

# Definition of the Service Unit Concept and Application of the Service Unit to ad- dress SDG 3

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**Supervised by** Prof. Dr.-Ing. Markus Lienkamp  
Clemens Pizzinini, M.Sc.  
Lehrstuhl für Fahrzeugtechnik

**Submitted by** Celia Cuñat Rausell, B.Sc.  
Kreittmayrstrasse 4  
80335 München

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## Project description

### Definition of the Service Unit Concept and Application of the Service Unit to address SDG 3

This thesis develops the definition of the Service Unit concept and its application to achieve SDG 3 by addressing the targets through potential Service Units. As a result of the research, a comprehensive and clear definition of the Service Unit has been obtained. This definition is contained in the central block of the VbS Canvas and serves as the value proposal provided by the supplier to the customer. A database of Service Units has been developed from current strategies performed by means of a vehicle that organizations are using. This validates the implementation of Service Units and VbS to enhance rural accessibility in Sub-Saharan Africa.

This master thesis develops the following items.

- Focus groups to refine the initial definition of the Service Unit and acquire successive iterations of the definition, ultimately leading to its finalization.
- Expert interviews as a form of validation of the definition. With the application of the definition to real business cases.
- Systematic literature review to identify current strategies used by companies to address SDG 3 targets and the application of the Service Unit framework to obtain a database of service units.
- Cluster and potential application analysis of the identified Service Units to visualize the additional requirements and components, have an initial estimation of the costs of each Service Unit, and to study the intensity of demand of Service Units in Sub-Saharan countries.

The thesis should document the individual work steps in a clear form. The candidate undertakes to complete the master's thesis independently and to indicate the scientific aids used.

The submitted thesis remains the property of the chair as an examination document.

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Prof. Dr.-Ing. M. Lienkamp

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Betreuer: Clemens Pizzinini, M. Sc.



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# List of Abbreviations

SDG	Sustainable Development Goal
SDL	Service-Dominant Logic
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
FU	Functional Unit
SU	Service Unit
VbS	Vehicle-based Services
SS	Sub-Saharan
WHO	World Health Organization
SSA	Sub-Saharan Africa
NCD	Noncommunicable diseases
UHC	Universal healthcare coverage
WASH	Water, sanitation, and hygiene



# 1 Introduction

The agricultural sector in Africa is economically growing and placing itself in the international value chains. However, rural areas of Sub-Saharan Africa (SSA) are not following the same economic growth as urban areas, due to the lack of access to services given by insufficient or non-existent infrastructure, scarceness of resources, and/ or geographical constraints. The aCar Mobility project [1] aims to offer new solutions for electric transportation in rural regions of Africa that overcome the restrictions to enhance the supply of services by implementing Vehicle-based Services (VbS), defined as “services in which the involvement of a vehicle is crucial for the value delivery” [2].

In the continuous search for new emerging markets and technology innovations, vehicle manufacturers reflect on existing norms and practices [3]. Current innovation and digitalization trends in the automotive industry show that vehicle manufacturers are shifting their value propositions toward customer integration and trying to achieve a higher collaborative perspective [4]. VbS implement the customer-centric view and attain to overcome obstacles by offering services directly to people. Difficulty accessing basic services challenges the economic and social development of the population [5]. VbS consider the importance of spatial accessibility and focus on improving access to services for rural populations to reduce isolation and enhance global development.

VbS can be used for different operations to achieve Sustainable Development Goals (SDGs) [6]. By addressing the social inequality between developed and underdeveloped countries, organizations contribute to accomplishing the SDGs.

Based on the results of Emanuel D’Amico’s research [5], all the targets contained in SDG 3: Ensuring healthy lives and promoting well-being for all at all ages [7], can be influenced directly or indirectly by VbS. The focus of this master's thesis is on this particular goal. SDGs are strongly interconnected, and addressing customer demands on SDG 3 results in improvements in targets from other SDGs and vice versa. Following the interactions expressed by Asma et al. [8] Figure 1.1 depicts the main relationships between SDG 3 and the rest of the SDGs.



Figure 1.1: Interaction between SDG 3 and the rest of the SDGs.

The use and offer of mobile clinics is rapidly increasing and mobilizing the resources to reach people increases accessibility to every person in the community [9]. UN organizations, such as UNHCR help marginalized people by promoting the social and economic development processes [10]. Many companies are focusing on providing delivery mobile healthcare services in rural areas. The aCar can be equipped with either a single service or a combination of multiple services and access rural areas to provide services through which the rural population can greatly benefit. The aCar is customized and parametrized depending on the specific needs and requirements of the Service Unit (SU), which describes the service provided.

Currently, there are obstacles in the cost-benefit analysis of human well-being and satisfaction. The criteria for evaluating these dimensions belong to human beings' cognitive and emotional realms. They are hardly quantifiable in terms of preference satisfaction and willingness to pay [11]. Developing a definition of the SU allows for a functional way of measuring services to perform cost-benefit calculations and leave behind the current indirect valuation methods which consist of looking at customer preferences and linking them to ecosystem services [11].

The SU also serves as the value proposition in the VbS Canvas [12], and is based on the Service-Dominant Logic (SDL) to shift the canvas onto a customer-centric model. The SU is the central block after which the whole business model is defined, converting the technical requirements of the engineering design into a business model.



## 1.1 Research Objective

The objective of this work is to develop a definition for the concept of a Service Unit based on the Functional Unit (FU) studied in Chapter 2. To put the concept into action and implement the framework, service units that evaluate SDG 3 will be acquired. This will involve conducting a comprehensive valuation of existing approaches that address the targets outlined in SDG 3 and adapting them to align with the service unit concept and suit a VbS.

The potential SUs will be subjected to cluster analysis. This analysis will help in evaluating the viability of each SU and selecting the one that best aligns with the overall goals and objectives of the framework, ensuring efficient allocation of resources for addressing the targets in SDG 3 with SUs. Additionally, the cluster analysis provides the supplier with a general idea of the different costs associated with each SU.

Finally, a study of the potential application of the SUs across the countries of SSA will give a visualization of the needs and requirements of those countries and serves as an initial study of the demand for SUs in each SS country.

The aforementioned process will answer the following research questions: “What is a service unit and how to define it?” and “How can SUs be used to address SDG 3 targets?”. This will result in the creation of a comprehensive database of SUs that can be effectively utilized by the aCar to provide targeted services to the rural population of Africa in alignment with SDG 3. This exemplifies the potential of VbS to overcome the existing challenges that hinder rural areas in Africa from accessing basic services and achieving the goals set in the 2030 Agenda for Sustainable Development [13]. By leveraging the database of service units, the aCar can contribute towards bridging the gap and facilitating sustainable development in these underserved areas of Africa.

## 1.2 Structure of the Thesis

The thesis will be structured into seven chapters.

The introduction sets the background and the goal of the objective. The second chapter examines the current state of the art, focusing on the FU and reviewing methodologies for concept definition.

The third chapter outlines the methodologies employed to obtain the results stated in chapter four. Chapter five presents the validation process through expert interviews of the SU definition and the validation of the potential SUs found in the literature search.

Chapter six engages in a discussion of the thesis, addressing its limitations and highlighting positive outcomes. Finally, chapter seven provides a summary of the entire thesis and presents prospects for future research.



# 2 State of the art

This chapter establishes a foundation for understanding the current state of the art in the Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Functional Unit (FU).

## 2.1 Life Cycle Assessment

According to the ISO 14040 [14] the LCA studies a product's life, from raw material extraction to disposal (cradle-to-grave), focusing on the environmental aspects and potential impacts throughout the product's life cycle. The LCA is applied in the sustainability framework to understand the potential impacts of products, make environmental improvements, and support environmental claims [15].

The LCA includes the production and use phase of the product and diversifies into unit processes such as the inclusion of transport, energy supply, and intermediate products. It is designed to assess the environmental impacts relating to the whole production chain of a good [16], turning the LCA into very complex product trees or life cycles with interconnected processes that form a product system [17]. The LCA analyses all systems that serve a specific function and have a specific performance.

LCA can be used to compare different products or services and to identify areas where improvements can be made to reduce environmental impacts [18] by calculating the environmental burdens associated with the functional unit [19]. It can also be used to perform informed decision-making in product design, and policy development; as seen in Figure 2.1.

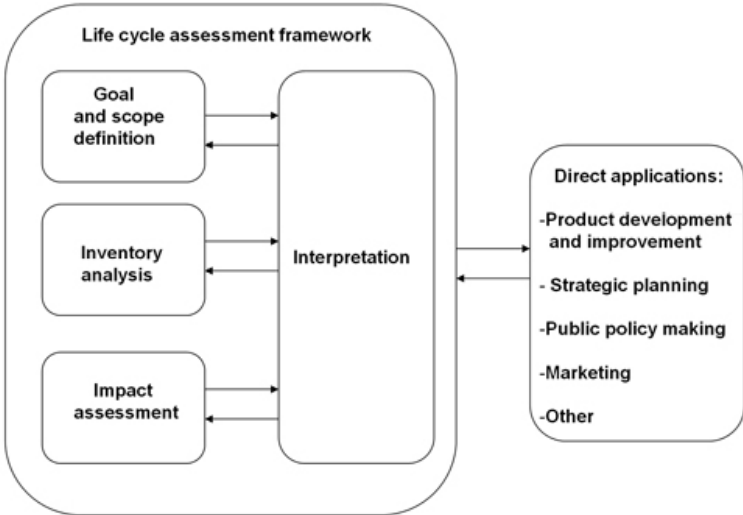


Figure 2.1: LCA phases according to ISO 14040 [14].

Overall, LCA provides a holistic and quantitative approach to evaluating the environmental performance of products and services for providing the same function [20], and it is a valuable tool for promoting sustainability and reducing environmental impacts. This life cycle must not be confused with the marketing and sales life cycle of products [21], which looks at the establishment of a product in the market.

### **2.1.1 Goal and Scope Definition in the LCA**

#### **Goal**

The goal definition establishes the context of the LCA study and is the basis for the scope definition. In the goal of the LCA, the purpose of the study is defined and described. A correctly defined goal has a strong influence on the validity of the conclusions and decisions made based on the results of the LCA [22]. The goal definition contains six aspects that influence the subsequent decision-making phases and provides guidance when reviewing LCA results:

1. Intended applications of results. These state the separate applications of the product or products studied and influence later phases of the LCA.
2. Limitations due to methodological choices. The limitations reflect what the results of the LCA can or cannot be used for.
3. Decision context and reasons for conducting the study. This aspect influences the appropriate elaboration of an LCA. The study must express the reasons behind its execution, establish a connection to the intended applications, and address the drivers and motivations relevant to decision-making processes.
4. Target audience. The goal definition must state to whom the results of the study are to be communicated. The level of detail in the documentation, technical explanations, and interpretations of results vary based on the target audience.
5. Comparative Studies to be Disclosed to the Public. To ensure transparency and quality of the study.
6. Commissioner of the Study and other Influential Actors. These should be stated in the goal of the study to highlight the potential conflicts of interest to readers.

#### **Scope**

The scope definition plays a crucial role in determining the product systems to be assessed and guiding the assessment process. It specifies the boundaries and parameters of the study, including the system boundaries [23], functional units, and life cycle stages that are considered in the analysis. It also outlines the methodology, data requirements, and valuation criteria to be applied during the assessment. The scope definition helps establish the framework for the LCA study ensuring that the appropriate product systems are examined and that the assessment is carried out consistently and comprehensively according to the predefined guidelines [24].

## 2.1.2 Economic Assessment in the LCA

The LCA must eventually take the economic consequences of product designs/alternatives into account. In the LCA methodology, neither the internal nor the external economic aspects of the decisions are within its scope [20]. The Life Cycle Costing (LCC) is integrated into the LCA to perform the economic assessment. The LCC can be defined as “an assessment of all costs associated with the life cycle of a product that are directly covered by one or more of the actors in the product life cycle, with complimentary inclusion of externalities that are anticipated to be internalized in the decision-relevant future” [25].

The LCC consists of methods that link existing financial data and cost information with the metrics of the LCA [25], comparing the cost-effectiveness of alternative investments or business decisions from an economic perspective. The LCC can be used to move the actors in the environment from indirect costs to direct actors in the value chain [26]. It assesses all costs associated with the life cycle of the product.

It is a cost management method to estimate costs associated with the existence of a product and is used for relative comparisons between products [27]. Therefore, decision-relevant differences have higher importance than absolute cost or environmental impacts. This method helps to improve a good, service, or process against its alternative options.

The LCC integrates the definition of a functional unit and system boundaries similar to the ones in the LCA [17]. When the LCC is part of a sustainability assessment in conjunction with the LCA, the functional unit of the LCC analysis has to be identical to that of the LCA [25], including the magnitude, since the LCC assesses the costs of the product system providing the function. One common reference (FU) is necessary to have a correct interpretation of results. As a consequence, the reference flows resembling physical material and energy flows have to be identical in the LCA and LCC [25].

The result of the LCC ideally corresponds to the actual costs related to the selected functional unit. The important actors in the life cycle are consumers who decide upon the acquisition of the product, its use, and disposal at the end of the product’s life. These decisions are made by the consumer based on the price of purchase of the product.

### LCC Framework

The LCC method follows the structure of LCA and covers the entire life cycle of a product. It aims to ensure that no information is lost in the process through aggregation, and that detailed analyses of each life cycle stage are thoroughly documented. In the cost calculation, all included costs are assigned to the examined product. This includes the costs further up in the product trees including energy and raw material costs in a highly aggregated form [17] and externalities that are anticipated to be relevant in the decision-making future [25].

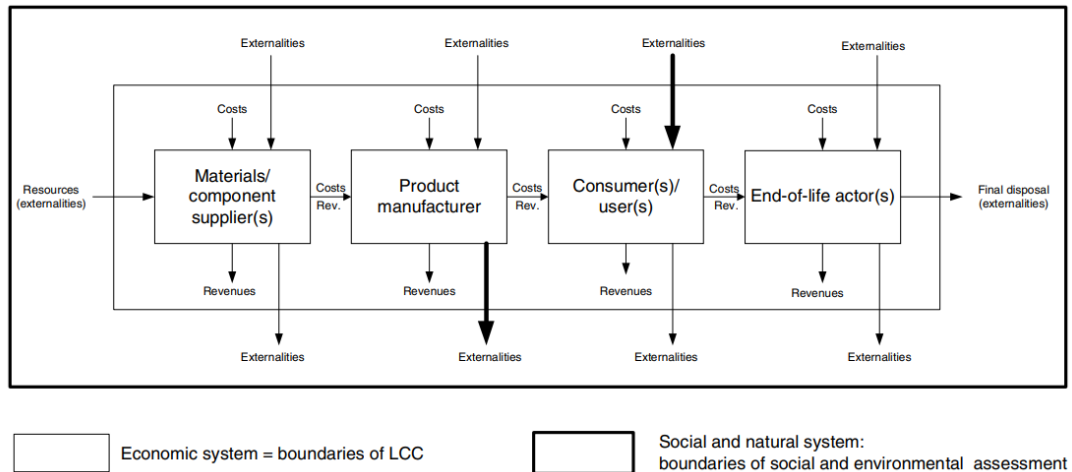


Figure 2.2: The conceptual framework of LCC [25].

Figure 2.2 summarizes the conceptual framework of LCC. The framework differentiates between internal costs along the life cycle of a product, implying that someone is paying for each stage of the product life cycle and can be connected to a business cost; and external costs that monetize effects of environmental and social impacts not linked to the producer, user, or handler of the product. These are outside the economic system but inside the natural and social systems.

In the LCC the existence of value-added and margins causes one to question whose costs one accounting for, as the costs of one actor, are the revenue for another one (consumer who buys the product and producer who manufactures it) [25]. The notion of value-added requires one to consider both costs and revenues in each stage of LCC.

Including LCC in LCA has positive implications, as highlighted by Norris [28].

- Enhances influence and relevance of LCA decision-making. Introducing the LCC in the assessment gives decision-makers access to a more comprehensive understanding of both the environmental and cost consequences connected to the different product alternatives.
- Improves identification of relationships between environmental and cost consequences, allowing for a holistic evaluation of the interaction between environmental impacts and costs. This approach facilitates the study of the most cost-effective methods to achieve environmental improvements.
- Avoids overlooking economically significant environment-related consequences. Neglecting LCC could result in missing economically important environment-related consequences. Incorporating LCC considers all significant economic implications of alternative decisions, providing a more accurate assessment of the overall impact.

In summary, the inclusion of LCC in LCA brings positive outcomes such as improved decision-making, capturing the relationships between environmental and cost consequences, and avoiding the oversight of economically important environment-related consequences. LCC serves as a complement to both LCA and product-related social assessments. Sustainable products need to be both financially viable for producers and economically accessible for users/consumers to be accepted in the market [17].

