

2.3 CONCLUSION

In this chapter the multi-criteria decision analysis approach and commonly used multi-criteria decision analysis models, that will later be applied when comparing potential products for the African Agency for Sustainable Innovation, were explained. Moreover, this paper discussed the Life Cycle Assessment method as a tool to evaluate the environmental impact of a product and its components and from there obtain an idea about its level of sustainability. This paper makes use of this tool in weighing potential products' sustainability, as sustainability is a key prerequisite for product that the African Agency for Sustainable Innovation assists.

In the next chapter the paper examines what criteria professionals use when examining products for the African market as well as current products on the market and possible reasons for their success or failure. This is helpful for designing the selection criteria model for the African Agency for Sustainable Innovation.

3. PRACTICAL EXPERIENCE IN PRODUCT SELECTION & ANALYSIS OF EXISTING PRODUCTS IN THE AFRICAN MARKET

Parts of this chapter have been altered or omitted before publication due to confidentiality of their content.

This chapter presents the practical experience of business professionals responsible for the selection and introduction of products and services to the African market. The information is gathered by numerous interviews and the major findings are accrued in the chapter. Furthermore, there is analysis of a selection of products introduced to the African market that are considered both innovative and sustainable. Both products that are widely accepted and such that showed promise but failed to capture market share and justify expectations are examined. The focus of the analysis is on the reasons for entering the African market, lifecycle, strategy and degree of market penetration.

3.1 PRACTICAL EXPERIENCE

The factors considered by business professionals in the process of determining the success potential of products in the context of the African market are derived from interviews with the respected professionals. It should be noted, that those factors could vary depending on specific product features, cultural peculiarities and target customer. The analysis includes talks/conversations with a number of professionals from all five countries within the scope of this study. Those specialists are directly responsible for the research, selection, and introduction of products to the market in question. The fields that they operate in are: electronics manufacturing, metal components production, sustainable energy, and software development. The complete list of interview questions can be found in Appendix 1.

3.1.1 Factors and measures when evaluating product potential

The goal of this section is to closely examine the key factors that entrepreneurs take into account when evaluation the feasibility of a potential product for the target market, as well as whether they make use of already existing sets of criteria. Interesting to find out also is the single most important factor, if any, that promises success.

The interview questions addressed in this section are as follows:

“What are measures that are used to determine whether a product is suitable for the African market?”

“Do you have a predetermined and consolidated set of criteria when evaluating new product potential?”

“Is there a single factor that you consider imperative for the success of a new product on the African market?”

From the perspective of the professionals leading factors to consider are the *economic costs* (gains and losses of one opportunity compared to another) related to the introduction of the new products, as well as the *continuous access to/availability* of the product. Those serve as prerequisites for further evaluation of the product. A factor that is considered advantageous, specifically for the African market, is the *durability* of the product.

From customers' perspective, according to professionals, *pricing* of the products plays imperative role in reaching multiple clients. The price of the products should be adjusted for the middle and lower socio-economic groups in order to achieve wide market penetration. Product *usability* and durability is also crucial, nevertheless customers tend to compromise durability for price. Factors such as environmental impact, although considered, are not deciding for the purchasing behavior of the customers.

All specialists that were interviewed responded that they do not use a predetermined and consolidated criteria models when evaluating a new product. They rely mostly on experience and heuristics, as opposed to scientifically proven criteria. This finding comes as no surprise since it complies with the observation from the literature review that the majority of manager/entrepreneurs use heuristics when assessing products. However, they admit that they would use a scientifically backed approach if there was one that fits the full spectrum of their needs.

When asked to single out one predominant factor that determines success in the African market the majority of professionals agree that it is the long term strategy of *product reformulation* (continuous upgrading) and *availability*. The reason for that is the observation that if the market perceives the product as not continuously available, the product will be rapidly substituted by

one that is better reformulated and readily available irrespective of other criteria. This is an unexpected finding from the interviews, since product availability is not viewed as a leading concern in the European market. Arguably the issues around availability derive from distribution problems that the entrepreneurs face. Such as logistical hurdles due to poor infrastructure in some of the markets. Distribution issues also discourage entrepreneurs to plan long term reformulation strategy of the products. Other factors that were singled out include extent to which the product meets the demand, its quality, its durability and last but not least its affordability.

3.1.2 Approaches to measure sustainability

The interview question corresponding to this section is:

“How do you measure sustainability?”

According to experts, measurement of *sustainability* in the African market is a difficult task and it differs between organizations and products. Generally used approaches to measuring sustainability involve looking at the lifetime expectancy of the product and its effects on the community. Also products that are durable and require no or less maintenance are perceived as more sustainable. There were no evidence, from the interviews, showing use of techniques to weigh the environmental impact of the products, such as the Life Cycle Assessment method described in the literature review in Section 2.2. It could be argued that the professionals can benefit from using literature frameworks in their sustainability assessment. The pros and cons of using literature frameworks versus the current ad hoc approached could be an interesting subject for a future research.

3.1.3 Factors considered when pricing the products

The interview question addressed in this section was phrased as:

“What do you take into consideration when pricing a product? Which is the leading factor?”

The responses here varied significantly between the respondents. However, they can be grouped in a number of ways. Experts with predominantly engineering and manufacturing background seem to focus more on the cost of production, disregarding to a certain extend the purchasing

power of the potential customer. While professionals with marketing experience tend to take into account the customers' ability to afford the product, and if the product does not suit that ability, it is either disregarded or iterated until it suits.