## 2.2 Functional Unit

Every human activity can be related to specific needs and the aim of fulfilling them by using material or non-material products. Products are produced to perform functions and provide services to fulfill customer requirements [18]. The FU is a vital component of the LCA that refers to a part of the product or service that performs a specific task or function. Incorporating the FU allows the comparison of the performance across the different products [29].

### 2.2.1 What is the Functional Unit

From the perspective of the LCA, the functional unit is a quantified description of the performance of the product systems, for use as a reference unit, allowing the comparison of different improvement options. It describes and quantifies those properties of the product, which must be present for a substitution to take place [18].

The functional unit describes the functionality of a product, service, or process as a quantified unit [30], which allows for valuations between products or services to be done equally. To facilitate accurate comparisons, it is important to establish a clear definition of FU that aligns with the scope of the study. This ensures that the assessment can be conducted in a manner that allows for precise and meaningful comparisons between different alternatives. Additionally, it serves as a reference to decide which unit points should be included and to what extent they are examined [24]. By defining the FU explicitly, the boundaries and specific criteria for evaluation are established, enabling consistent and reliable assessments within the defined scope.

Pedroso et al. [29] and Weidema et al. [18] follow the definition stated in the ISO 14040:2006 [14] that defines the FU as “the quantified performance of a product system for use as a reference unit”. Fleischer and Schmidt [31] established the relationship between the FU and the LCA in their definition by stating that “the functional unit is the reference to which input/output fluxes and environmental effects are normalized”. Grahl et al. and Gao et al. use the latter definition in their research on the LCA [17] and Environmental Life Cycle optimization [32]. DeMarco and Fortier [30] state that the FU “describes the functionality of a product, service, or process as a quantified unit facilitating comparison across similar studies”. Hauschild et al. [33] define the FU as “a quantitative description of the function or service for which the assessment is performed, and the basis of determining the reference flow of product”.

Arzoumanidis et al. [34] define the FU as “a quantified description of the function of a product that serves as the reference basis for all calculations regarding impact assessment of the different features of the product under study”. They focus their study on the FU inside the Social Life Cycle Assessment (S-LCA). The S-LCA has a business-oriented methodology and focuses on assessing the social impact of the organization’s processes, rather than on the function of the product they manufacture. Overall, all the definitions state the characteristic of reference and comparison across different products or services.

### 2.2.2 Applications of the Functional Unit

This section states the possible sectors of products where the FU is used inside the LCA and S-LCA. Based on the results obtained by Arzoumanidis et al. [34] on their literature review for the application of FUs in the S-LCA and LCA, a research is conducted to find the main quantities used to define the FU in the different industries (Table 2.1).

Table 2.1: Summary of main FU quantities in different industries.

Sectors	FU quantity
Agriculture, forestry, and fishing	Mass, volume, area, energy, economic value, product unit [23, 35].
Mining	Mass, time, product unit [36, 37]
Manufacturing	Mass, energy, product unit, area [38]
Electricity and gas	Mass, energy, area, [39, 40]
Water supply; waste managements and remediation activities	Volume, mass, environmental impact [41, 42]
Construction	Area, energy, environmental impact, insulating value, product unit [43, 44]
Transporting and storage	Distance, time, passengers transported, mass [29, 45–47]
Accommodation and food service	Mass, time, product unit [48, 49]
Information and communication	Time, energy [50]

Based on the data shown in Table 2.1, it is evident that mass is the most used quantity to define the FU. Out of nine sectors, mass is utilized in seven of them, followed by product unit and energy. Focusing on vehicles and transportation services, it is important to highlight that the most common FUs for this sector are mass, distance, time, and passengers transported. Pedroso et al. [29], Ding, Pat et al. [45] and Al-Thawadi et al. [46] use FUs based on “passengers transported per unit of time”, “travel demand per km”, and “passenger per kilometre” to compare different services in the transportation industry and ensure evaluations on equal terms. Regarding goods transportation, the most common FU is mass, establishing a reference on the mass transported in the vehicle for comparison [47].

### 2.2.3 How to Define the Functional Unit

A FU defines the qualitative aspects and quantitative aspects of the function to be assessed in the LCA. These can be seen as obligatory and positioning properties. The obligatory properties describe the features that the product must possess and are usually expressed in technical terms. Positioning properties are optional features and are used for competition positioning.

The functional unit needs three parts to be completely defined: the magnitude of the service, the duration of the service, and the expected level of quality [51]. To do this, the functional unit should answer the questions “What?”, “How much?”, “For how long?/How many times?”, “Where?” and “How well?” [24]. The functional unit should always contain a functional aspect rather than just a physical quantity such as 1 kg, 1 L, or 1 MJ. This allows for the comparisons to be done taking into account the intended purpose and the value that the function provides.

To accurately define the FU, it is crucial to have a clear understanding of the relevant market. By comprehending the market context, including its dynamics, competition, and customer preferences, it becomes possible to identify the specific functions that the product or service



should deliver. This knowledge enables the development of an appropriate and meaningful FU that aligns with the needs and expectations of the market. The target market is analyzed through the process of market segmentation and can be done geographically, temporally, and/or by customer segmentation [18].

- Geographical segmentation of a market is determined by the differences in natural geography such as climate, landscape, and transport distances. It is also shaped by regulatory or administrative factors specific to the different regions, and cultural preferences of customers in those areas where the product is consumed.
- Temporal segmentation is employed for service products, taking into account peak hours, rush hours, or seasonal fluctuations. For physical goods, temporal segmentation is typically applied when there is insufficient supply or capacity to meet demand.
- Customer segments are defined in terms of functional requirements they seek to fulfill through products, rather than on the products themselves. This approach focuses on understanding the specific needs that customers have and tailoring product offerings accordingly.

Segments must be adequate to support a separate product line with minimum overlap, implying that product substitution from segment to segment can be neglected. The FU can be defined in terms of the properties required for the market segment [52].

The FU avoids shortcomings by being normalized, it allows to make meaningful decisions amongst products and systems because it is used as a reference for comparison [29]. This results in a better understanding of the comparisons among specific stakeholders. Normalization is necessary for comparison between any product or process in the LCA [19]. It expresses the performance or impact of a product in the reference unit, in this case, the FU. The reasons why the normalization of the functional unit is done:

- **Standardization:** Normalization provides a standardized FU that allows for consistent comparison of products and systems. Expressing the performance in a common unit enables meaningful comparisons and facilitates communication in decision-making [19].
- **Relevance:** The choice of the FU may vary depending on the specific application or stakeholder perspective. Normalization allows for a selection of a FU that is relevant to the specific context or stakeholders involved, ensuring that the assessment results are meaningful and applicable to the intended audience [32].
- **Comparison:** Normalization enables comparison of various products or systems. It allows for the identification of relative strengths and weaknesses, hotspots, or areas for improvement across different options, which can inform decision-making and optimization efforts [19].
- **Simplification:** Normalization can simplify complex performance or data by expressing it in a single reference unit, facilitating its interpretation and communication. It can compress a wide range of data into a single value or indicator, which can aid in decision-making, reporting, or policy development [53].

An appropriately defined functional unit should specify the service that is expected out of the system as well as a numeric value with a physically measurable value, like for instance time, energy, or water consumption [29]. Studies on Social-LCA and LCA [34] conclude that the FU

selection depends merely on the product/service and there is a prevalence of the use of mass as a quantity for FU identification.

The definition of the FU depends on the role of the stakeholder [32], it can be viewed from the perspective of the supplier or the customer and the functionality of the product or service is defined according to which one is more appropriate for them. The function identified in the FU should be as close as possible to the end-use of the product [54]. Products can have multiple functions or functions which are not easily defined and can be valued in various ways according to different stakeholders, that is why functional units tend to be difficult to select [53]. However, in LCA terminology, the FU is always seen from the view of the customer [25].

The above-described information on the FU is summarized in Table 2.2 and provides a concise overview of the papers that contain each of the primary characteristics that define the FU in the LCA.

*Table 2.2: Summary of the Functional Unit's characteristics.*

Literature source	Numeric value (physically measurable quantity)	Function comparison/Product substitution	Market relevancy (segmentation)	Economic Assessment
Weidema, Wenzel et al. [18]	x	x	x	
Pedroso, Bermann et al. [29]	x	x	x	x
Traverso, Petti et al. [55]	x	x		
ISO 14040 [14]	x	x		
Klöpffer, Grahl [17]	x	x	x	x
Gao, You [32]	x	x	x	x
Chester, Horvath [19]	x	x	x	
DeMarco, Fortier [30]	x	x		x
Hauschild, Rosenbaum et al. [33]	x	x	x	x

## 2.3 Research Gap

The LCA is used to assess the environmental impact a product or service has throughout its whole life cycle. From the extraction of the raw material until the disposal of the final product manufactured. It is applied in the sustainability framework and analyzes all systems that serve a function [17]. LCA analysis can be used to compare products or services by calculating the environmental effects associated with a defined FU for different alternatives.

To perform the economic assessment of the LCA, the LCC is introduced. This assessment aims to highlight the economic consequences of the different product and service alternatives. It encompasses all the costs associated with the life cycle of a product or service and the results of the LCC correspond to the costs related to the FU.

The FU defines the performance or function of a product or system and provides a reference to compare the inputs, outputs, and environmental impacts associated with the product or system. The FU can be applied in many different industries. In the transportation industry it is applied by describing the function of the transportation per kilometer, time, or the mass of the goods transported.

Table 2.2 lists the defining characteristics of the FU, which includes a comprehensive review of all essential aspects covered by the FU, or that require in-depth study to adequately define it. This highlights the importance of conducting a thorough examination. The FU needs a quantified magnitude with a numeric value that allows for a physical measurement and a functional aspect that allows for comparison to be carried out. The magnitude is normalized to clearly define the reference value and perform better comparisons. To accurately define the FU, the market segment where the product or service is going to be applied needs to be studied and understood to identify the proper functions of the studied element. Studying the market segment will result in a better knowledge of the stakeholders, customers, and the end-use product.

There are some limitations and areas with need of improvement in the LCA and FU [56]. Product manufacturing or service provision cause economic and social impact during their life cycles. However, the LCA excludes social and economic aspects from its analysis [57]. Stakeholder needs and requirements need to be addressed during the goal and scope definition of the LCA. Not integrating social and economic assessment limits the influence of the LCA in decision making, because the relationship between environmental and cost consequences is not included in the alternatives [28]. Additionally, social impacts are independent of the processes used to produce the assessed alternatives, therefore integrating these aspects in the LCA is challenging [57]. To resolve these issues, the LCC is introduced, but integrating both LCA and LCC is difficult because it is out of the scope of the LCA, and its difficulty increases with the integration of social assessments [25].

It is required to have a unique FU when comparing different products or systems. When considering services, the non-quantifiable or difficult to quantify functions could cause the FU to not be accurately defined, because they can be more subjective and as a result less comparable [58]. Additionally, the FU does not describe the product or service itself, but it describes one functionality. Adequately selecting the FU is important, because different FUs leads to different results. This becomes a limiting factor when the items assessed have more than one functionality or have sub-functions that are not considered when determining the FU and results in failing to reflect the reality well [56]. This happens in strict functionally equivalent comparisons and system dependency issues. These refer to part-specific changes that cause changes in other parts and as a consequence, the whole system performance changes [58].

To resolve the limitations and problems of the LCA and FU, and apply them to vehicle-based systems, the SU and VbS Canvas are introduced. The SU is the value proposal of the VbS Canvas and is linked to the customer, supplier, and engineering requirements of the vehicle. The VbS Canvas uses the customer-centric orientation and the SDL and the economic assessment is also integrated in the costs and revenue streams blocks. Its methodology, validity, and application is discussed in López Ortega's work [12].

The FU will be the basis from which the definition of the SU is derived and must contain all characteristics listed in Table 2.2. The SU serves as a quantified description of the VbS provided. With its definition and application, the supplier can establish the costs associated to it and perform comparisons among different SUs. It allows for a functional way of measuring the cost-efficiency of the VbS. The SU determines the delivery of value through VbS. The SU is directly linked to its supplier and customer via the VbS Canvas.

# 3 Methodology

This chapter provides an overview and explanation of the methodologies employed in this thesis. It outlines the approaches taken to address the research objectives and presents the steps and procedures followed in conducting the SU definition and validation through expert interviews. It also defines the methodology used to identify and validate suitable SUs and explains the SU cluster analysis.

## 3.1 Concept Definition Methodologies

Concept definition methodologies are systematic approaches used to clarify, analyze, and establish the meaning and scope of concepts. This section explores concept definition methodologies, such as conceptual analysis, operationalization, and theoretical frameworks, and discusses how they are used to define concepts.

Developing good concept definitions can be challenging due to several reasons. Selecting the attributes and characteristics that define a concept can be difficult when dealing with abstract and complex ideas [59]. Capturing the essence of an abstract idea and describing its key attributes or characteristics, while maintaining it simple and clear is a demanding task [59]. Ambiguity in the definitions can arise as a consequence of subjectivity and interpretation of different individuals [60]. The varying perspectives and disciplines of researchers can lead to confusion when using a concept if it is not clearly defined [61]. The evolving nature of concepts requires definitions to remain relevant throughout the concept evolution.

### 3.1.1 Theory Construction

Conceptualizing a new idea involves thoroughly examining its meanings, understanding how people perceive it, and analyzing existing literature and knowledge to identify the essential elements that need to be incorporated into the framework. W. Afzal [62] proposes Theory Construction for new concept development, making use of qualitative and quantitative perspectives to conceptualize, operationalize and empirically validate a concept.

Figure 3.1 depicts the proposed methodology where both qualitative (substantive) and quantitative (structural) perspectives are identified. The substantive aspect (where this MT is focusing) is outlined in the first phases and includes the conceptualization of the construct and the development of the initial definitions.

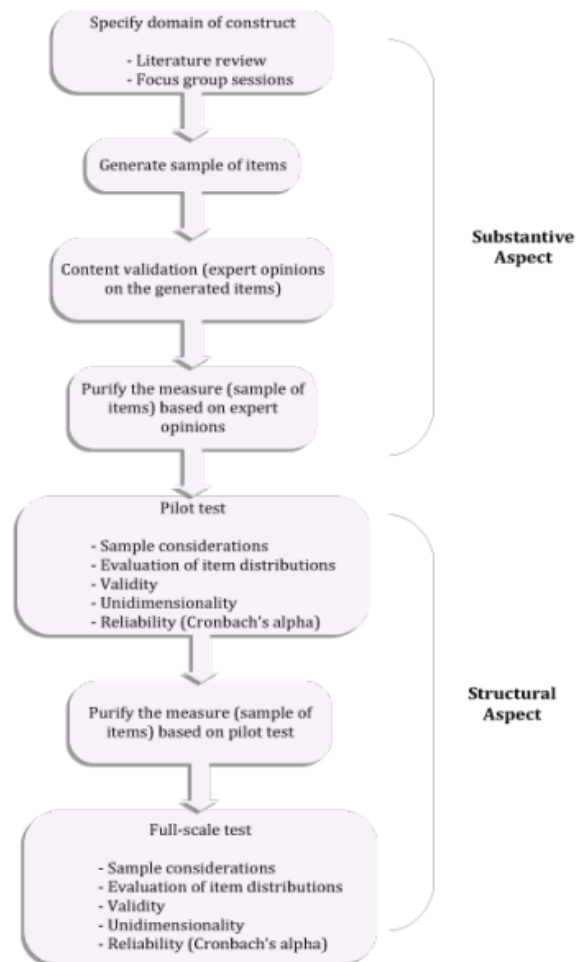


Figure 3.1: Theory construction methodology [40].

The first phase of the substantive aspect specifies the domain of a construct identifies and reviews relevant literature to delimit the attributes that should be included and excluded from the definition of the concept. A clear and comprehensive understanding of the intended construct is a crucial initial stage in conceptualizing it with precision and detail. The delineation of attributes facilitates the researcher to identify the relevant content and any constructs that are associated with the target concept to define. In this phase, focus groups are performed to help to understand people's perspectives of the concept.

In the second phase, the objective is to generate sample items that capture the domain identified in the previous phase. The dimensions included in the generated items are based on the literature review, relevant knowledge, expert advice, and feedback from the focus groups.

After the items are generated, their content validity must be assessed. Haynes et al. [63], defined validity as "the degree to which elements of an assessment instruments are relevant to and representative of the targeted construct for a particular purpose". The content validity demonstrates the meaningfulness of the concept. The content validation is purified, and the final data is collected. The purpose is to increase the alignment between the conceptualization and operationalization of the concept, by including only the items that are good representatives of the concept.

The structural aspect ensures that the generated items are empirically valid and correspond to the theory developed in the substantive phase. This attains sample consideration, evaluation of

sample distribution, and assessment of one-dimensionality. Sample size needs to be considered as the statistical power increases with the increase in sample size and detrimental effects are reduced in larger samples. Small samples can result in an inaccurate assessment of consistency and non-representation [64].

As stated by Hair et al. [65] “Validity is the extent to which a measure or set of measures correctly represents the concept of study”. It represents the extent to which a concept is appropriate. Both content and convergent validity need to be assessed. Convergent validity occurs when items measuring the same construct exhibit strong correlations with each other, particularly when the correlations between similar items are higher than correlations between items measuring different constructs [66]. “Reliability is the degree to which measures are free from error and therefore yield consistent results” [67]. This results in replicable studies and the homogeneity of observations, meaning that items can be repeated using similar participants under the same or different approaches.

### 3.1.2 Developing Good Conceptual Definitions

The lack of clarity in the definition of a new concept causes challenges at the conceptual and operationalization level. At the conceptual level, it increases the complexity of distinguishing the focal concept from others similar in the field. When a concept is not clearly defined, it leads to confusion and raises questions about the understanding of itself [61]. Poor definition of a concept leads to deficient operationalization and introduces errors in the research. A good conceptual definition should identify the key characteristics that are in common and unique to the phenomenon. For high-quality concept definitions, Podsakoff et al. [59] define four main stages that must be performed.

Figure 3.2 **Error! Reference source not found.** summarizes the stages for developing good concept definitions. The steps are described as sequential, but the process of a new concept definition is iterative and although it is recommended to follow all the approaches, practical limitations can prevent researchers to apply every recommendation described in the guideline.

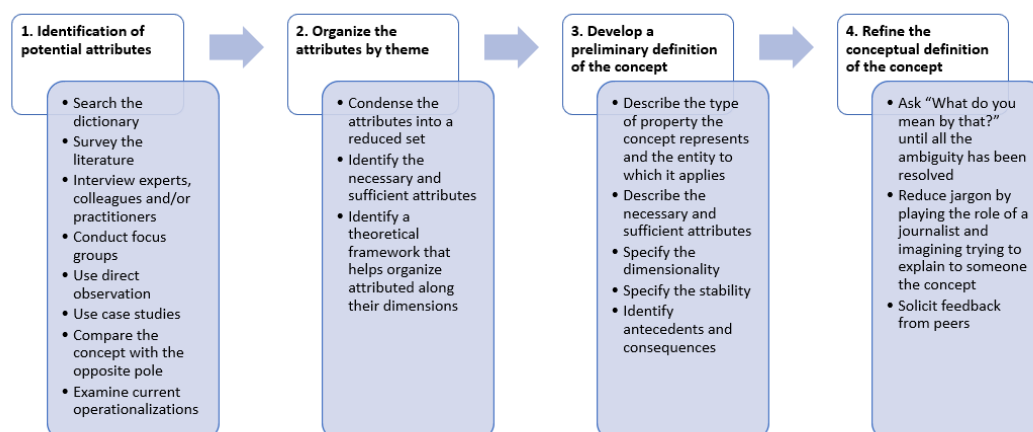


Figure 3.2: Stages for developing good conceptual definitions [59].

The first stage focuses on the identification of potential attributes of the focal concept. The paper describes different techniques and sources that could be used to collect information on the characteristics of the concept.

- Searching the dictionary to examine the definition of the focal concept and to specify the definition with greater impact.
- Literature review to identify how the concept has been previously developed and defined, and the critical characteristics for the correct concept definition. This technique helps the researcher find concepts with different names that capture the same conceptual domain and allows them to distinguish the focal concept from other related ones.
- Interviews with experts (subject matters, colleagues, and practitioners) help determine the key themes or attributes of the concept.
- Focus groups allow the researcher to collect information on the different perspectives of the concept and to add detail to the concept definition.
- Case studies have proven worthwhile to detect attributes of the concept and to examine how it is applied in real-life situations.
- Comparing the focal concept with the opposite pole, has value to discern the main differences and increase clarification.
- Examining and/or creating new operationalizations of the concept clarifies areas of the definition and evaluates what is captured by the concept.

The second stage is to organize the attributes defined in the first stage and classify them into necessary and sufficient attributes. A necessary property of the concept is things that all examples of the concept must contain, these are essential characteristics that define the concept. Sufficient properties are described as unique properties that only examples of the concept possess.

Step three develops a preliminary definition of the concept. The definition must describe the general nature of the conceptual domain by specifying the type of property the concept represents and the entity to which it applies. Elaborating on the conceptual theme of the concept helps to clarify the intention by specifying the fundamental attributes of the concept.

The last step is to refine the conceptual definition. This step ensures that the reader understands the concept when they are first exposed to it and the conceptual definition is clear, concise, understandable, and not subject to multiple interpretations.

### **3.1.3 Operational Definitions of Concepts**

The abstract state of a concept implies that is not directly observable, it is the proper definition of a phenomenon [59]. Through operational definition, one can obtain evidence of its relationship with other concepts. The operational definition of a concept is fundamental to ensure clarity, replicability, comparability, and practical application of the developed framework [62]. This step in the concept definition establishes an unambiguous definition of the concept and ensures it is well-defined by the application of the framework, this means it can be replicated and reproduced in different research and applied in different manners to measure variables and analyze data.



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Ennis [68] proposes four methods for the operationalization of a concept, thus enabling to connect the definition of the concept to the instruments and procedures:

1. Giving examples.
2. Giving a set of operations as the meaning of the concept.
3. Equating a phrase or sentence containing the term with a phrase or sentence about a combination of operations and observations.
4. Providing implication relationships among operations, observations, and the concept.

Developing an operational definition of concepts ensures that the concept can be understood by a broader population. Operational definitions are used for the validation of concepts or to address ambiguity between concept definitions [69]. The operationalization results in a connection of the abstract concept to a correct measurable unit and ensures a mutual understanding between parties.

## 3.2 Service Unit Definition Methodology

The first objective of this master thesis is to develop the definition for the Service Unit. The SU concept is used in the aCar Mobility project [1] together with the concept of VbS [2] to define the services carried out in rural areas of SSA. The SU concept must have a comprehensive meaning for all the individuals that use it, including the population of SSA. The key characteristics and attributes of a concept must be identified to clarify the meaning of the concept and prevent it from being used to refer to other phenomena. This identification helps to organize the complexity of a new concept into simpler definitions that will facilitate communication between the supplier of the SU and the tool.

After reviewing the methodologies used to develop conceptual definitions in Chapter 3.1, it is decided to follow the methodology described by Podsakoff et al. [59], because this methodology suggests methods to identify the key attributes of the concept to obtain clear definitions. An insufficient definition can result in an inadequate operationalization of the concept, leading to a lack of clarity in the concept and inaccurate measurements, therefore a clear definition will avoid operationalization deficiencies. Additionally, the guideline also suggests methods to improve existing definitions, which will be used to improve on the preliminary definition of the SU. Based on the recommendations of Podsakoff et al. [59], the methodology used to define the Service Unit is depicted in Figure 3.3.

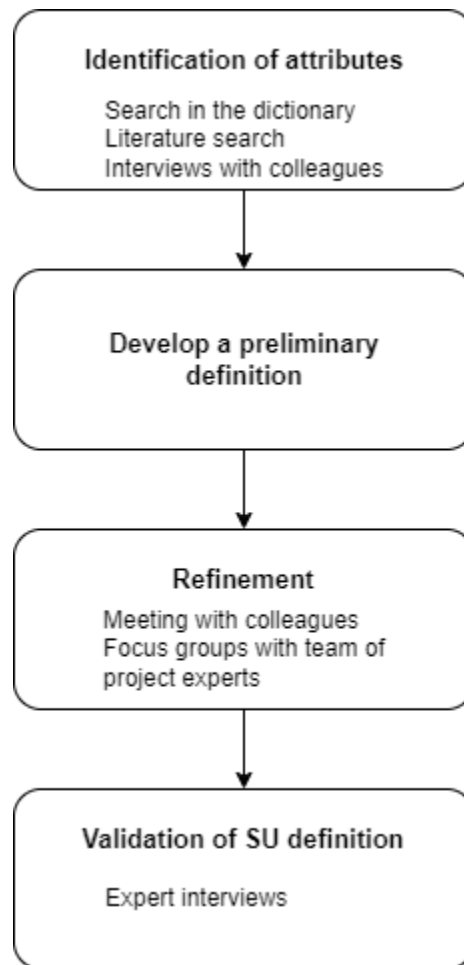


Figure 3.3: Service Unit definition methodology.

The methodology is distributed into four steps. The initial step involves identifying the attributes that define the SU. This is accomplished by conducting literature research focused on the functional unit, as its characteristics share similarities with those of the service unit. By exploring existing literature on the functional unit, valuable insights can be gained to help define the attributes and characteristics that apply to the service unit.

Interviews are conducted with team colleagues, to gain a comprehensive understanding of all the requirements for delivering a VbS. These interviews serve as an opportunity to gather information and insights from individuals who possess valuable knowledge and expertise related to the functioning of the aCar.

The second step is producing a preliminary definition of the SU. This definition contains the attributes identified in the previous step and serves as a starting point for further analysis. It aims to provide a basic understanding of the SU among team members and stakeholders. It also serves as a reference point for future refinements of the concept and as a first iteration for the next steps in the process.

The third step involves refining the preliminary definition. A meeting is conducted in collaboration with Inés López Ortega to gather feedback on the preliminary definition and engage in a brainstorming session to explore potential refinements and improvements.

Following the first refinement with Inés López Ortega, three focus group sessions are performed to evaluate the clarity and comprehension of the developed frameworks. The focus groups are carried out following the guidelines proposed by Onwuegbuzie et al. [70] and are explained in

detail in Chapter 3.2.1. Following each focus group, a new iteration of the SU definition is obtained and thoroughly analyzed. This iterative process continues until the final SU definition is achieved.

The last step is to validate the defined framework via expert interviews. This method follows the principles outlined by Audenhove and Donders [71] described in Chapter 3.2.2. The objective of the expert interviews is to confirm the validity of the framework and explore the alignment between the theoretical definition and usability of the VbS Canvas and the SU definition. This is achieved by applying the expertise of a selected group of professionals working in companies where a vehicle is crucial to deliver value.

### 3.2.1 Focus Group

Focus groups enable the researchers to receive active feedback from the team experts regarding their understanding of the SU definition. The SU, along with its application and additional sub-systems, encompasses a wide range of knowledge areas within the project and plays a crucial role in value creation. Obtaining feedback from various parts of the team leads to developing a better definition that will incorporate all essential aspects of the vehicle.

The number of focus group sessions is defined by the state of the feedback gathered during the sessions. After the third focus group, the state of saturation [70] is achieved, where less information and the observations and conclusions reached imply no further actions to be performed.

The format of each session is hybrid, thus allowing more people to take part in the focus groups, and the duration is estimated to be of one hour. The moderator team is composed of Inés López Ortega and Celia Cuñat. They explain the objective of the focus group and facilitate information to keep the discussion ongoing. The expert groups are formed from the aCar project members, including a supervisor and at least four other members as observed in Table 3.1.

*Table 3.1: Participants of the focus group sessions.*

Session 1 (24.01.2023)	Session 2 (13.02.2023)	Session 3 (04.04.2023)
Clemens Pizzinini	Korbinian Götz	Clemens Pizzinini
Irénée Froissant	Josef Kamysek	Irénée Froissant
Jakob Steger	Jakob Steger	Jakob Steger
Dominik Wernberger	Dominik Wernberger	Dominik Wernberger
Vitus von Lojewski	Vitus von Lojewski	
Frédéric du Pré de Saint Maur	Irem Yazgan	

At the beginning of the session, the VbS Canvas [12] is introduced with a short explanation and a use case that the participants have to use to fill out the Canvas. During each session, moderators take notes based on observation and the sessions are recorded for better evaluation and analysis. The extracted information from the focus group is analyzed in two diverse ways. The first one follows Glaser and Strauss's [70] approach, relying on the analysis of the most recurrent challenges encountered to fill the Canvas. The second approach, suggested by Onwuegbuzie et al. [70], involves the participants answering a set of individual questions regarding their opinion on the overall usability of the Canvas.

### 3.2.2 Expert Interviews

Expert interviews are a form of qualitative validation that allows the researchers to collect inside information on how the theoretical framework applies to the interviewees' specific disciplines. Multiple experts are interviewed by researchers Celia Cuñat Rausell and Inés López Ortega to increase the validity and reliability of data [72].

The first step is the identification of experts, the right peoples to interview within organizations with specific knowledge. This includes workers, entrepreneurs, cooperation agents, organizations etc. Following the recommendations from Grieger et al. [4] and Wallin [73], the number of interviews conducted fell within the range of five to ten. The selection criteria followed the snowballing strategy [71] and focused on experts related to companies that offer a service using vehicles and operate in Africa. This means that the expert sample has specific business knowledge of mobile services in SSA.

Approaching experts is a critical step in the expert interview process because interviewers need to gain the trust and interest of the experts during the first contact. In the first contact, the researchers explain the whole aCar project, the focus of the researcher's study, and the objective of the interview. After the experts agree to participate in the interview, they are sent a copy of the protocol three days before the scheduled session. The protocol specifies the duration of the session (45 minutes to 1 hour) and that the interview will be recorded, as well as stating questions that will be asked to the expert in order to ensure transparency. It also contains a detailed description of the project, the VbS Canvas and SU definition, and an applied case study to be familiarised with the tools that will be used during the interview.

The interviewers prepare a semi-structured guide for the interview because the aim is to implement systematizing interviews, where technical and exclusive knowledge from the expert is uncovered about a certain topic. These interviews access the information directly by asking straightforward questions [71]. The interviewers have a list of predefined questions, with room for follow-up questions as they arise during the interview.

The usability of the VbS Canvas is also assessed in the expert interviews. Usability is a very important part from the user's perspective and can make a difference between performing and completing a tasks successfully without any frustration [74]. Usability is a key aspect of the tool that will keep the organization in a higher position in comparison to its competitors [74] because it causes simplicity when using the tool, which achieves user satisfaction and increases profits.

Issa and Isaias [74] explore various principles to assess the usability within Human-Computer Interaction. The purpose is to obtain feedback directly from the users, so that developers can improve the system design and ensure good communication and performance between the users. To determine the usability of the VbS Canvas the experts are asked to rate on a scale from 1 to 5 the evaluation criteria, with 1 being the minimum score, and 5 the maximum. Table 3.2 presents the evaluation parameters [74].

Table 3.2: Evaluation criteria to assess the VbS Canvas' usability.

Evaluation criteria	Question
Learnability	How easy was to understand and use the tool?
Flexibility	How applicable is the tool for different cases and situations?
Robustness	What is the level of support provided by the tool?
Efficiency	Once users understand the tool, how quick is it to use?
User Satisfaction	How enjoyable was it to use the tool?

The usability assessment is included in the protocol sent to the experts three days in advanced of the interview. This enables them to review and fully understand the evaluation criteria when performing the scoring. The usability degree will be then calculated, and the results can be used by the researchers to perform design improvements regarding the feedback received.

The scheme of the interview is as follows. First, the interviewers introduce the project and explain the aim of the interview, then the experts are asked to introduce themselves. The next step is to display a blank VbS Canvas and ask the expert to fill it with a mobile service. In most cases, they are recommended to use the service their company provides, defining this way their own SU following the formula and definition stated in the VbS Canvas. After the completion of the VbS Canvas, some additional questions are asked to obtain direct feedback regarding their expert opinion on the elements of the Canvas and the definition of the SU. These questions assess the usability of the tool.

To finalize the interview, a short conclusion is carried out. The interview is then transcribed to collect and analyze the data obtained from the expert's answers.

### 3.3 Identification of Suitable Service Units

Providing an empiric interpretation of an abstract concept is the simplest form of operationalizing a concept. Following the first method proposed by Ennis [68], the operational definition of the SU concept is performed by giving examples. By generating a sample of items, a connection between the defined concept and the specific examples is created, increasing the clarification and concreteness of the concept. A set of items that define the concept can be created by considering a literature review [62].

The following methodology is employed to determine the appropriate Service Units for accomplishing each target contained in SDG 3. After identifying all targets and indicators of SDG 3, a comprehensive review of the existing literature is conducted to explore the strategies recommended by institutions and experts for attaining these indicators.

The systematic literature review follows the guidelines suggested by Okoli and Schabram [75].

The first step is to define the aims and objectives of the literature review. The objective of the systematic literature review is to uncover practical approaches and viable solutions that professionals have extensively studied and researched to contribute to the successful realization of the

2030 Agenda. The purpose of the literature review is to answer the question “How to apply strategies to achieve SDG 3?” and consequently acquire a compilation of multiple viable SUs that can be performed to accomplish each target inside SDG 3.

The search is carried out with the research engine Google Scholar without imposing any initial time limit and it is performed by searching the following keywords: “Strategies to achieve SDG 3. x”, being ‘x’ for each target inside SDG 3.