Using the approach with emphasis on the costs of the product, professionals usually consider factors such as development cost, duty and other taxes, currency exchange rates etc. To this sum, or base cost, the seller then adds a certain percentage of the sum to secure his profit and hope that the customers would afford it. Common mistake pointed out by the interviewees here is that sometimes people apply enormous margins, which impairs the commercialization of the product. Starting from the customers prospective, professionals begin by defining the need that the product fulfils. What problem does it solve? Is the solution appropriate? How does it compare to others? What is that optimal price that will allow the target customer to purchase it? The leading driver of this approach is the purchasing power of the customer. Ideally, one have to consider both, but products that are priced affordably for the target customer seem to be more successful on the African market.

In the Western world companies can afford to charge extra for 'sustainability' as a product feature, due to the readiness of the customer to pay a premium for such products. Interesting finding is that this is not widely accepted in Africa, where more often than not customers compromise sustainability for a lower price, forcing the business professionals to not emphasize on that when pricing.

3.1.4 Common reasons for success or failure of products

This topic was examined via the following interview questions:

"Can you give an example of a very successful product on the African market? What is the reason for its success?"

"How about one that is considered to have failed the expectations? What is/are the reason/s for its struggle?"

When it comes to most common reasons for failure of products; poor pricing, due to failure to acknowledge the purchasing power of the target buyer is the most common. Such products fail

even if they are significantly better than cheaper competing products on the market. Another common reason for failure is the inability to engage the end customer due to undefined or poorly targeted product capabilities. It is rather common that people disregard products due to lack of education about the product functionalities.

Commonly pointed to as a successful product were the various solar lamps coming from China and the modular/predesigned homes. The reason for the success of the solar lamps was their affordability and the convenience associated with not having to burn kerosene or paraffin to generate light. The modular houses' popularity was fueled by the ease of installation and relatively low cost.

Interesting finding is that a product that seemed promising at first but did not live up to the initial expectation was again a solar lamp, the European born Product A. According to the interviewees, the lamp is sustainable and quite durable, but it overpriced when compared to the purchasing abilities of the majority of the people who actually need it. It should be mentioned however, that there were no evidence for a distribution strategy of Product A lamps for Africa. The distribution efforts of the producer company seem to be focus in Europe, with a model that donates one Product A lamp for each one that is purchased. This could be a possible explanation of the higher price. You can see an in depth analysis of this product in Section 3.2.

In summary from this part of interviews, this paper received further evidence that affordability is a key prerequisite for successful products in Africa and sustainability tends to be compromised for a lower cost.

3.1.5 Common mistakes made by business professionals

Below is the interview question related to this section:

“What is the most common mistake that business professionals make when introducing a new product on the African market?”

According to professionals a common mistake that managers make when introducing new products is market generalization. The African market is segmented, and the product should be tailored for each segment. It is reported that unsuccessful products fail to take people's specific needs into account, due to lack of field research and insufficient feedback from the clients.

Another common mistake is that managers tend to focus on the middle and higher class assuming it will generate higher returns, disregarding the low-socioeconomic groups. A recurrent suggestion given by the interviewees was the use of field tests whenever possible to mitigate the discrepancies between the perceived need and the actual need of the customers.

3.1.6 Potential of Africa as a market for innovative and sustainable products

To get an idea of the enthusiasm, or the lack of it, that business professionals have towards the African market, the following interview question was designed:

“Can you please give a forecast of the potential of Africa as a market for innovative and sustainable products?”

The interviewed business professionals spoke positively towards the potential of Africa as a market for innovative and sustainable products, due to the fast pace of economic development in the continent and the quest to catch up with the developed economies. Especially in the areas of technology and sustainable development. However, both the products and their marketing has to take into account specific factors such as purchasing power, stable supply chain, cultural specifics etc.

3.2 ANALYSIS OF EXISTING INNOVATION AND SUSTAINABLE PRODUCTS

A closer look into the innovative and sustainable products that are already available on the African market is presented in this part of the research. The aspiration is to examine the mission of the product/company and whether the product is sustainable. Additionally, what is the strategy and degree of market penetration as well as the price of the product and how it compares to the purchasing power of the customers.

The focus of the analysis is on solar lamps in particular, that is due to the emphasis of the African Agency for Sustainable Innovation on renewable energy consumption and production and the talks with African entrepreneurs indicating solar lamps as a point of interest for the market. Taking Product A as an example and then comparing it with other solar lamps on the market will give us necessary insights.

Product A is a solar powered LED lamp that can serve as an assistant light in areas with no access to electricity produced by the Dutch-based company. The product is about the size of a human palm; it has a compact solar panel on one side and two LED lights on the opposite side. The battery can be fully charged in 5-10 hours and can last for several hours of use. The product design is simple, efficient and durable and the materials used to produce it are completely recyclable. That along with the fact that it runs on renewable energy makes the product rather sustainable. Additionally, the product could be considered innovative as it makes use of patented chip to gather and convert sunlight efficiently.

The long term goal of the company that brings Product A to life is to 'eradicate energy poverty plaguing over a billion people worldwide' according to their mission statement. The company took the online crowdfunding approach for the initial introduction of the product and in 2012 held a successful campaign on a popular crowdfunding platform. The second iteration of the product (referred to as Product B in this publication), Product B featuring ports for charging other devices such as phones and tablets, was also introduced via the same medium and was successfully funded. The company's business model includes donation of a portion of the profits to solar projects in Africa and a buy-one-give-one policy for donating a unit to a family in Africa for every unit sold in the Western world.