In the case of having no useful results with the initial search, the keywords to search should include the key information in the indicators. For example: “strategies to reduce maternal mortality”, and “strategies to increase health emergency preparedness”. The search stops when repeated articles propose the same strategies to address the target or indicator.

The research papers are classified between useful and not useful according to the applicability of their content to the SU definition. This involves the possibility of transporting the proposed goods or performing the given service by vehicle. Additionally, the information from the papers is extracted and organized to form a database with the document specifications. This includes the title, author, year of publication, and a small summary of the content and target to which that paper refers.

The validation of the identified SUs is performed in Chapter 5.2 by identifying companies, organizations, and institutions that are performing activities that align with the SUs. Finding entities that are performing the SUs in real-life situations increases the reliability and applicability of the SUs [76].

### 3.4 Cluster Analysis

Cluster analysis serves as a tool to compare and differentiate the identified SUs. The SUs are partitioned into groups according to different clusters [77]. This aids in the process of identifying the most suitable SU and ensuring the efficient allocation of resources for addressing the targets in SDG 3. This analysis studies the internal process, which refers to the engineering design in the VbS Canvas [12] and concerns the infrastructure of the vehicle and the service requirements that the aCar must have for the supplier to be able to provide the VbS.

Additionally, this analysis is useful for the supplier of the SU. Categorizing the SUs allows the supplier to identify the SU costs and it highlights the patterns and groupings that can be done with the SUs. The clusters support decision-making processes because they help to visualize the features and additional requirements of every SU and the supplier can form an initial idea of the necessary resources and costs associated with every cluster.

*Table 3.3: Cluster identification and description.*

Cluster	Description
Service Duration	Duration of the service performed to the customer.
Frequency	How often should the service be provided to supply the whole service?

Cluster	Description
Additional Staff	Extra personnel, added to support the driver, who is directly involved in providing the service unit. (Doctor, Nurse, Doctor and Nurse, and Counsellor).
Consumable Product	Product consumed in the performance of the SU (it can be loaded to and unloaded from the aCar to serve the customer).
Permanent Components	Additional components necessary in the vehicle to supply the SU (Fridge, Medical Equipment, and Other).
Type of service	The SU is performed by delivering a good to the customer or by performing a treatment (service) to the customer.

The relevant clusters defined in Table 3.3 are derived from two building blocks contained in the VbS Canvas [12] and contain sufficient information to cluster the SUs [77].

Service duration and Frequency are included in the building block VbS Logistical activities, defined as “the activities that the organization must perform to create and deliver value to its customers”. With the information on the service duration, the supplier of the SU can study how many SU can be provided in one day to set realistic timelines and ensure the availability of the necessary resources to address the daily demand of the SU.

The frequency of supply of the SU to complete the whole service is an important characteristic that needs to be assessed when designing the schedule of the aCar. SUs with higher frequency result in lower efficiency because the vehicle has to go back to areas that has already visited to complete a service, whereas SUs with a frequency of one only require the VbS to be performed once and then move on to deliver the SU to other customers that are in different locations. The service duration and the frequency are useful to have optimized routing, scheduling, and allocation of resources of the vehicle.

Staff, Consumable Products, and Permanent Components are contained in the Service Resource System building block. This block is defined as “the set of goods, personnel, or utilities necessary for the delivery of the service”. The staff depends on the nature of the SU and is composed of the extra personnel, apart from the driver, required to provide the SU. This master thesis focuses on SDG 3, therefore all the SUs which require medical treatment will have to be performed by a medical specialist. The addition of staff to perform the SU affects the costs of the service provided, as salaries must be paid.

Consumable products are the products inside some SUs that deliver value to the customer. The purchasing costs of the consumable products must be taken into account by the supplier when assessing the SUs. Additionally, the consumable products affect the performance of the vehicle because of the effect the additional weight of carrying every product has on the energy consumption of the vehicle.

The permanent components are the necessary auxiliary equipment to supply the SU. The additional equipment entails a greater investment for the SU supplier and depending on the nature of the equipment the investment varies. A mobile clinic equipped with medical equipment has higher investment costs than a water tank installed in the back of the vehicle. The permanent components also increase the engineering design demands. The vehicle has to be designed to contain the additional equipment and components necessary to perform the SU.

The final cluster category is type of service. In this cluster, the SUs are categorized between delivery or treatment. Delivery SUs are those in which a good is provided to the customer. Generally, the delivery SUs have a lower service duration and involve consumable products, which are the goods provided to the customers. Treatment SUs involve interventions, therapies, and procedures performed by specialists to achieve the desired outcomes, therefore this type of SUs require additional staff and longer duration to perform the treatment.



# 4 Results

In this chapter, the results for the Service Unit definition and identification are presented. The results include the definition of the SU, the identification of viable SUs to address all the targets inside SDG 3, the cluster analysis, and the application potential of the SUs in different countries in SSA.

## 4.1 Service Unit Definition

Following the methodology described in Chapter 3.2 the definition of the SU is derived from the FU because its defining characteristics comply with some of the requirements of the SU.

An appropriate FU describes a quantity of a product or product system based on the performance it delivers in its end-use application [18]. Similarly, the SU describes the VbS performed by the aCar concisely and the VbS Canvas establishes the additional components required to deliver the SU in the most effective form. To fully define the FU, a numeric value must be assigned to specify the compared quantity used for comparison across different products. The SU specifies an unambiguous quantity of the whole service performed that is used for parametrization and tailoring of the aCar.

When defining the FU and establishing a SU, the target audience of market segmentation must be considered. This way the SU and its additional requirements are appropriately defined in order to serve the VbS and the FU can be fully defined in order to perform correctly the LCA.

The economic assessment of a product or system is performed according to the functionality described in the FU. Similarly, the costs of the VbS are related to the service provided, hence the SU.

### 4.1.1 Identification of Attributes

The functional unit is defined as a “description of a quantity of a product or product system based on the performance it delivers in its end-use application” [78]. For the FU to be completely defined, it should answer the questions “What?”, “How much?”, “For how long?/How many times?”, “Where?” and “How well?” [24]. The numerical value expected from the system should be specified using a measurable quantity to ensure clarity and usefulness. Studies on Social-LCA and LCA show a prevalence in the use of mass as a quantity for FU definition [34]. Additionally, it is important to normalize the value, making it comparable and suitable for use as a reference.

It is crucial to understand the target customer and the market segment that contains the customer to develop an appropriate FU that aligns with the market’s needs, expectations, and requirements. The definition of the functional unit (FU) is determined by considering the

perspective of the stakeholder. When focusing on the supplier's viewpoint, they need to consider which functionality of the product or service is most suitable for the customer. Based on this assessment, the FU is defined accordingly, emphasizing the specific function that aligns with customer needs and preferences [54].

As a result of the interviews with members of the aCar team, new aspects that are important for the development of the vehicle arise. The location of the service performed as well as the frequency of the service is important to establish the routing of the vehicle. The amount of services performed, as well as the mass and volume of the products have to be defined to study the number of vehicles needed, according to the individual capacity of one vehicle.

The additional resources, required to perform the service have to be defined. This includes the resources that are directly linked to the service unit, such as personnel needed and in case of supplying a good, the type of good that is supplied. The supplementary components required to provide the service unit must also be included. By identifying and specifying these resources, it becomes possible to understand the complete set of elements needed for delivering the service effectively.

Table 4.1 contains a summary of the identified attributes that should be included to correctly and completely define the concept of the service unit.

*Table 4.1: Summary of the identified attributes.*

Attributes
Unit of measurement (mass, volume, product unit)
Frequency of use
Quantity
Location
Function
Type of good
People/partners involved.
Functional requirements

### 4.1.2 Preliminary Definition of the Service Unit

The service unit is the smallest, most valuable unit of a VbS. It describes the transported good or service in a unitary quantity, through which revenue for the supplier and value for the customer will be created. It can be for example 1 kg of bananas, a vaccine, or the transportation of a doctor.

Additionally, the quantity transported, frequency of transportation, and location from/to where the service is going to be performed need to be described. This will be used for the availability of the VbS.

It serves as a reference, as the vehicle will be parametrized according to the functional requirements of the service unit. This means that the service unit must be defined with mass and when it is appropriate with volume, as this will influence the vehicle concept.

When the service unit is a consumable good, the type of good needs to be stated, whether it is a bulk, liquid, refrigerated good etc. This is used to select the vehicle's additional components,

necessary to transport the desired good. Some service units are the transportation of people or need additional staff to be performed. This must be stated to account for a seat for the people to be secure in the vehicle.

Figure 4.1 is an overview that is used to visualize the service unit and its additional requirements in a more organized and balanced form.

Service Unit Resources	Service Unit	Service-in-use					
-Type of Good -People/Partners	-What are we offering? -Mass -Volume	-Frequency -Quantity -Location					
<b>Functional Requirements/Components/Service functional requirements</b>							
-What other materials/resources are required to provide this service unit? -What other materials do the final consumers of the service unit need?							
	X (mm)	Y (mm)	Z (mm)	Connection to battery	Orientation constraint	Accessibility	Non-stackable

Figure 4.1: Preliminary definition of the Service Unit.

### 4.1.3 Refinement and Validation of the Preliminary Definition

In the meeting with Inés López Ortega, the SU overview is compared with the VbS Canvas, and the characteristics that have already been outlined in the VbS Canvas are eliminated from the SU definition. The researchers propose the concept of the SU, restricting it to the core of the service while incorporating the supplementary requirements, components, resources, and logistical activities into the VbS Canvas [12] to maintain the completeness of the definition. The emerging result is a fresh conceptualization of the SU, where it becomes a phrase that can be completed using a specific formula. The updated SU formula now closely follows the structure of a FU, because it is a phrase that conveys information instead of having a visualization in the form of a canvas.

To validate the refined definition of the SU and the VbS Canvas, the researchers conduct three focus groups to assess the clearness and understanding of the developed frameworks. In the focus group sessions, the complications towards defining the SU and application of the use case to the VbS Canvas are observed and subsequently analyzed to perform improvement actions. In the next focus group, the improvements performed after the analysis are introduced and evaluated again for its effectiveness.

Table 4.2: Results and actions to be performed after focus group 1.

VbS Canvas block	Challenges observed	Actions to be performed
Service Unit	SU is not correctly identified. Many options were discussed.	Rework the definition and structure of SU and link it to the Customer block.

## Results

VbS Canvas block	Challenges observed	Actions to be performed
	Did not follow the established formula. Difficulty to continue filling the canvas if the SU is not correctly defined.	
Customer profile	Difficulty identifying the customer. Customer segment is redundant, this information is already contained in the demographics	Need to establish a link between the SU and the customer. Rework the definition of the customer: receptor of the SU
Provider	Demographic not relevant	Delete the question. It does not add value.
Interaction	Confusion with customer involvement and the meaning of active/passive Difficulty understanding what the interface is	Define the terminology to increase the comprehensiveness of the block.
Key activities	Quantity unclear	Define the quantity precisely and link it to the design of the vehicle. Maximum number of SU transported in the car per working day
Service resource system	Confusion with the meaning of each category, especially function Physical asset is not appropriate and misleading	Provide a clear definition of the terms. Rename the term physical assets to increase comprehensiveness.
Cost structure	Explanation needed for who assumes the costs	Additional explanation or rephrasing to make it clearer.
Revenue streams	Customer value-based pricing could not be identified.	Delete the question. It has no added value to the canvas.

Table 4.2 presents the challenges observed during the first focus group and the actions to be performed for the second iteration of the VbS Canvas. The main problem observed is the identification of the SU. If the SU is misidentified, this makes it difficult to complete the other dimensions of the Canvas. The difficulty in understanding the SU is also evident when it comes to identifying the customer. A way of linking the SU and the Customer must be developed so that when one of them is identified, the other is a logical consequence.

It is observed to be easier to fill in and understand the Canvas when the SU concept is familiar and clear. Irenée, who has been working closely with service units can fill in his Canvas perfectly. The goal is to simplify the Canvas so that it is more accessible so that every user can understand it, without needing too much expertise on the subject.

All the participants were able to identify that the objective of the Canvas is to give structure to business ideas. They state that it is easy to understand because the questions guide you. The open-ended questions are more difficult than the closed-ended ones that propose the answer.

Many of the questions prove to be unnecessary and others too ambiguous. This requires defining all terms and eliminating questions that do not add additional value to the VbS idea.

*Table 4.3: Results and actions to be performed after focus group 2.*

VbS Canvas block	Challenges observed	Actions to be performed
Service Unit	Only one verb from the formula was identified. "Performing action" was not assigned. Confusion in identifying the customer and the supplier	Adapt the SU formula.
Provider	Confusion in identifying the provider.	Clearly define who is the provider. Provide an answer to the questions who invests? Who receives the economic benefit?
Interaction	Confusion with customer involvement and de meaning of active/passive	Remove the question on the interaction. It may be redundant with the exchange. Remove the options in the relationship question. Make it open to increase accuracy.
Cost structure	Moderators had to specify that the cost per service includes car rental, transportation etc.	Rework the question to make it clearer.

Table 4.3 presents the challenges observed during the second focus group. In this case, a document explaining each of the Canvas terms was provided to the participants before the session to facilitate their understanding. Those who read it had a better comprehension of each of the parts. In general, the Canvas has been better understood than in the first focus group. There has been less confusion in identifying the SU. It is necessary to continue to rework the definition of SU to better connect it with the identification of the customer and the supplier.

*Table 4.4: Results and actions to be performed after focus group 3.*

VbS Canvas block	Challenges observed	Actions to be performed
Service Unit	No observed challenges	No actions are necessary.

Table 4.4 shows the participants had no difficulties in filling out the Canvas. At this point, saturation is achieved. All questions are answered without major complications. The prototype for the third focus group incorporates the findings from the analysis of focus group 2 and includes a brief explanation or definition of each element in the Canvas. This has been proven to increase the clarity of the blocks and help participants to fill out the Canvas in a smoother manner.

**Error! Reference source not found.**, Table 4.3, and Table 4.4 show the insights and perceptions of the participants for the SU block throughout the three focus group sessions. The data extracted from the transcription and researcher's notes are carefully examined, coded, and categorized to identify recurring ideas and areas of agreement or disagreement between

participants. Through this iterative process, emerging ideas are refined, leading to a more comprehensive understanding of the SU concept.

The analysis revealed important insights and refinements to the initial definition of the concept. Participants' contributions provided clarification, expanded dimensions, and highlighted potential applications of the concept in different contexts. Identifying the SU was challenging in the first focus groups because of the varying opinion on who was the provider of the SU. This highlighted the necessity of linking the definition to the Customer and Supplier of the service block in the VbS Canvas.

Figure 4.2 represents the VbS Canvas after the last focus group session.

<p><b>SERVICE RESOURCE SYSTEM</b></p> <p>"Set of goods, personnel or components necessary for the delivery of the service"</p> <ul style="list-style-type: none"> <li>- Consumable Product</li> <li>- People</li> <li>- Permanent Component</li> </ul>	<p><b>VbS LOGISTICAL ACTIVITIES</b></p> <p>"The activities that the organization must perform in order to create and deliver value to its customers".</p> <ul style="list-style-type: none"> <li>- Frequency</li> <li>- Quantity</li> <li>- Location</li> <li>- Service duration per customer</li> </ul>	<p><b>SERVICE UNIT</b></p> <p>"The transportation and service provided to the customer of the smallest unit of the object for which the customer is willing to pay a price."</p> <p><i>Verb 1 (movement of the aCar) and Verb 2 (service provided to the customer) of Metric (mass/product unit) of Object supplied.</i></p>	<p><b>VbS PARTNERS</b></p> <p>"Individual or organization that delivers the Service Unit and receives a compensation in exchange".</p> <ul style="list-style-type: none"> <li>- Who is the provider?</li> <li>- Does he have Key Partners?</li> <li>- What are his core competencies?</li> <li>- How do his capabilities and resources align with the needs and expectations of his target customer?</li> </ul>
			<p><b>CUSTOMER PROFILE</b></p> <p>"Receiver of the performing action verb of the SU. It is the person who benefits from the SU and is willing to pay for it"</p> <ul style="list-style-type: none"> <li>- Who are the customers?</li> <li>- What are their demographics (age, gender, income level, etc.), behaviors (how they make purchasing decisions) and attitudes (what they value, what motivates them)?</li> <li>- What are our customer needs and expectations?</li> </ul>
			<p><b>INTERACTION</b></p> <p>"Analysis of customer-supplier relationships to co-create value."</p> <ul style="list-style-type: none"> <li>- How is the exchange done? On demand, sporadically, by subscription, collaboratively?</li> <li>- What type of interface? Indirect or direct?</li> <li>- Which types of relationships should be developed?</li> </ul>
<p><b>COST STRUCTURE</b></p> <p>"Costs associated with delivering the service to customers"</p> <ul style="list-style-type: none"> <li>- What are the fixed and variable cost?</li> <li>- Who assumes the costs?</li> </ul>		<p><b>REVENUE STREAMS</b></p> <p>"The way in which the person or organization extracts profit from the operation of the SU"</p> <ul style="list-style-type: none"> <li>- What else valuable do the provider get than money?</li> <li>- What are the key performance metrics of the business success?</li> <li>- For which benefits is the customer really willing to pay?</li> <li>- How would they prefer to pay?</li> </ul>	

Figure 4.2: VbS Canvas after focus group 3.