The company operates using the triple bottom line framework, a framework introduced by Elkington in 1994, in which an enterprise considers economic, social environmental results equally important. The term 'bottom line' is usually used in accounting statements to show profit or loss at the very end of the statement. The main idea of the triple bottom line approach is to maximize *profits*, without causing harm to the *planet* while trying to make *people's* lives better (Slaper & Hall, 2011). The two products seem to be the embodiment of that philosophy.

The company claims that the Product A is the best solar lamp in its class. This claim rests on an independent testing by Intertek (multinational inspection, certification and product testing company) reported on the site of the product. According to the reported results, Product A provides suitable for reading light on a single charge approximately for twice as long as the other seven lamps that were tested.

When it comes to pricing Product A retails for 29 euros and Product B for 69 euros. According to the professionals this price is affordable for the high income class in Africa, but expensive for the lower income part of the market. That comes as no surprise because 61% of Africa's population lives on less than 2 dollars a day and 44% lives on less than 1.25 dollars a day, which is well below

the poverty line (AfDB, 2011). Therefore, it is reasonable to assume that the pricing impairs the possibility for wide adoption of this high-quality, innovative and sustainable product by the African consumers. To put that price in prospective, typical retail price of solar lamps in Africa is about 10 euros dependent on the country.

Currently there are about 41 thousand Product A units in sub-Saharan Africa, a little over 8 thousand of those are in the five countries (Nigeria, Ghana, Ethiopia, Kenya and South Africa) that are examined closely in this study. There are reportedly 1 million solar lamps used in Africa, and around 110 million off grid households according to the World Bank Institute. Considering the size of the market and the fact that the vast majority of Product A units in the market are donated and not bought by the customer, the predominant opinion of our interviewees is that the market penetration of the product is minor and there is sizable room for improvement.

Two findings stand out from our analysis of innovative and sustainable products in the African market. Firstly, there is evidence that the triple bottom line products are well accepted by the wider public, which can be very beneficial when using crowdfunding as a sales channel. That combined with the sustainability element that is imbedded in the triple bottom line framework makes it suitable for a criterion to use when evaluating potential products. Secondly, the analysis of the existing products confirmed the findings from the interviews that pricing fitting the purchasing power of the low socio-economics is prerequisite to achieving wide market penetration of the African market.

3.3 CONCLUSION

This chapter studied the practical experience of professionals along with current products available on the African market in order to find commonly used selection criteria associated with wide product adoption. In summary, the leading factors emerging from the analysis are economic costs, continuous availability and reformulation of the product, durability, usability and pricing. Evidence highlighting the importance of a triple bottom line approach also emerged during the analysis. In the following chapter, the study designs the selection criteria model for innovative and sustainable that is to be used when examining product for the African market. Furthermore, this research identified the reasons behind the use of the individual criteria in the model, as well as the approaches to measuring them.

4. SELECTION CRITERIA MODEL FOR SUSTAINABLE AND INNOVATIVE PRODUCTS

This chapter devises and presents a set of selection criteria to be used by the management of the African Agency for Sustainable Innovation in their potential product evaluation. The selection criteria model considers the core capabilities (sustainable energy) and core values (see Section 1.2) of the company, the most promising product selection methods described in literature and used in practice (see Section 3.1), along with the experience from previously introduced product in the target market (see Section 3.2) to produce the model.

4.1 SET OF CRITERIA

A set of criteria have been designed based on the preceding chapters of the research, this set is to be used by the management team of the African Agency for Sustainable Innovation when assessing the market potential of innovative and sustainable products. The set considers aspects such as product design, pricing, components' lifecycle, usability and strategy. It comprises of the following criteria:

- Sustainable energy field relevance
- Sustainability score
- Affordability for the low-socio economics
- Ability to be continuously produced, delivered and maintained
- Durability
- Usability (Ease of use)
- Possibility for continuous customer involvement
- Triple bottom line compatibility

The criteria are based on interviews with the management of AASI, literature review and interviews with professionals (see Section 3.1), and analysis of existing products (see Section 3.2). The criteria '*sustainable energy field relevance*' and '*sustainability score*' are included to reflect the core capabilities and values of AASI. There are also sufficient evidence from literature and interviews to include the '*affordability for the low-socio economics*', '*ability to be continuously produced*', '*durability*', '*usability*', and '*possibility for continuous customer involvement*'. The

'triple bottom line compatibility' reflects the analysis of existing products in the market. Last but certainly not least the criterion *'affordability for the low-socio economics'* is included because of the evidence for its importance from practical experience and from analysis of current market status (see table 4.1).

Criteria	Based on
Sustainable energy field relevance	Core capabilities of AASI
Sustainability score	Core values of AASI
Affordability for the low-socio economics	Interviews with professionals & Analysis of existing products
Ability to be continuously produced, delivered and maintained	Interviews with professionals
Durability	Interviews with professionals
Usability (Ease of use)	Interviews with professionals
Possibility for continuous customer involvement	Interviews with professionals
Triple bottom line compatibility	Analysis of existing products

Table 4.1: Each criterion matched with the source of the evidence for its inclusion.

Detailed justification for the selection of each individual criterion as well as suggestion on how to measure them is given in Sections 4.1.1 through to 4.1.8.

4.1.1 Sustainable energy field relevance

After discussions with the executive personnel of the African Agency for Sustainable Innovation, it became apparent that the predominant expertise within the company are in the *sustainable energy field*, therefore the firm is expected to have an advantage when working with products

within that area. However, it should be noted that although advisable this criterion does not preclude products from other fields to be considered.

Measuring whether a product complies with that criterion is relatively straightforward. The sustainable energy field includes renewable energy sources such as solar, wind, wave, and alternative fuel generated energy. Alternative or non-conventional fuels are any substances or materials that can be used as a fuel outside of the conventional fuel sources. Conventional fuels are all types of fossil fuels, as well as nuclear materials and any artificial isotope fuels generated by a nuclear reaction. When it comes to sustainable energy, there are two important aspects: production and consumption. Therefore, both products related to sustainable production and sustainable consumption of energy are to be considered by the company.

4.1.2 Sustainability score of the product

This criterion is directly related to the core values of the company. The mission of the African Agency for Sustainable Innovation is about ensuring the sustainable future of the African continent by promoting sustainable development. Therefore, it comes without noting that the sustainability of the products under the company is a key prerequisite.

The sustainability score is measured by the Life Cycle Assessment method presented in Section 2.2. An outline of the methodology of the method can be found in Appendix 2. The lower the negative impact a product has on the environment a product has the more desirable it is for AASI to take on.

4.1.3 Affordability for the low-socio economics

Based on the literature review and interviews, affordable for the low-socio economics is an important prerequisite for success on the African market. Given that almost two-thirds of sub-Saharan Africa lives below the poverty line, it is not surprising that this is a leading criterion. The importance of affordable pricing was also observed during the analysis of existing products on the market.

To measure the degree of affordability, one should start with calculating the purchasing power of the target customer for the product and then compare it to the retail price of the product. It is also important to take into account whether the product is for personal use or it can be shared

between different people. If the product allows use across multiple groups, such as families or communities, then the purchasing power or budget of the unit as a whole should be taken for the comparison. This criterion is geared towards the low-socio economic groups, hence the people with weak purchasing power. This can deem certain product unsuitable since innovative products tend to be expensive in their first version. However, this criterion is key for the widespread adoption of any product across the African market, thus it cannot be disregarded.

4.1.4 Ability to continuously produce, deliver and maintain the product

From the interviews it became apparent that if the product were not continuously available people would not rely on it or even avoid purchasing it at all. Therefore, the continuous production, delivery and maintenance should be secured. Potential issues with production could be lack of/uneconomical raw materials, poor supply chain, and insufficient production capabilities. The infrastructure in sub-Saharan Africa is generally of low quality, and to mitigate the risks deriving from that, one should apply careful consideration and planning in his delivery strategy. Various countries also have different legislations concerning an identical product, so it is important to be aware of the differences. Some products also require maintenance, which should be covered by the produce.

All aforementioned variable should be considered when determining the weight of this criterion in the decision making process. Product with foreseeably stable, replicable and scalable production process are to be receive higher score as oppose to ones that could be expected to have issues in production. Also the clearer the delivery, distribution and maintenance strategy the better score of the product.

4.1.5 Durability of the product

The sturdiness and the capability to withstand wear or decay is an important feature for the African market. That is due to the ruff environment that most of the products are expected to be used in, therefore it is important to consider the durability of the products as a criterion.

How durable a product is, can be measured by looking into the product design as well as the quality and life expectancies of the different components that it is comprised of. Typically, the product manufacturer has conducted testing and has data on the durability of the product. If

there are concerns about the credibility of the testing, the use of a third party independent testing organizations is advisable.

4.1.6 Straightforward usability (ease of use)

Straightforward usability is another criterion that professionals use driven by the tendency of complicated or unfamiliar products to face a hard time in their adoption by the African consumer. Ideally, the use of products should come intuitively or it should be understood by an uncomplicated and prompt presentation.

The level of usability can usually be judged by applying common sense. Nevertheless, for complicated cases, and dependent on the available time and resources, a company can use test groups. The principle is that they give the product to a group of potential customers and evaluate their experience with the product.

4.1.7 Continuous customer involvement

Continuous customer involvement in the product design is proven to yield positive results and professionals in Africa tend to make use of it to bring more refined products to market. Therefore, the strategy for continuously taking into account the end user and involving him in the product iteration process serves as a criterion in this study.

The customer involvement strategy can be dependent on the customers as well as the features of the product. The feasibility of that strategy is what is to be considered when measuring this criterion. This could be qualitatively assessed dependent on product and customer specifics.

4.1.8 Triple bottom line

Based on the analysis of existing products on the African market in point 3.2, it seem that AASI can benefit by using the triple bottom line framework in selecting products. Products complying with the three dimensions (economic, environmental and social) have advantages such as public and governmental support and are also in line with the core values of the organization. To measure the extent to which a product complies with this criterion, one should look at the effect it has on both people and planet while generating profit. Products that do not comply with one

of those dimensions cannot be considered triple bottom line and therefore, these products fail this criterion.

4.2 ASSIGNING VALUES AND WEIGHTS TO CRITERIA

In the decision making process each individual criterion of a possible product will be given a score to quantify and measure it. These scores range between 1 and 10, 1 being the lowest possible score and 10 being the highest. If a certain product does not comply with one or more of the criteria then it does not receive any score for the respected criteria. It should be noted that it is not advisable to consider products that do not comply at all with one or more of the criteria. The 1 through to 10 grade scale was chosen due to the fact that AASI is based in the Netherlands, a country widely employing that scale. Therefore, the managers of the company will be already familiar with this system. In the aggregation of the scores each criterion can be assigned with a different weight according to the preferences of the company. For the purposes of this study all criteria will be taken with the same weight. The reason for that is that the criteria are similar in their importance, and there is no sufficient need to distinguish between them.