The findings of the analysis performed after the last focus group serve to develop the final SU definition that is then applied to identify the SUs. This definition includes all the feedback and conclusions gathered during the focus groups while maintaining the derivation of the FU as the foundation:

The service unit is the simplest unit of the objects or services that are being transported, through which revenue for the supplier and value for the customer will be created. It answers the question "What is the offering that the supplier is giving to the customer?"

The service unit includes the movement action which is performed by the aCar and the service that the provider is giving to the customer. It serves as a reference for the whole offering and must be defined with a mass or product unit and when appropriate with volume.

Additionally, the quantity transported, defined as the maximum capacity of service units in the aCar per working day, the frequency of transportation, and the location from/to where the service is going to be performed need to be described. Knowledge of the market segment to which this service is going to be served is important to understand the additional physical assets, personnel and functions the service unit needs to be fully supplied. This will be used for the availability of resources of the VbS and it is stated in the VbS Canvas [12].

From the previous description, the Service Unit can be defined as:

***"The transportation and service provided to the customer of the smallest unit of the object for which the customer is willing to pay a price."***

The service unit can be expressed concisely by following the hereunder structure. It is composed of a verb of movement action that the aCar is performing, generally the transportation of the good or the service that is supplied, the service performed to the customer, a metric measures the service unit and serves as a reference of what one unit of the service is, and finally the object/service supplied to the customers:

**Verb 1 (movement of the aCar) and Verb 2 (service provided to the customer) of Metric (mass/product unit) of Object/service supplied.**

For example, in the case of a mobile medical clinic examples of service units could be transportation and administration of 1 vaccine, transportation and extraction of 1 sample of blood, transportation, and performance of 1 dental check-up etc. For the movement of goods, it can be specified as transportation and selling of 1 kg of bananas, or transportation and supply of 1 l of water etc.

## 4.2 SU Identification

SDG 3 aims to ensure health and well-being for everyone, no matter their age or economic background. The SDG 3 targets are classified into five overlapping subgroups: reducing morbidity and mortality of vulnerable groups (especially mothers, newborns, and children), reducing communicable and non-communicable diseases, reducing risk factors, providing universal healthcare, and strengthening the healthcare sector [79].

The literature review exposes that the strategies used to achieve SDG3 consider a holistic approach. Policymakers, organizations, and individuals collaborate to study the complexity of health issues, combining sustainability in their strategies to maximize positive impact. Overall, collaboration within sectors, disciplines, and stakeholders is necessary to achieve the targets.

The actions found in the literature review can either be performed directly on individuals or have an indirect effect on the people. Strategies addressing targets 3.1, 3.2, 3.3, 3.4, and 3.7 suggest a direct approach to the objective by providing a treatment that includes attendance by a specialist and/or possible delivery of drugs, medicines, or products. The SUs can easily be formed from these strategies and the framework can be applied directly. The necessary resources to prevent and treat diseases can be directly installed and delivered by the aCar, and the medical specialists required to attend and perform any procedure can be transported in the vehicle.

For the rest of the targets, strategies proposed include some direct actions to individuals, but there is a high number of suggested strategies that include media campaigns to raise awareness and promote behavior change, the collaboration between organizations and governments to create policies, and increasing financial resources to improve healthcare systems. Extracting the SUs and transforming the strategy into a VbS poses a bigger challenge because these actions cannot be performed to individuals and consider the role that government and other institutions have in achieving the SDGs.

The targets show strong interdependence between one another and are mutually supportive reinforcing each other's objectives [79]. The targets concerning sexual and reproductive health (3.7), universal healthcare (3.8), infectious diseases (3.3), and non-communicable diseases (3.4),

strongly influence maternal mortality (3.1) and play an important role in ending preventable deaths of children under-five (3.2).

Cardiovascular diseases, cancers, and chronic pulmonary diseases account for 31.3 million deaths annually [80]. Therefore, reducing the target on non-communicable diseases (3.4) can be achieved easier by approaching other targets which are linked to the diseases, such as substance abuse (3.5) and tobacco control (3.a), because many of the consequences and adverse effects of substance and tobacco consumption result in non-communicable diseases.

Achieving UHC (3.8) will improve the achievement of all other SDG 3 targets. UHC includes affordable prices for basic essential medicines and vaccines and health professionals that provide treatment and education on healthy lifestyles. Women during pregnancy and childbirth (3.1), newborns and infants (3.2), people suffering from diseases (3.3 and 3.4), and people who have been injured in accidents (3.6) require effective and safe treatment. Receiving education and advice on healthy sexual behavior (3.7) and counseling for alcohol and tobacco use (3.5 and 3.a) are included in the public health service. To achieve this target; recruitment and training of a strong workforce (3.c), and development and access to essential vaccines and medicines (3.b) are necessary.

The interaction among targets also implies that identical strategies can be employed to obtain various objectives, therefore providing one SU leads to the achievement of different targets. The literature research confirms the interdependence among targets and the result of the SU application shown in Table 4.5, depicting these relations by having repeated SUs throughout different targets.

Table 4.5: Identified SUs to address SDG 3 targets.

SDG target	SU	Literature
3.1 Maternal mortality	Transport and performance of a post-partum check-up Transport and attendance to a woman during labor Transport and performance of an abortion intervention	SDG Target 3.1 Maternal mortality [81]
	Transport and attendance to a woman during pregnancy	Strategies to reduce the global the burden of direct maternal deaths [82]
3.2 Newborn and Child mortality	Transport and performance of a pediatric check-up Transport and performance of a newborn check-up Transport and administration of a newborn vaccine	Global, regional, and national progress towards Sustainable Development Goal 3.2 for neonatal and child health: all-cause and cause-specific mortality findings from the Global Burden of Disease Study 2019 [83] Achieving Sustainable Development Goals of Agenda 2030 in Bangladesh: the crossroad of the governance and performance [84]
3.3 Communicable diseases	Transport and delivery of an antiretroviral medicine	Culture and African contexts of HIV/AIDS prevention, care, and support [85]
	Transport and delivery of 1 box of condoms for women Transport and delivery of 1 box of condoms for men	
	Transport and delivery of 1 box of antibiotics Transport and delivery of 1 box of antiretroviral medicine	Tuberculosis in sub-Saharan Africa: opportunities, challenges, and change in the era of antiretroviral treatment. [86]
	Transport and administration of 1 box of antimalaria treatment Transport and deliver of 1 insecticide-treated bed net	Combating Malaria in Africa [87]



SDG target	SU	Literature
	<p>Transport and performance of 1 rapid diagnostic test for malaria</p> <p>Transport and performance of 1 Hepatitis B test</p> <p>Transport and delivery of 1 box of antiretroviral medicine</p> <p>Transport and administration of 1 Hepatitis B vaccine</p>	<p>New WHO guidelines for the treatment of malaria [88]</p> <p>Hepatitis B in sub-Saharan Africa: strategies to achieve the 2030 elimination targets. [89]</p>
3.4 non-communicable diseases and mental health	<p>Transport and performance of a pediatric check-up</p> <p>Transport and performance of a cardiologic consultation</p> <p>Transport and performance of an oncologic consultation</p> <p>Transport and performance of a pulmonological consultation</p>	<p>Chemotherapy intravenously in children with cancer at home, the nurse practitioner makes it possible! [90]</p> <p>NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4 [91]</p>
3.4 non-communicable diseases and mental health	<p>Transport and administration of 1 HPV vaccine</p> <p>Transport and administration of 1 Hepatitis B vaccine</p> <p>Transport and attendance of a therapist</p> <p>Transport and delivery of 1 box of 10 kg of basic food and hygiene products</p>	<p>NCD Countdown 2030: pathways to achieving Sustainable Development Goal target 3.4. [92]</p> <p>Mental health and wellbeing in the Sustainable Development Goals [93]</p> <p>NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4 [91]</p>
3.5 Substance abuse	<p>Transport and attendance of a therapist</p> <p>Transport and performance of an informative talk on drug and alcohol abuse</p> <p>Transport and attendance of a counselor</p>	<p>The WHO Special Initiative for Mental Health (2019-2023): Universal Health Coverage for Mental Health [94]</p> <p>Current advances in the treatment of adolescent drug use [95]</p> <p>Family and social aspects of substance use disorders and treatment [96]</p>
3.6 Road traffic injuries	<p>Transport of 1 person</p> <p>Transport and performance of an informative talk on safe driving practices</p> <p>Transport and delivery of 1 bicycle helmet</p> <p>Transport and delivery of 1 motorcycle helmet</p> <p>Transport and delivery of 1 seat-belt</p>	<p>Challenges of localizing sustainable development goals in small cities: Research to action [97]</p> <p>Road traffic accidental injuries and deaths: A neglected global health issue [98]</p> <p>Cost-effectiveness of strategies to prevent road traffic injuries in eastern sub-Saharan Africa and Southeast Asia: new results from WHO-CHOICE [99]</p>
3.7 Sexual and reproductive health	<p>Transport and performance of an obstetrician consultation</p> <p>Transport and delivery of 1 box of female condoms</p> <p>Transport and delivery of 1 box of male condoms</p> <p>Transport and insertion of 1 IUD</p> <p>Transport and delivery of 1 box of birth control pills</p> <p>Transport and performance of 1 consultation with a family planning specialist</p>	<p>Emerging infectious diseases and outbreaks: implications for women's reproductive health and rights in resource-poor settings [100]</p> <p>Investing in Family Planning: Key to Achieving the Sustainable Development Goals [101]</p> <p>Time trends and sociodemographic inequalities in the prevalence of adolescent motherhood in 74 low-income and middle-income countries: a population-based study [102]</p> <p>Investing in Family Planning to Achieve Sustainable Development Goals in Nigeria [103]</p>

## Results

SDG target	SU	Literature
3.8 Universal health coverage	Transport and attendance of a primary care doctor	Measuring the availability of human resources for health and its relationship to universal health coverage: estimates for 204 countries and territories from 1990 to 2019: a systematic analysis for the Global Burden of Disease Study 2019. GBD 2019 Human Resources for Health Collaborators [104]
	Transport and supply of 1 box of medicines	Essential medicines for universal health coverage [105]
3.9 mortality from environmental pollution	Transport and arrival of 1 person	Challenges of localizing sustainable development goals in small cities: Research to action [97]
	Transport and supply of 1l of water	WASH and Health working together: a 'how-to' guide for neglected tropical disease programs. [106]
	Transport and delivery of 1 water tank	
3.a Tobacco control	Collection and disposal of 1l wastewater	
	Transport and performance of an informative talk on tobacco use	Recommendations Regarding Interventions to Reduce Tobacco Use and Exposure to Environmental Tobacco Smoke [107]
	Transport and delivery of 1 box of nicotine patches	Individual differences in preferences for and responses to four nicotine replacement products [108]
3.b Development, assistance, and vaccine coverage	Transport and administration of 1 DPT vaccine	Child vaccination in sub-Saharan Africa: Increasing coverage addresses inequalities [109]
	Transport and administration of 1 Polio vaccine	
	Transport and administration of 1 BCG vaccine	
	Transport and administration of 1 Measles vaccine	
	Transport and administration of 1 Hepatitis B vaccine	Vaccinology in sub-Saharan Africa [110]
	Transport and administration of 1 Rotavirus vaccine	
	Transport and administration of 1 Cholera vaccine	
	Transport and administration of 1 HPV vaccine	
	Transport and supply of 1 box of medicines	Mapping the supply chain of anti-malarial drugs in Sub-Saharan African countries [111]
3.c Health workforce	Transport and supply of 1 box of medicines	Measuring the availability of human resources for health and its relationship to universal health coverage: estimates for 204 countries and territories from 1990 to 2019: a systematic analysis for the Global Burden of Disease Study 2019. GBD 2019 Human Resources for Health Collaborators [104]
	Transport and attendance of a dentist	
	Transport and attendance of a primary care doctor	
3.d National and global health risks	Transport and extraction of 1 sample of blood	Health security capacities in the context of COVID-19 outbreak: an analysis of International Health Regulations annual report data from 182 countries. [112]
	Transport and performance of a training on health emergency	A strategic framework for emergency preparedness [113]
	Transport and supply of 1 medical PPE kit	
	Transport and arrival of 1 person	

### 4.3 Cluster Analysis

Cluster analysis is conducted to evaluate the required resources for delivering the SUs in a manner that is both efficient and effective. This analysis enables suppliers to compare the additional resources and personnel needed for each SU and make informed decisions regarding the SUs they will provide. The cluster categories allow the provider to establish an idea of the necessary resources and costs associated with every cluster grouping. The whole classification of the SU into the cluster categories can be found in Appendix C: Cluster Classification

Figure 4.3 **Error! Reference source not found.** depicts the number of SUs assigned to each category inside the type of delivery cluster. If a SU is defined as a treatment service, it involves specialist personnel that are performing an action on the customer. Delivery SUs are defined as services that involve the delivery of a good to the customer, these can either require a specialist to do so, or just the driver of the aCar

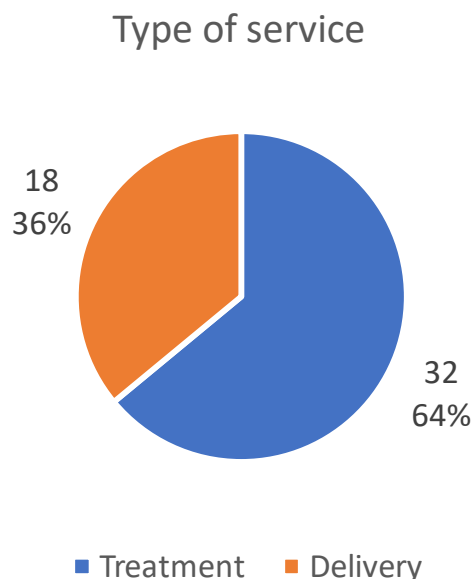


Figure 4.3: SU distribution by type of service; treatment or delivery.

The VbS cost model developed by Florian Kink [114] identifies the cost drivers that define service costs. José María Vallez performed a qualitative research process to assess the validity of the cost drivers defined in the cost model [115]. In this assessment, the researcher studied the economic and technical aspects of eight different companies that use vehicles for value delivery. Based on the information obtained in the expert interviews conducted for the validation, the researcher concluded that the salary cost is the most significant cost driver, irrespective of the service offered or performed. The remaining cost drivers have a considerably minor influence on the total costs of the service. The distribution of the staff required to perform the SUs is shown in Figure 4.4. It is important to highlight that all SUs require a driver. In this overview, the number associated with the driver accounts for SUs that require no additional staff other than the driver.

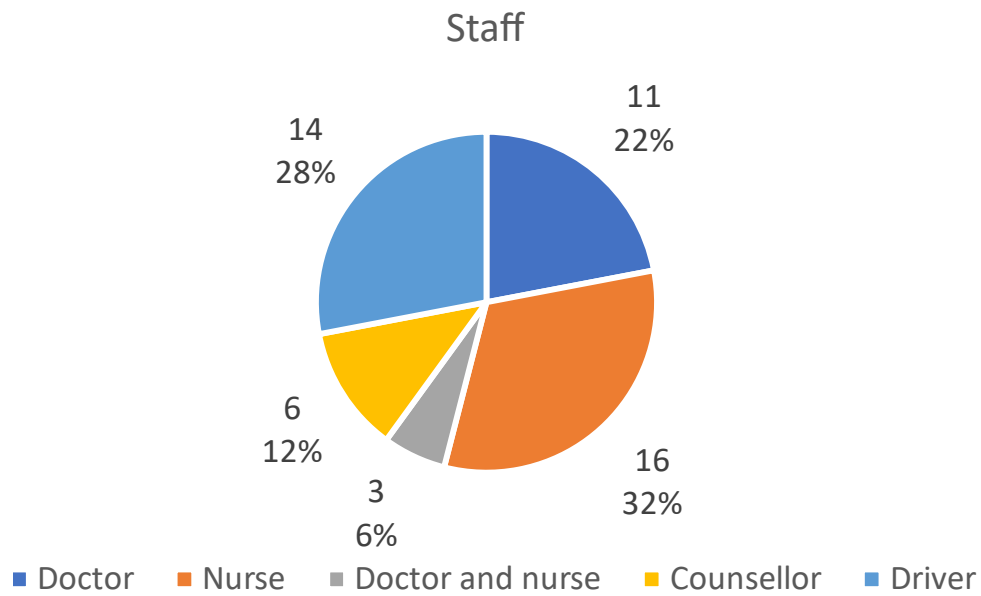


Figure 4.4: SU distribution by staff required.