4.3 CONCLUSION

This section presented the set of criteria designed during this study along with justification for the choice and various ways to measure these criteria. The set comprises the following criteria: Sustainable energy field relevance; Sustainability score; Affordability for the low-socio economics; Ability to be continuously produced, delivered and maintained; Durability; Ease of use; Possibility for continuous customer involvement; Triple bottom line compatibility. Furthermore, the 1 though to 10 scale was suggested as a suitable tool to quantify each criterion. This allows ease of measurement and benchmarking, both between the criteria itself and between other products. The use of this selection criteria model will provide a more comprehensive, systematic and quantifiable approach for selecting and evaluating potential product for the African Agency for Sustainable Innovation.

In the succeeding chapter, this paper examines the purchasing power of the customers in the countries within the scope of the research to allow the designing of an economic model for measuring affordability of products for the African market. This economic model is used to evaluate affordability as part of the application of the selection criteria model. After assigning values to both products, this research proceeds with an MCDM model to compare the products in order to give discussion and recommendation.

5. ECONOMIC COMPARISON MODEL FOR MEASURING AFFORDABILITY OF INNOVATIVE AND SUSTAINABLE PRODUCTS TO THE AFRICAN MARKET

Parts of this chapter have been altered or omitted before publication due to confidentiality of their content.

This chapter is divided into four major sections. The first one deals with examination of the purchasing power and behavior of the African consumer. The second one designs an economic model for examining affordability of innovative and sustainable products. Thirdly, this chapter includes application of the selection criteria model from Chapter 4 to evaluate potential products for the African Agency for Sustainable Innovation. Lastly, there is a comparison of the products using an MCDM tool to single out the most feasible product. The chapter also includes a discussion of the findings and recommendations.

5.1 PURCHASING POWER OF THE LOW SOCIO-ECONOMIC GROUPS

This section looks into the buying power of the citizens of Nigeria, Ghana, Ethiopia, Kenya and South Africa. The purchasing power of both individuals and households is presented due to the possibility of potential products being not only for single person use, but also for shared use.

5.1.1 Approach to Measuring the Purchasing Power

The ability of African individuals and households to purchase products is measured for the purpose of this study. The approach to measure it involves taking the gross domestic product at purchasing power parity (GDP at PPP) per capita per year for each of the five countries. When the measure for a household as a whole is needed, the GDP (PPP) per capita is multiplied by the mean number of family members in each country, respectively.

5.1.2 Purchasing behavior in Africa

According to (Kotler, 1986), customer behavior is diverse, and customers are irrational, therefore they will not always prefer a cheaper product rather a product to which they are already accustomed. An idea of the consumer purchasing behavior for a country can be acquired by looking at Hofstede's cultural dimensions. Analysis across those dimensions for every country

within the scope of this research was already conducted above (see Section 1.4). In this section, this research deliberates on how each dimension can influence the buying behavior of a country's customer.

The *power distance* can shed light on the way people perceive the importance of a brand, as token of status. It can also influence the way that customer gather information about the product or services when making a buying decision (De Mooij, 2011). In cultures with high power distance, which is the case for the five countries that this paper examines (see figure 1.4), customers can be prone to purchase brands that symbolize higher status and accept purchasing advice from authority without questioning it.

The *individualism/collectivism* can influence the degree to which the consumer takes decisions individually or is influenced by the collective opinion in the society. It also explains the communication behavior, and whether it requires high or low context. The majority of the countries in this research fall under the collectivistic category meaning that their buying behavior is shaped by conformance and sharing, rather than self-confidence and self-expression (De Mooij, 2011). Such insights can influence the way companies position their products (advertising content and marketing channels).

The *masculinity/femininity* of the culture explains the differences in the cultural drivers, such as success and competitiveness for predominantly masculine societies and balance and modesty for feminine ones, as well as the different roles of males and females (De Mooij, 2011). Most of the countries in this research fall under the more masculine oriented societies, therefore the specific cultural drives have to be accounted for in designing the product positioning strategy.

The *uncertainty avoidance* can be used to explain the difference in the adoption of innovation and the precision with which consumers analyze potential products. The scores in this dimension are intermediate, with Ghana leaning towards high uncertainty avoidance and South Africa towards low. High uncertainty avoidance culture prefer product positioning that is detailed and precise and the one with low tent to prefer the use of humor in advertising (De Mooij, 2011).

Long term orientation examine the degree to which people are willing to overlook short term gains in pursuit of bigger future gains. This dimension influence the attitude of the customer toward long term investments. Nigeria, Ghana and South Africa score low in this dimension (no data is available on Kenya and Ethiopia), which signifies low affinity towards long term investments and preference towards short term gains. This means that even if a product

promises high savings in the long run, the consumer will most likely prefer a product with lower but immediate savings.

5.1.3 Measuring the Purchasing Power

A reliable way to measure the purchasing power is to look at the gross domestic product (GDP) of a country. The GDP is calculated by taking the entire monetary value of all goods and services that are produced within a country for a set time period, most commonly a year. The total GDP of a country is divided by the number of citizens in the same country to calculate the GDP per capita. To adjust for the exchange rate differences between the countries' currencies we take the GDP at purchasing power parity (PPP) in USD.

It is important to have an idea of the purchasing power of a household as a unit as well, due to the fact that certain products can be shared across a household, therefore taking the combined ability to buy the product of a family is a useful metric. The average household size in sub-Saharan Africa is 5.3 persons per household (Bongaarts, 2001). Therefore, the GDP (PPP) per household was calculate by multiplying the GDP (PPP) per capita for each country by the average household size.