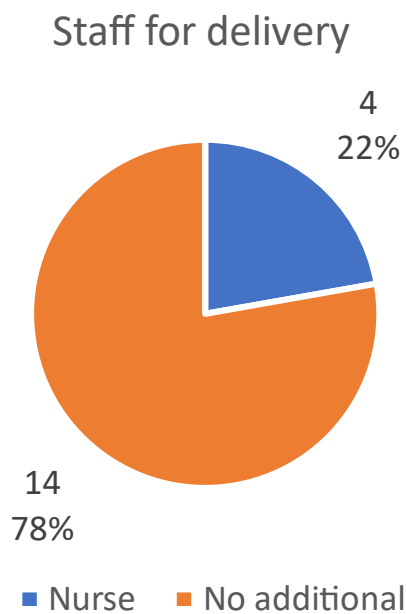


Figure 4.5: Additional staff required for delivery SUs.

Figure 4.5 represents the staff required inside the category delivery. In comparison, delivery of a good requires a driver and only 4% of the SUs have an additional member of staff to be provided. This results in lower service costs for those SUs that are performed by a delivery.

Figure 4.6 compares the SUs based on whether they require any permanent components or not to provide the service. The permanent components are installed in the aCar and are necessary for the complete and correct provision of the SU.

## Permanent components

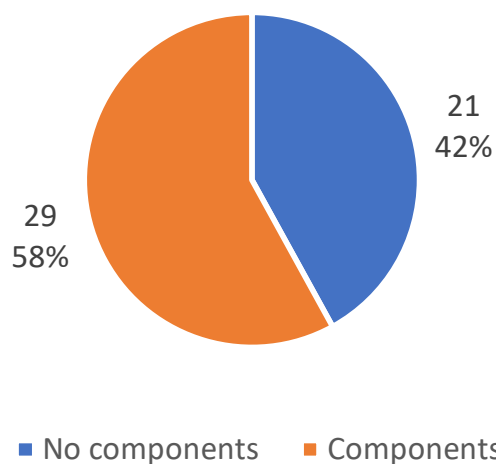


Figure 4.6: SUs requiring or not permanent components.

Figure 4.7 distributes the different permanent components by the amount of SUs that require a specific type of component. It is observed that in 65% of the cases, the permanent components required are medical equipment. This is because this master thesis focuses on SDG 3 good health, and well-being. Medical equipment is required in all treatment SUs to have the necessary material and equipment to perform the SUs while maintaining hygiene protocols. All vaccines must be refrigerated during storage and until administration, therefore, all SUs that provide a vaccination are refrigerated goods and require a fridge that will store them at the appropriate temperature. Other permanent equipment includes seats to transport people, and water tanks to store liquids.

## Type of permanent components

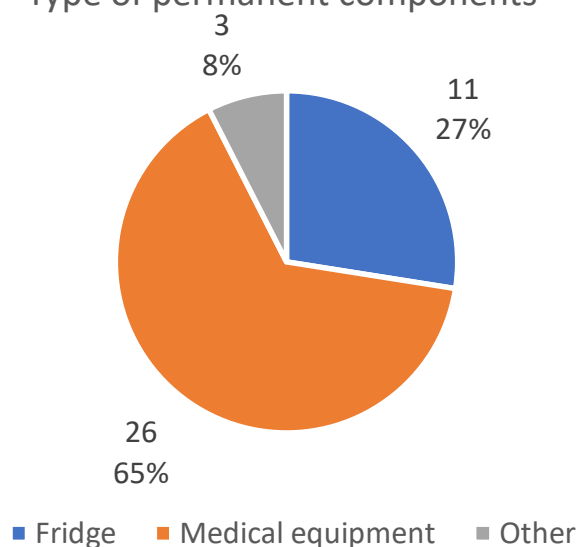


Figure 4.7: Distribution of permanent components.

All delivery SUs and certain additional SUs possess a shared characteristic: a product is either consumed or delivered during the execution of the SU. Consequently, as SUs are conducted, two outcomes occur simultaneously. First, the weight of the aCar decreases due to the consumption or delivery of products. Second, the number of available SUs decreases as they are performed. Figure 4.8 compares the number of SUs where a product is consumed and not consumed.

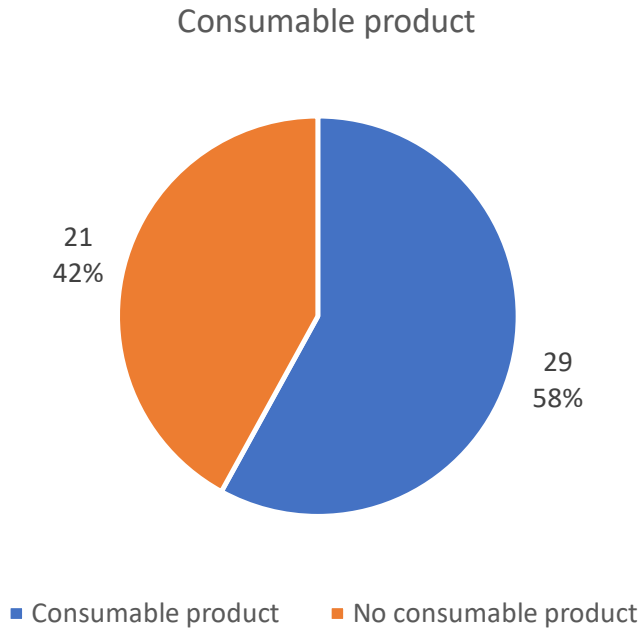


Figure 4.8: Comparison of SUs containing or not consumable products.

In Figure 4.9, the diagram corresponds to the split between the SUs containing consumable products and the different types of SUs. Out of the 29 SUs that involve a consumption or delivery of a product during their performance, 11 of them are treatments. These correspond mainly to vaccine administration.

Type of SUs containing consumable products

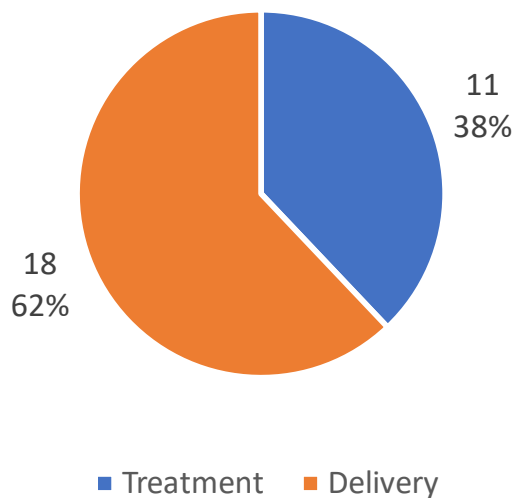


Figure 4.9: Types of SUs containing a consumable product.

Figure 4.10 represents the service duration. The visual representation showcases various time ranges, indicating that 62% of the SUs are completed within less than 30 minutes. Understanding the time required for each SU holds valuable information as it facilitates the improved organization and scheduling of SUs. Furthermore, conducting multiple SUs within a day reduces operational costs per SU, thereby enhancing cost efficiency.

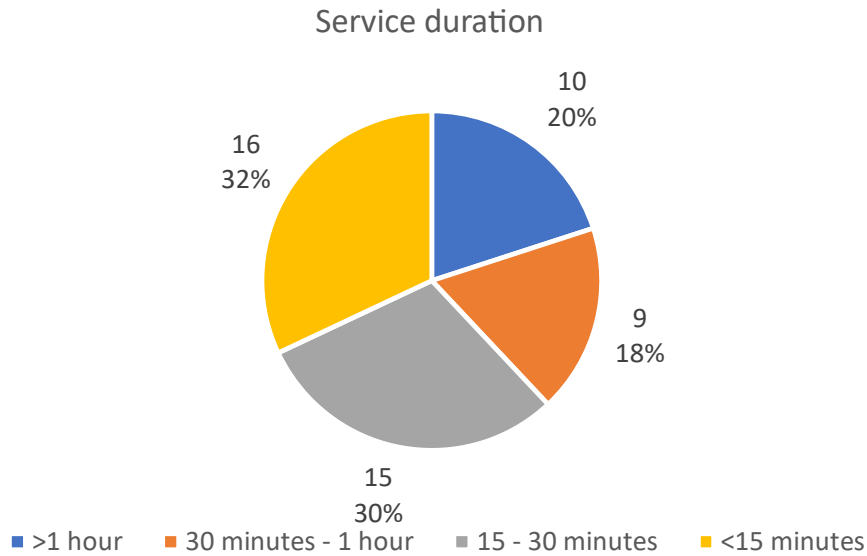


Figure 4.10: SU service duration

The graph in Figure 4.11 displays the relationship between the service duration and the type of service. It can be observed that 16 out of 18 delivery SUs are performed with a duration of under 15 minutes. This means that the number of service units performed in one working day of 8 hours can be at least 32. This information is valuable for the provider to allocate the necessary resources and optimize the routing and scheduling. All treatment SUs have a duration longer than 15 minutes. It is common knowledge that medical treatments require an exchange between the specialist and the patient, based on trust and comprehension of the issue at hand, which ultimately leads to a more time-intensive process for customer care.

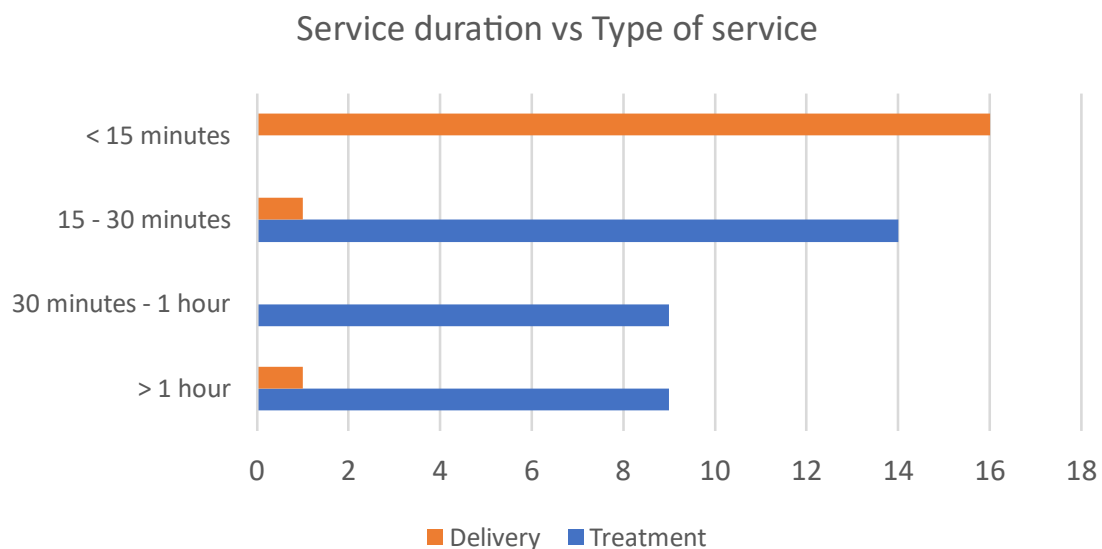


Figure 4.11: Service duration and type of service.

Figure 4.12 shows a diagram of the staff required to perform each SU according to the service duration. It is important to highlight that all SUs require a driver. In this case, the driver accounts for the SUs that do not require any additional members of staff. It can be observed that for SUs with a longer duration, more additional staff is needed to perform the services. This is because these SUs involve a treatment that only specialized members of staff can perform.

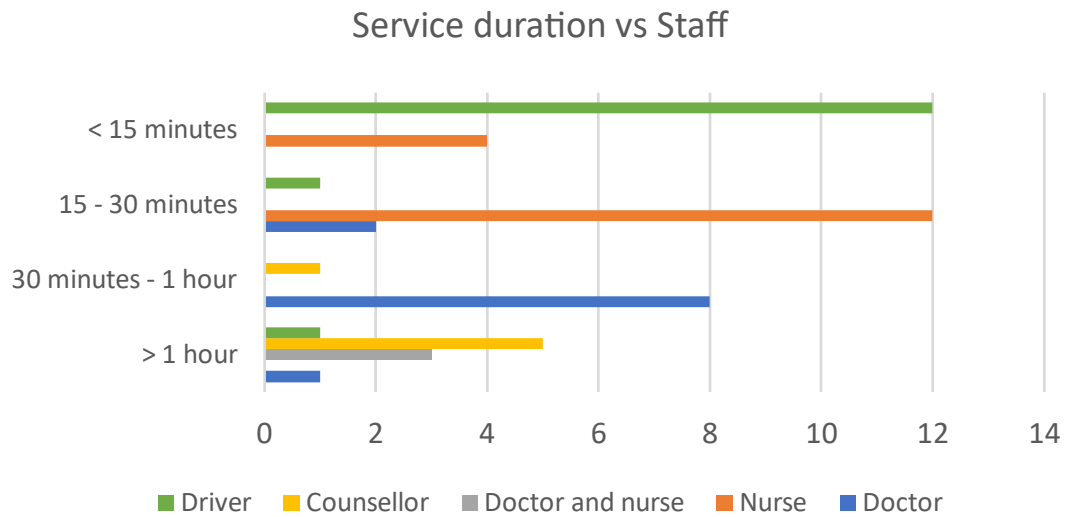


Figure 4.12: Service duration and staff.

Finally, Figure 4.13 depicts the frequency of SU necessary to complete the whole treatment or delivery. It is observed that 86% of SUs are one-time services. This presents an advantage as the aCar does not need to repeat the same SU to achieve its completion. Instead, it can effectively utilize its resources to travel to other locations and serve to a broader customer base.

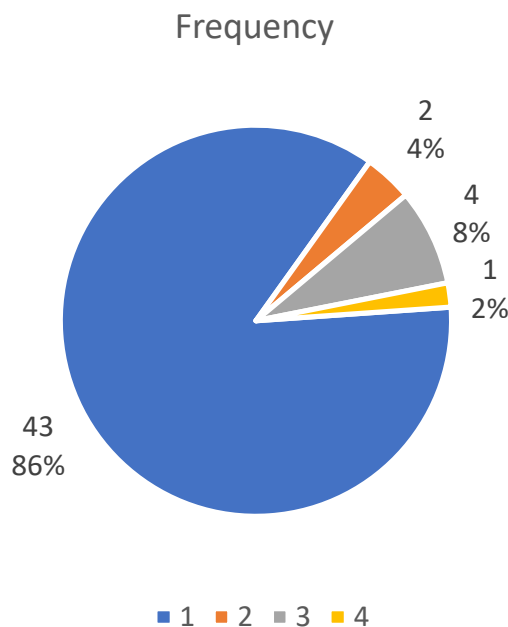


Figure 4.13: Frequency of provision of SU necessary to perform the complete service.

Cluster analysis identifies similarities among the different SUs and grouping them allows the supplier to assess easier the required resources. It helps identify clusters that have similar resource needs and allows for a more equitable distribution of resources based on those needs.



This optimizes resource allocation and utilization, ensuring efficient use of the available resources. Therefore, resource optimization is achieved, because resources are allocated appropriately according to the necessary support that each cluster requires.

It provides valuable insights, comparison, and evaluation of SU based on the cluster categories. Understanding the characteristics and needs of the different clusters means that the aCar is customized according to the SU and the supplier can tailor its strategy to maximize the amount of SUs offered. This assessment takes into account the supplier's perspective and enhances the efficiency and effectiveness of the design of the aCar when supplying a SU because they can develop targeted strategies and plans to address specific needs, ensuring better outcomes, and more effective SU provision. This enables informed decision-making regarding which SU to prioritize according to the additional resources available and the costs linked to every category.

## 4.4 Application Potential of SUs

The study of the potential applicability of the SUs to the different SS African countries serves as a tool to compare which SU is more appropriate in which country. Even though all SUs can be applied in every country, there are many differences in characteristics and healthcare needs within countries that require different SUs, therefore information regarding the current healthcare status and SDG 3 targets is compared. This assessment is performed because of the varying conditions and circumstances present in each country.

In the next section, to analyze the potential application of the SUs to address the most critical targets and compare the suitability of each SU, a global comparison is performed by examining and contrasting the status of Africa and the rest of the world. The data obtained from the WHO SDG statistics [116] positions Africa in a comparatively worst situation in comparison to the global mortality ratio, incidence, vaccination coverage, and other relevant factors.

The aim of target 3.1 is to reduce the global maternal mortality ratio to under 70 per 1000 live births. The maternal mortality ratio and the percentage of births attended by skilled professionals are used to obtain Figure 4.14, depicting the intensity of need for the SU transport and attendance of a woman during labor. The countries with a mortality ratio above 70 and with a percentage of attended births by skilled professionals below 90% are suitable for the SU transport and attendance of a woman during labor. SSA shows the highest maternal mortality rate in comparison to other regions of the world. The country with the highest mortality ratio is South Sudan, with 1223 deaths per 100.000 live births and a percentage of attendance by skilled professionals of 39,7%. Transporting a medical team to the rural areas of South Sudan to attend women in labor, can make a difference between life and death for both mother and newborn [81].

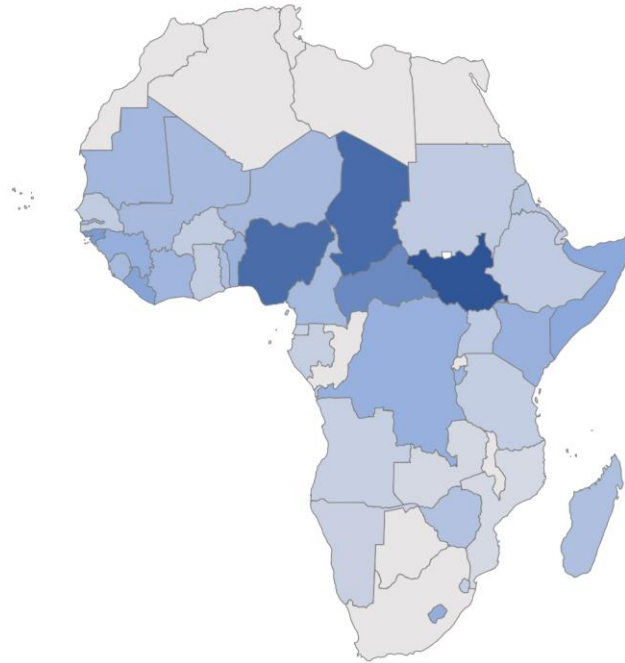


Figure 4.14: Intensity of the need for SU transport and attendance of a woman during labor.

Target 3.2 is related to newborn and child mortality and aim 3.2 is to decrease under-5 mortality to 25 per 1000 live. SSA and South Asia account for more than 80% of the global under-5 deaths. Regarding neonatal mortality, SSA showed the highest mortality incidence in 2021 [117]. To reduce child mortality, one of the strategies suggested by experts is to increase the number of pediatric consults, as prompt diagnoses can be performed and treatment for diseases can be offered, leading to better survival [83]. Figure 4.15 is obtained based on the under-five mortality rate per 1000 live children and represents the intensity of the need for SU transport and performance of a pediatric check-up.

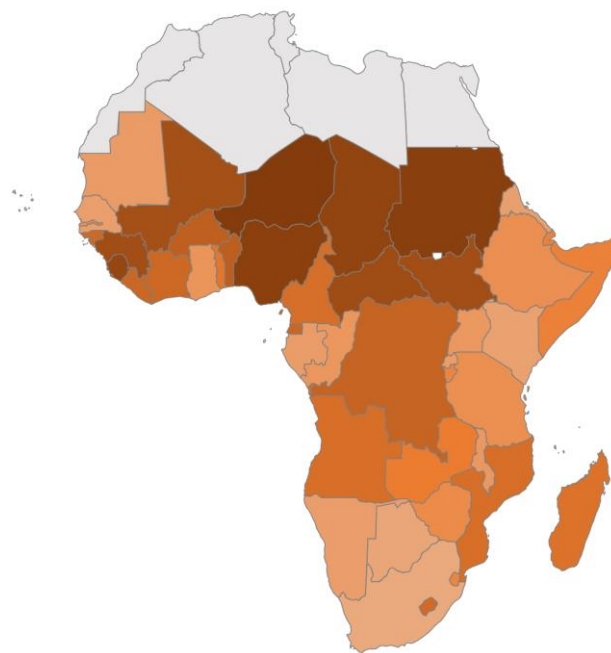


Figure 4.15: Intensity of need for the SU transport and performance of a pediatric check-up.

Ending epidemics such as AIDS/HIV, malaria, tuberculosis, and neglected tropical diseases is contained in target 3.3. Malaria has 100 times more incidence than other communicable diseases with 247 million cases in 84 malaria-endemic countries in 2022 [118]. All SSA countries have recorded cases of malaria. This means that it has not been eradicated in these countries. Figure 4.16 represents the malaria incidence per 1000 population and establishes which countries are lacking strategies to combat malaria and would benefit more from the SUs regarding malaria testing [88], prevention [87], and treatment [87].

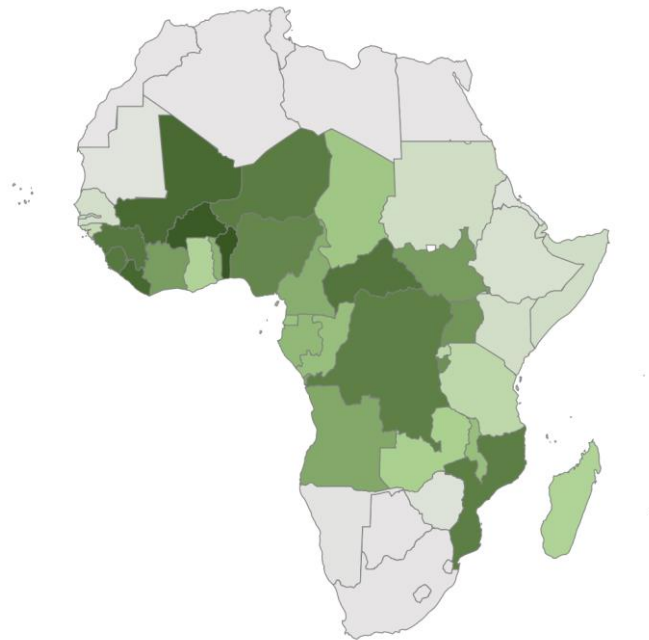


Figure 4.16: Intensity of need for strategies to test, prevent and treat malaria.

Target 3.4 aims to reduce premature mortality from noncommunicable diseases (NCD), these being cardiovascular, cancer, diabetes, and chronic respiratory diseases. Cardiovascular diseases with 19,7 million deaths globally, followed by cancer with 9,3 million, have the most incidence of SSA. A study was conducted to compare the deaths caused by the four diseases, to identify the most critical NCD in each country, and to determine the recommended SU for the treatment. Figure 4.17 represents the countries in which the SU transport and performance of a cardiologic consultation or transport and performance of an oncologic consultation are recommended to reduce mortality and achieve the SDG target [91]. Given the vast difference between cardiovascular disease and cancer incidence, the results recommend cardiologic consultations in a higher number of countries.

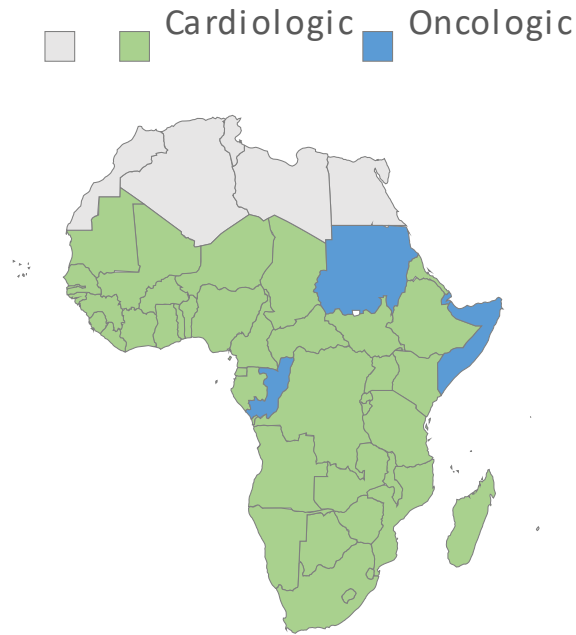


Figure 4.17: Recommended consultation for NCD per country.

Ensuring that every person has access to a primary healthcare doctor is one of the main strategies to achieve target 3.8 on universal health coverage [104]. The standard ratio of the patient size for a primary healthcare doctor is 1:2.500 [119, 120]. The SU transport and attendance of a primary healthcare doctor aligns with the objective by addressing the lack of physicians in different countries. This is one of the first steps toward achieving universal healthcare [104]. If all The data extracted from the indicates the number of primary health doctors per 10.000 people [121], therefore a minimum of four doctors must be assigned. Figure 4.18 portrays the number of necessary primary healthcare doctors in each country to achieve the minimum standard ratio per 10000 people in each country.

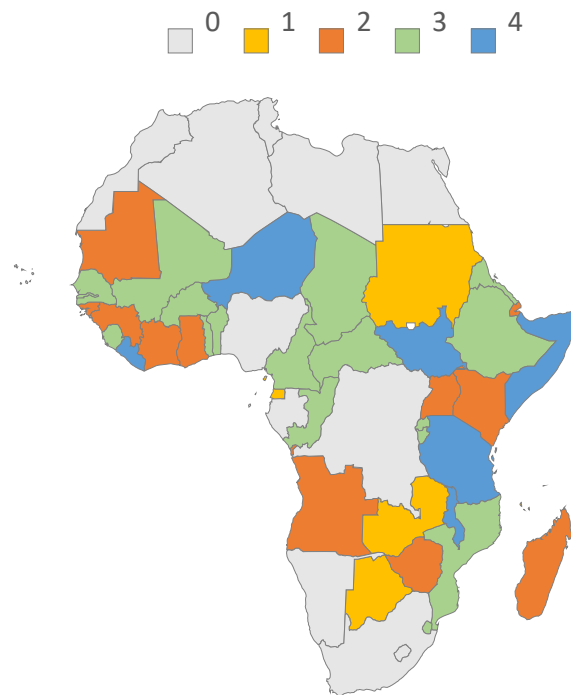


Figure 4.18: Number of necessary primary healthcare doctors per 10000 people per country.

Target 3.9 addresses the deaths and illnesses caused by chemicals, pollution, and contamination. 91% of the population lives in places where air pollution exceeds the maximum limit established by the WHO [122]. Access to drinking water, sanitation, and adequate hygiene (WASH) is crucial to achieve the Global Goals. There are still many deaths in the world attributed to the inexistence or lack of WASH services. This is observed especially in Africa, where the average mortality rate is 29 points above the global average. Figure 4.19 **Error! Reference source not found.** portrays the mortality rate attributed to unsafe WASH services and represents the intensity of the need for SUs that aim to increase access to WASH services, such as the transport and delivery of water, water tanks, and the disposal of wastewater to avoid poisoning.

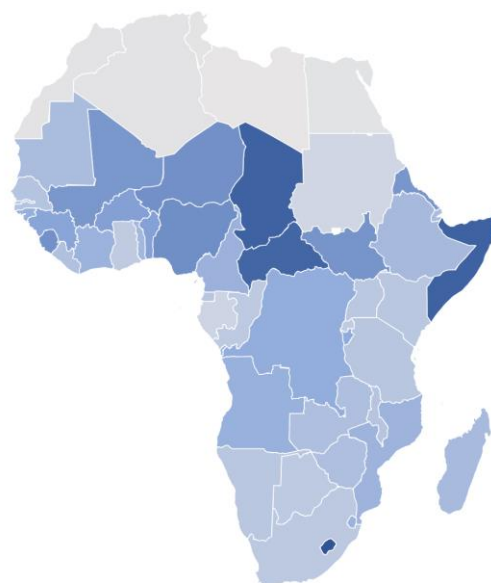


Figure 4.19: Mortality rate attributed to unsafe WASH services.

One indicator of target 3.b is ensuring all population is covered by all vaccines included in the national vaccination program. In SSA, vaccines for measles, hepatitis B, BCG (tuberculosis), DPT (diphtheria-tetanus toxoid and pertussis), rotavirus, and polio are recommended [109, 110]. The immunization coverage of all the abovementioned vaccines is assessed in Figure 4.20 **Error! Reference source not found.**, to obtain the most suitable SU providing transport and administration of the vaccine with lowest immunization coverage in each SSA country.

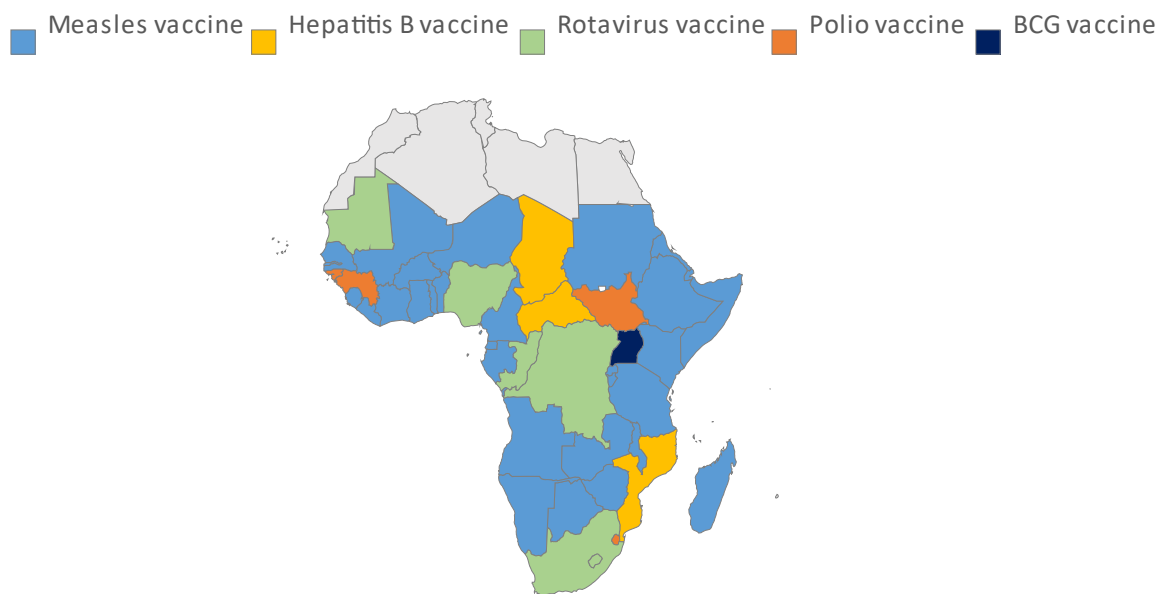


Figure 4.20: Recommended vaccine to administer according to immunization levels.

For the remaining targets, the potential application of the SUs is not analyzed because SSA is not so critically affected or is better positioned with respect to the global average. For example, even though more than 80% of tobacco users are in low- and middle-income countries, Africa is the region with the lowest tobacco prevalence in the world, positioned 12 points below the global value average.

Studying the application of services in different SSA countries ensures that the services provided are locally relevant and responsive to the unique circumstances and requirements of each country. SSA countries vary significantly in terms of their socioeconomic conditions, healthcare infrastructure, population demographics, and cultural contexts. Understanding the requirements of different countries helps tailor interventions and strategies to apply the potential SUs, thus delivering more effective and sustainable solutions that directly benefit the local populations according to their needs and demands.

This assessment serves as a valuable tool to obtain a superficial overview of the SU demand in SSA. It analyses the SUs according to a customer perspective, taking into account their needs and providing the SUs where there is a higher lack of that specific service, thus increasing customer satisfaction. By understanding their needs, the provider can address the most critical problems in those areas and prioritize some SUs over others. Knowing customer demand improves decision-making when choosing the most effective SU and reduces the risk of providing a SU that will not be consumed by the population.

Additionally, supplying the needed SU allows the provider to establish a relationship and trust with the customer. This is beneficial because the provider can build a solid customer base and

after covering the basic needs, the provider can increase its supply of SUs, offering more services to its customers.





# 5 Validation

This section focuses on assessing the validity of the SU definition and establishing its potential application in real business cases. The verification of the identified SUs is also studied in this chapter, and an overview of the current approaches used by companies to apply similar strategies to the ones describes in the SUs to address the SDG targets is stated in this chapter.

## 5.1 Expert Interviews

Expert interviews are conducted to obtain the independent verification and validation of the SU concept definition [123], following the methodology described in Chapter 3.2.2. This method allows the researchers to observe the applicability of the definition by seven experts in their respective areas of expertise. Table 5.1: Description of experts and their projects. Table 5.1 presents the description of each interviewed expert.

Table 5.1: Description of experts and their projects.

Name	Position	Location	Project description
Toni Heigl	Co-founder MANA Mobility	Ghana	This enterprise was created to offer an ecosystem for e-mobility solutions in Africa with a platform connecting drivers, passengers, and goods that are transported by affordable, reliable, and functional EVs manufactured in Ghana.
Gabriela Herrero Luis de Sande	AUARA	Spain	A social enterprise that finances clean water drinking projects in underdeveloped countries by selling bottled water. Their revenue is dedicated to funding these projects, and they collaborate with NGOs to ensure access to safe drinking water for communities in need.
Roger Christen	Co-founder Solar E-cycles	Kenya	Provide affordable environment-friendly, solar-powered mobility and power for homes or small businesses. Offering affordable and sustainable access to e-mobility and renewable electricity.
Celeste Tchetgen Vogel	Co-founder eWaka Mobility	Kenya	Mobility technology company focused on leasing a range of electric vehicles, such as bicycles, scooters, and motorbikes.