The preceding approach to measure the purchasing power was chosen before the household income statistics (usually provided by governmental agencies for urban development). This is due to the fact that the GDP is calculated using precise economic data and techniques as opposed to the household income statistics which are predominantly examined by surveys that simply request the individuals to estimate their own income. In addition the GDP calculation includes corporate profits of companies, while typically household income statistics exclude them. Table 5.2 reports the buying power of individuals and households for Nigeria, Ghana, Ethiopia, Kenya and South Africa according to the GDP at PPP.

	GDP PPP per capita per year in USD (2014) ²	GDP PPP per household per year in USD (2014)
Nigeria	\$ 6 100	\$ 32 330
Ghana	\$ 4 200	\$ 22 260
Ethiopia	\$ 1 500	\$ 7 950
Kenya	\$ 3 100	\$ 16 430
South Africa	\$ 12 700	\$ 67 310

Table 5.2: The GDP (at purchasing power parity) per capita and per household for the five countries within the scope of this research.

The purchasing power appears to vary significantly between the five countries with Ethiopia being at the lowest side of the spectrum with almost 8.5 times lower GDP per capita/household than South Africa, which has the highest. South Africa is the clear leader here with value slightly more than twice as much as the country with the second highest from this group, Nigeria. Although South Africa has a high GDP per capita/household compared to the other examined countries, it is still relatively low compared to countries in the Western world.

The results from the buying power assessment make it really interesting to see what is the affordability price point and whether and which products would be deemed affordable.

5.2 ECONOMIC COMPARISON MODEL

The goal of this section is to design a comprehensible and replicable economic model to use when determining the affordability of products for a specific market.

² Data collected from <https://www.cia.gov/library/publications/the-world-factbook/fields/2004.html> (retrieved on 28th of June 2015)

5.2.1 Introduction and Common Application of Economic Models

An economic model is a theoretical hypothesis about economic processes illustrated by a selection of variables and their relationships. The economic model simplifies reality in order to make complex processes more comprehensible (Ouliaris, 2011).

The economic models usually consist of set of mathematical equation aimed at providing usable idea of how an economic phenomenon works. The structure of the equations reflects the specific purpose of the model and the author's underlying assumptions about the reality. Generally, the empirical economic model includes two types of variable: endogenous and exogenous. An endogenous variable is determined within the model's equations or as an outcome of the model, while exogenous are variable that do not need to be explained by the model and are taken from the outside environment. Real world examples of exogenous variables are policy variables, interest rates, taxation rates etc. For an economic model to be considered scientifically valid its results are expected to be precise and replicable (Ouliaris, 2011).

5.2.2 Economic Comparison Model for Innovative and Sustainable Products

This section has been omitted before publication due to confidentiality of its content.

5.2.3 Assumptions of the Economic Model

This section has been omitted before publication due to confidentiality of its content.

5.2.4 Limitations and Conclusion

This section has been omitted before publication due to confidentiality of its content.

5.3 MULTI CRITERIA SELECION MODEL APPLICATION

In this section of the research this paper makes use of the selection criteria model from the preceding chapter to evaluate and single out a product that is with high potential and is in line with AASI's mission. The company is currently looking into two new Dutch born inventions in the sustainable cooking and solar power storage domains. The selection criteria are applied to the products in order to quantify their potential.

5.3.1 Product 1 Introduction

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5.3.2 Application of Selection Criteria Model to Product 1

Parts of this section have been altered or omitted before publication due to confidentiality of their content.

In this section this paper used the set of criteria designed in the previous chapter of this study to evaluate Product 1 and determine whether it is a suitable product to take under the African Agency for Sustainable Innovation. A detailed explanation about each criterion and possible ways to measure it, can be found in section 4.1.1. The results for this particular evaluation were obtained in the following ways. For the “*sustainable energy field relevance*” this research looked at whether the product and its functions are connected in any way to sustainable energy production or consumption. For “*sustainability score*” this paper conducted a small scale LCA

analysis using data provided by the team of inventors and information about the materials used in the product. For the *“affordability for the low-socio economic”* criterion the economic model from section 5.2 was applied. For *“ability to continuously produce, deliver and maintain”*, *“durability”* *“usability”* score this paper utilized information obtained from the Product 1 team and limited tests were done by the AASI team. For *“possibility for continuous customer involvement”* this paper looked at the product capabilities and business model and for *“triple bottom line compatibility”* this research looked at the product’s social and environmental impact as well as the profit orientation of the company. It should be noted that *“sustainable energy field relevance”* as well as the *“triple bottom line compatibility”* are rather bipolar criteria, meaning that products either comply with them or not. Thus, they are either awarded maximum points or none. The results are reported in Table 5.1 below.

Criteria	Product 1’s Score
Sustainable energy field relevance	10
Sustainability score	7
Affordability for the low-socio economics	3
Ability to be continuously produced, delivered and maintained	6
Durability	7
Usability (Ease of use)	6
Possibility for continuous customer involvement	5
Triple bottom line compatibility	10

Table 5.1: Scores of Product 1 for each criteria.

5.3.3 Product 2 Introduction

This section has been omitted before publication due to confidentiality of its content.

5.3.4 Application of Selection Criteria Model to Product 2

Parts of this section have been altered or omitted before publication due to confidentiality of their content.

In this section, similarly to section 5.3.2, the selection criteria model to evaluate Product 2 and examine its potential feasibility with AASI, was applied. Details about the various criteria can be found in section 4.1.1. To evaluate Product 2 this paper looked at whether and how that product is *related to the sustainable energy field*. Moreover, this research obtained information from the product's website and its crowdfunding campaign to measure its *sustainability score*, its *ability to be continuously produced, delivered and maintained*, as well as its *durability, usability, and triple bottom line compatibility*. To measure *affordability for the low-socio economics* the economic model was employed (see Section 5.2) by using data for fuel usage of kerosene lamps, candles and batteries from reports of the United Nations Environmental Programme (UNEP). An important note is that "*sustainable energy field relevance*" and "*triple bottom line compatibility*" are rather bipolar criteria, meaning that products either comply with them or not. Thus, they are either awarded maximum points or none. The results from the evaluation are reported in Table 5.2 found below.

Criteria	Product 2's Score
Sustainable energy field relevance	10
Sustainability score	7
Affordability for the low-socio economics	5
Ability to be continuously produced, delivered and maintained	9
Durability	9
Usability (Ease of use)	8
Possibility for continuous customer involvement	7
Triple bottom line compatibility	10

Table 5.2: Scores of Product 2 for each criteria.

5.4 COMPARISON OF POTENTIAL PRODUCTS (WEIGHTED SUM MODEL)

In this section this study compared Product 1 and Product 2 using a multi-criteria decision analysis methods; the Weighted Sum Model (WSM) (see Section 2.1.2). This model is chosen as most suitable in this instance due to the homogeneity of the units of measurement in the criteria selection model. Table 5.3 depicts the score of the Product 1 and Product 2 for each of the eight criteria, as well the weight of each criterion. For the purposes of the study, there is no distinction between the importance of the various criteria (see Section 4.2), and therefore all criteria bear equal weights ($1/8=0.125$). The WSM equation is as follows:

$$A_i^{\text{WSM-score}} = \sum_{j=1}^n w_j a_{ij}, \text{ for } i = 1, 2, 3, \dots, m.$$

inputs:

$A_i^{\text{WSM-score}}$ = total importance of product

m = number of alternative products

n = number of criteria

w_j = weight of importance of criterion

a_{ij} = performance value of alternative

	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	C ₇	C ₈
w _j	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
A ₁	10	7	3	6	7	6	5	10
A ₂	10	7	5	9	9	8	7	10

Table 5.3: Shows the score for each criteria of A_1 (Product 1) and A_2 (Product 2) and the weight of importance of each criterion (w_j).

When the formula is applied on the numerical data for Product 1 there is the following score:

$$A_1^{\text{WSM-score}} = 0.125 * (10 + 7 + 3 + 6 + 7 + 6 + 5 + 10) = 6.75$$

When the formula is applied on the numerical data for Product 2 there is the following score:

$$A_2^{\text{WSM-score}} = 0.125 * (10 + 7 + 5 + 9 + 9 + 8 + 7 + 10) = 8.125$$

Results:

$$A_1 = 6.75 < A_2 = 8.125$$

Thus, the better alternative is A_2 , which is Product 2.

This is a sample calculation to illustrate the use of MCDMs for measuring the better of multiple alternatives. The current calculation uses two alternatives, but there could be multiple number of alternatives in other instances. The above calculation also assumes the relative importance of each criteria as equal, nevertheless if the management of the African Agency for Sustainable Innovation deems suitable to distinct between the different criteria they can employ diverse values for the weights of the criteria.

5.5 DISCUSSION

Parts of this section have been altered or omitted before publication due to confidentiality of their content.

The results of the comparison between Product 1 and Product 2 point towards the latter having a higher potential for success in the African market. However, neither of them seems affordable according to the economic model calculation for the preferable one-year period (see section 5.3.2 and 5.3.4). Since there are tremendous health benefits associated with the adoption of these two innovative products, as substitute for the harmful products currently used, it is worth to discuss alternative option to make the new products more affordable.

The inventors' team of the Product 1 could employ an approach for introduction of the product to the African market by leasing or selling the product to African entrepreneurs, who in turn are to provide it as a kind of utility service to the local population. The entrepreneurs can charge a fee per hour or per energy used. In line with the idea that the product could be used as utility, its design is made such that it is transportable. Another option could be allowing purchase of the product in installments, that in case the producer has the capital to sustain that model.

It could also be worth testing some more unorthodox options, such as getting a company or a sports team to sponsor the product. In return the product can be branded with the company's/team's logo, which will generate goodwill for the brand. It is also advisable that the team focuses on lowering the cost of the unit. The product can also be shared across larger groups of people than a household, therefore targeting local institutions such as schools, could be a beneficial strategy.

Product 2 product appears suitable for leasing under the pay-per-use model, therefore this option should be further examined. An opportunity could be also for the local distributors to allow purchase payments in installments. This idea derives from the application of the economic model (see Section 5.3.4), where it became apparent that by the savings from the use of Product 2 for two years, a household would save enough to fully repay the product. Product 2 is also rather suitable for sponsorship by a company or a team as described above.

Generally, an idea for a funding approach for products that prove unaffordable could be that the customer pays an amount equal to the affordable price point according to the economic model and the remainder of the sum is covered by governmental or private initiatives. This way the affordability of the product is ensured and since the customer also has funds invested in the product, there is a lower chance for misuse (sub-optimal or improper use) and poor treatment of the product.

5.6 CONCLUSION

The preceding chapter designed an economic model for measuring products affordability and showcased the contrast between two products (Product 1 and Product 2) by employing the multi criteria selection model to rate the products, and weighted sum MCDM to compare them to one another. The results showed that the Product 2 scored better than the Product 1 in the overall comparison. However, both products proved unaffordable when a period of one year was used in the calculations of affordability (see Section 5.3.2 and 5.3.4). The underlying conclusion is that

both products are hard to afford for a direct purchase by the African customers therefore lowering the price of the products or alternative ways for financing should be considered (see Section 5.5).

6. CONCLUSIONS AND RECOMMENDATIONS

Parts of this chapter have been altered or omitted before publication due to confidentiality of its content.

This chapter, outlines the findings of the research, as well as their managerial implications. Section 6.1 discusses the overarching objectives of the research, the methods and the results. Section 6.2 provides recommendations for the management team of AASI on how to successfully employ the findings of the study and section 6.3 discusses the opportunities for future research.

6.1 CONSLUSIONS

This study researched and developed a selection criteria model for innovative and sustainable products, which can be used as an evaluation tool to assist the African Agency for Sustainable Innovation in its business operations. The model consist of the following set of criteria:

- Sustainable energy field relevance
- Sustainability score
- Affordability for the low-socio economics
- Ability to be continuously produced, delivered and maintained
- Durability
- Usability (Ease of use)
- Possibility for continuous customer involvement
- Triple bottom line compatibility

These criteria reflects AASI's core competences and values, common practices of business professionals, and analysis of successful and unsuccessful innovative and sustainable products in the African market. This model was tailor made for the organization and is specifically applicable when considering innovative and sustainable product for the context of the African market.

However, the approach used to design it can be duplicated for different company capabilities and values as well as for different market context. This model was designed with products suitable for consumer rather than commercial use in mind, although some products can serve dual purpose.

Under the premise that improper pricing is a common reason for inability to capture significant share of the African market, this research developed an economic model to ensure affordability for the biggest part of the market, namely the low income consumer.

The application of both the economic and selection criteria models was illustrated by evaluating two products (Product 1 and Product 2). This allowed for a comparison of the products using a weighted sum model. The results from the comparison pointed out that Product 2 had higher potential. However, both products proved to be with a higher than the affordable price. Therefore, to improve the chances of success of the products on the African market the managers should either lower the price or look for methods to mitigate the financial tow on the consumers.

6.2 RECOMMENDATIONS

This section provides recommendations on how and when the two models should be implemented. The selection criteria model is suitable to use when the attributes of a potential product need to be quantified in order to get a better idea about the product or measure it against another one. Nevertheless, the model also can be used as a blueprint when looking for potential product, and ensuring that they fit the predetermined criteria. The criteria model also allows for different depths of product analysis as the measurements for each criterion are flexible and can be determined depending on the desired thoroughness of the analysis. Thus, making the model useful for quick evaluation as well as detailed, more extended one.

The economic comparison model can be used as part of the criteria model for assigning value to the affordability criterion or on its own to evaluate pricing of products. The model was designed for the purposes of measuring affordability, but it can also serve as a tool to measure returns on investment and payback periods. An important feature of the model is also that its complexity can be easily altered by adding relevant variable according to the desired depth and accuracy of the analysis.

Based on the outcomes of the study the product that showed higher scores was the Product 2, however the Product 1 must not be discarded as it scored well on the criteria model. Especially given that it is still in early stage of product development. In designing the marketing strategies and business models for the products, entrepreneurs and consultants should account for the specific traits of the African market described in this research. It is also advisable to consider strategies to mitigate the commonly observed issues related to affordability.

6.3 FUTURE RESEARCH POSSIBILITIES

In future research it would be interesting to expand the complexity of the economic comparison model. It would be beneficial to see how additional valuables alter the results of the model. The model can also be expanded in future research to account for whether consumers have the initial capital available to purchase the product, along with the current view that looks from economic savings perspective.

The current research focuses on data from five countries in the design of the selection criteria model, and even though they are culturally similar, there might be differences that were unaccounted for. Future research could focus on a single country to design a country specific model and get a more comprehensive insights on what products can be successful in that country. Future research can also examine and consider more closely the competitors on the market, as well as the entrepreneurial teams behind the products. Lastly, it would be interesting to see to what extend those two models can be applicable in the contexts of other developing countries.

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Appendix 1 – Interview Questions

This interview is designed to examine the common measures used by business professionals to determine the potential of an innovative and sustainable product to be successful in the context of the African market. The interview is part of an academic research with the overarching goal of outlining the product criteria that are related to positive performance in the market.

Interview Questions:

Tell us about yourself?

What are measures that are used to determine whether a product is suitable for the African market?

Do you have a predetermined and consolidated set of criteria when evaluating new product potential?

Is there a single factor that you consider imperative for the success of a new product on the African market?

How do you measure sustainability?

What do you take into consideration when pricing a product? Which is the leading factor?

Can you give an example of a very successful product on the African market? What is the reason for its success?

How about one that is considered to have failed the expectations? What is/are the reason/s for its struggle?

What is the most common mistake that business professionals make when introducing a new product on the African market?

Can you please give a forecast of the potential of Africa as a market for innovative and sustainable products?

Appendix 2 – Life Cycle Assessment Stages

A general approach for conducting a Life Cycle Assessment of a product is:

Stage 1: *Define the Goal*

This step consists of defining the desired outcomes and the scope of the assessment.

Stage 2: *Analysis of Inventory*

This step consists of mapping out all processes involving product development, from raw materials to waste products. All consumptions and emissions are to be considered.

Stage 3: *Assessment of Impact*

Specific environmental effects are identified, grouped and weighted.

Stage 4: *Implications and Improvements*

Results are interpreted and points of improvement are identified.