Name	Position	Location	Project description
Najjiba Katesi	FABIO	Uganda	NGO that aims to reduce poverty by providing sustainable and environmentally friendly transportation solutions.
Ward Tanghe	Founder E-trails	Kenya	Renting electric bicycles for public transportation and cargo movement.
Daniel Alfaro	Founder OAN International	Benin	NGO that investigates existing resources and ways to improve people's quality of life and raise social awareness of inequalities.

The first aim of the conducted interviews is to validate the VbS Canvas as a tool that describes a business model and serves as a bridge between the engineering design requirements and the business aspect of the project. The second aim of the interviews is to apply the SU definition to obtain a series of examples from real business cases, thus validating the framework.

The experts were asked to use their expert knowledge to identify and define their companies/organizations' SUs by applying the framework to their value proposition. Once the interviewees had introduced their projects, they were asked to transform their value proposition into a SU and fill out the Canvas.

The first step in filling the Canvas was to correctly define the SU. Some interviews focused on providing feedback and ideas to integrate into the Canvas, such as the importance of partnerships, payment plans, and payment methods. Therefore, the Canvas was not completed, and the SU was not defined.

In the interviews where the VbS Canvas was completed, the learnings from the focus groups are applied and interviewees are asked to start filling the Canvas by defining the SU. It is found that after correctly identifying the SU experts could easily complete the rest of the canvas because they know how to apply their business model based on the value proposition that is the SU. Overall, analyzing the transcripts and applying the information collected from the interviews to fill out the Canvas, resulted in an overview of the different business models. In this master thesis, the focus is on the results obtained to validate the SU, therefore Table 5.2 illustrates the SUs identified by the experts in the interviews. It is important to highlight that by having various business models different SUs are identified. The transcripts of the interviews can be found in Appendix B: Expert Interviews.

*Table 5.2: SUs identified in the expert interviews.*

Company/NGO	SU identified
MANA Mobility	Transport and delivery of 500 kg of cargo.
AUARA	-
Solar E-cycles	Leasing of 1 electric tricycle.
eWaka Mobility	Transport and delivery of 5 kg of cargo.
FABIO	Transport and arrival of one passenger in a taxi ride. Transport and guidance of 1 visitor during a tour guide. Transport and delivery of 30 kg of goods to restaurants.

E-trails	Leasing of 1 electric bicycle.
OAN International	-

The expert interviews allowed different companies to apply their value proposition to the framework and define SUs using the formula. By having experts generate SUs, a connection between the defined concept and the specific examples is created and verified since expert knowledge has been applied to define the examples. The theoretical concept is compared with real-world expertise and applied in specific business value proposals by people with extensive experience in the respective fields.

After assessing the SU definition, alike SUs are defined among companies with similar value proposals, therefore, the application of different expert knowledge, viewpoints, and perspectives has resulted in the same outcome. This confirms the accuracy and applicability of the SU based on the expert's practical experience.

The experts also evaluated the canvas with a numerical score to obtain a quantification of the Canvas's performance. This rating illustrates the practicality of the Canvas on a scale of 1 to 5 for different aspects of the Canvas and shows the effectiveness of its ability to connect business and technical requirements of the project. Table 5.3 shows the average rating of the VbS Canvas received in the expert interviews for the different evaluation criteria.

*Table 5.3: Rating of the VbS Canvas according to the evaluation criteria.*

Evaluation criteria	Rating
Learnability	4,7
Flexibility	4,2
Robustness	4,5
Efficiency	4,5
User Satisfaction	4,2

Overall, expert interviews serve as a valuable tool to validate and enhance the SU definition by leveraging the expertise and insights of individuals with relevant knowledge and experience. They also act as a suitable method to validate the VbS Canvas and demonstrate that it can be used as a tool to relate the engineering design requirements with the business part. Additionally, the final questions performed during the interviews allow the researchers to obtain an objective evaluation of the VbS Canvas.

## 5.2 Validation of the Proposed SUs

To perform the validation of the proposed SUs, another research is undertaken. This investigation focuses on identifying companies, organizations, and institutions that are actively engaged in pursuing the SDG goals and carrying out activities that closely align with or resemble the suggested SUs. Following the circumstances described by Venable, Pries-Heje et al [76], suggest that "a critical goal of the evaluation is to rigorously establish that the utility/benefit will continue in a real-life situation", examining these entities, their initiatives, and their alignment with

the proposed SUs strengthens the reliability and efficacy of the identified SUs as there already existing examples that perform the SU and validate the applicability of them in real life situations.

The validation via companies, organizations, and institutions includes an evaluation of the strategies and programs they implement, as well as the way these actions are executed, focusing on mobile means. By scrutinizing their approaches and implementation methods, the validation process seeks to gain insights into best practices and optimize the selection of suitable SUs.

Table 5.4 represents the SUs along with the companies, institutions, or organizations that offer services applicable to the SUs, accompanied by a brief description of the project.

Table 5.4: Validation of SUs.

SU	Company	Project
Transport and performance of a post-partum check-up	Riders for health	Regular visits by health workers to remote communities for pre-and post-natal services.
Transport and attendance to a woman during labor	The White Feather Foundation	Village ambulances (two-wheeled trailers) provide a safe way for patients to get to the hospital
Transport and performance of an abortion intervention	AIDS Foundation South Africa	Perform termination of pregnancies on mobile sites
Transport and attendance to a woman during pregnancy	Doctors without borders	Prenatal care and family planning for women outside hospital walls with mobile clinics
Transport and performance of a newborn	Riders for health	Services to the most remote communities including newborn care
Transport and performance of a pediatric check-up	Pediatric care Africa	Medical outreach programs in local communities to improve the healthcare situation of children
Transport and administration of a newborn vaccine	Doctors without borders	Vaccination and malnutrition screening for children and newborns outside hospital walls with mobile clinics
Transport and delivery of 1 insecticide-treated bed net	Think Humanity	Provide free bed nets to people from isolated and underdeveloped villages
Transport and delivery of an antiretroviral medicine	CHAT: Communities Health Africa Trust	Delivers innovative door-to-door HIV/AIDS services
Transport and delivery of 1 box of condoms for women	AIDS Foundation South Africa	Offer of male and female condoms and lubricants, the offer of HIV testing services, and TB and STI screening.
Transport and delivery of 1 box of condoms for men		
Transport and administration of 1 Hepatitis B vaccine	AIDS Foundation South Africa	Hepatitis B screening and immunization programs
Transport and performance of 1 Hepatitis B test		
Transport and delivery of 1 box of antibiotics	The Global Fund to Fight AIDS, Tuberculosis, and Malaria	Provide direct services to communities and offer treatment to people who have tuberculosis, drug-resistant tuberculosis, and patients with antiretroviral HIV therapy
Transport and performance of 1 rapid diagnostic test for malaria	Doctors without borders	Mobile clinics drive to visit remote villages to test for and treat malaria.
Transport and delivery of 1 box of antimalaria treatment		
Transport and performance of a cardiologic consultation	Odulair	Customized mobile clinics and medical vans designed specifically for Africa that provide different medical services.
Transport and performance of an oncologic consultation		
Transport and performance of a pulmonological consultation		
Transport and attendance of a dentist		

SU	Company	Project
Transport and administration of 1 HPV vaccine	GAVI, the Vaccine Alliance	Taking vaccination into communities to reach more girls.
Transport and delivery of 1 box of 10 kg of basic food and hygiene products	Operation Hunger	Delivery of a food parcel to families within the target communities who have no source of income
Transport and attendance of a therapist	Amref Health Africa	Increase access to quality promotive, preventive, curative, and restorative health services.
Transport and performance of an informative talk on drug and alcohol abuse	Doctors without borders	Mental health support and counselling performed by local counsellors trained by Doctors Without Borders
Transport and attendance of a counsellor		
Transport and arrival of 1 person	SOTRA	Improving urban mobility of the population by operating buses, taxis, and water taxis.
Transport and performance of an informative talk on safe driving practices	SOTRA	Campaigns to raise awareness to respect the driving code and operating instructions, to reduce the number of accidents
Transport and performance of 1 consultation with a family planning specialist	CHAT	Delivery of innovative door-to-door services such as family planning
Transport and insertion of 1 IUD	MSI Reproductive Choices	Reaching remote communities through last-mile services and providing a choice of contraceptive methods and provision of skilled obstetric care, leaving no one behind.
Transport and performance of an obstetrician consultation		
Transport and delivery of 1 box of birth control pills		
Transport and supply of 1 box of medicines	Life Bank	Have a range of logistics solutions to get life-saving medical supplies to the population, no matter the scenario or location.
Transport and supply of 1 medical PPE kit		
Transport and attendance of a primary care doctor	Riders for health	Transport of health workers to deliver a range of services to even the most remote communities.
Transport and supply of 1l of water	WorldVision	Purify existing water sources in communities and distribute them to the neighborhoods
Transport and delivery of 1 water tank	Jojo	produces a range of water filtration, rain-water harvesting, and storage tank solutions ideal for domestic applications
Collection and disposal of 1l wastewater	Suez Africa	Operation of wastewater treatment plants
Transport and performance of an informative talk on tobacco use	Truth initiative	Mobilizing "truth trucks" to connect with youth and young adults through the venues they understand and trust.
Transport and administration of 1 DPT vaccine	Living Goods	Supporting CHW to close the childhood immunization gap and increase demand, especially in hard-to-reach communities.
Transport and administration of 1 Rotavirus vaccine		Perform follow-up visits to ensure all inoculations happen on-schedule
Transport and administration of 1 BCG vaccine		
Transport and administration of 1 Polio vaccine	VillageReach	Vaccination campaigns with multiple vaccination sites in the villages.
Transport and extraction of 1 sample of blood	LifeLabs	The mobile lab collection team has a range of services to make lab tests simple and convenient.
Transport and performance of a training on health emergency	Resolve to save lives	Planning and implementation, with a focus on disseminating best practices among countries and supporting local learning
Transport and arrival of 1 person	Flying Doctors Nigeria	Road ambulance and helicopter ambulance enables to transfer critically unwell patients.

From the different companies, institutions, and organizations studied there is robust evidence of current use of mobile services that comply with the identified SUs. Companies are focusing on reaching out to rural areas and communities to provide the necessary services to achieve good health and well-being.

No companies have been found that offer services that align with the SUs transport and delivery of a bicycle and motorcycle helmet, a seatbelt, and a box of nicotine patches. This however does not imply a big limitation because the delivery of these goods, according to the cluster classification does not require any additional components to the aCar.

## 6 Discussion

This section aims to analyze and interpret the results obtained by the researcher. The aim of deriving a definition of the Service Unit was to define the concept that serves as a value proposition in the VbS Canvas and to define a formula to establish the services that the aCar will provide.

The SU definition is derived from the FU and follows a methodology based on scientific papers. It combines several tools that ensure the comprehensiveness and validity of the definition. The formula for the SU definition is established to serve as a guideline and ensure a correct and complete definition of the SU. This definition, together with the rest building blocks contained in the VbS Canvas ensures that the aCar is designed to meet both business and engineering requirements, resulting in an optimal design that delivers efficient and effective services.

The refinement and validation of the SU definition are based on two empirical methodologies that suggest using distinct tools to arrive at a comprehensive, comparable, and practical definition of the SU. The guidelines followed use focus groups to have a refined and understandable definition, and expert interviews to validate the definition and its application through real business cases. These two methods are complementary as both rely on qualitative analysis.

Conducting focus group sessions has been useful to gain expert feedback on the SU definition and create new iterations after every session until saturation was achieved. However, the limited number of participants in each focus group caused saturation to be achieved quicker. This is due to the small number of individuals who are familiarized with vehicle-based services, the SU concept, and the additional requirements of the aCar that are included inside the building blocks of the VbS Canvas.

The use of expert interviews to validate the SU definition had some shortcomings due to the number of interviews conducted. Approaching experts and receiving a confirmation for an interview supposed a difficult challenge, because the researchers received many rejections. The similarity between the companies resulted in alike SUs, that even though this implies the correct application of the framework, the SUs identified were not as diverse as expected. This would have been improved if a bigger number of interviews were conducted to obtain a wider range of real-world applications of the SU definition.

From the literature review conclusions regarding the strategies to achieve SDG 3 targets can be drawn. The strategies described by experts are divided into different focuses, giving a treatment by a doctor, providing drugs, medicines, or products to achieve the targets, developing new policies, increasing funding, and media campaigns. Targets that include strategies of the provision of treatment, or a product facilitated the application of the framework to find an appropriate SU. On the other hand, targets in which their strategies decline towards policy development, funding, and a higher media presence, posed greater challenges when developing the SUs.

Providing an empiric interpretation of an abstract concept is the simplest form of operationalizing a concept. Validation via exemplification has been used to finalize the definition of the SU and ensure concreteness and absolute clarity. Examples of SUs and how they have been applied in real-life situations are especially useful because they connect abstract concepts with the concrete world. The search for companies that offered mobile services which resembled the SUs helps establish a level of confidence and ensures that the SUs can be performed.

Cluster analysis is a useful tool to classify the different SUs according to specific characteristics that define the necessary additional requirements and are useful to establish the design and schedule of the aCar. Grouping similar SUs is beneficial because they can be transported and performed without requiring any design changes and additional components to the aCar, enhancing efficiency and effectiveness in providing SUs. Suppliers can use the results of the cluster categorization as an overview of the main costs associated with each category, and also with the specific SUs inside them.

The potential application of the SUs has been done country-wide throughout SSA. This causes some uncertainty because the data in the indicators account for the rural and urban areas of the countries, therefore the information depicted in the figures may not be completely reliable. Using only rural data may result in different outcomes for the needs of a country and the priority of actions between countries may differ. However, the assessment of the potential application of the SUs gives a helpful representation of the main necessities and the SUs that can be provided to assess these needs and help in the progress towards achieving the targets in SDG 3.

The cluster analysis and the potential application of the SUs complement each other as one can see the required additional components and logistical activities of the SUs and the countries where the application of those SUs is more beneficial. It can also be observed as having a target area to assist, obtaining the suitable SUs to satisfy those countries' needs, and choosing the most appropriate SU to supply and meet the needs based on the available resources.

In conclusion, this section provides a comprehensive analysis and interpretation of the findings, shedding light on the research objectives and addressing both research questions. Through the integration of relevant literature and the examination of data available, this study has contributed to the existing body of knowledge in the field of VbS and how they can be used to achieve SDGs. The limitations of the research are acknowledged, offering opportunities for future studies to build upon and refine the findings. Overall, the discussion section serves as a platform for critical reflection and meaningful interpretation, showcasing the significance of this research.



## 7 Summary

This master thesis is part of the “aCar Mobility Research Project” based on offering renewable e-mobility solutions for SSA via the use of VbS. The vehicles increase accessibility by delivering services to the people. This master thesis aimed to accomplish two objectives. Firstly, it focuses on the development of the definition of the SU concept, which is the central block of the VbS Canvas and connects all the blocks. Secondly, the thesis aims to obtain a comprehensive database of SUs that can effectively address the targets contained in SDG 3.

To define the service provided, the SU definition is developed through an iterative process. Focus groups were used to assess and develop new definitions to achieve a clear and comprehensive definition. The SU contains the service value to the customer and is the simplest unit of the object or services transported in the aCar. It is defined with a measurable quantity that is used to parametrize and customize the vehicle. The definition of the concept was thoroughly validated through expert interviews. The insights and perspectives shared by the experts confirmed and strengthened the accuracy and completeness of the SU definition.

The systematic literature review of the current strategies suggested by experts to achieve SDG 3 resulted in a database of 50 SUs that aim to address the targets of SDG 3. As it is observed in Table 4.5, the same SU can be used to achieve different SDG 3 targets. This is because of the interconnection and relation between targets. Additionally, performing actions to improve SDG 3 will result in further improvements in the remaining SDGs because they are all related, and actions in an SDG affect others.

The cluster analysis serves as an assessment performed from the provider’s perspective to analyze the resources and requirements of the proposed SUs and study the engineering design of the aCar. Additionally, the provider of the SUs can use the cluster categories to compare the costs between SUs.

Meanwhile, the application potential of the SUs evaluates from the customer’s perspective, taking into account the customer's needs and service demands in various countries. These studies serve as an assessment of the demand and can be used to find the most suitable SU.

The obtained SUs were validated by establishing the utility and application of the SUs in real business cases. The results of the validation show that the use of vehicles is an effective strategy to provide healthcare services to rural communities that have little or no access to basic healthcare. From all the studied institutions, organizations, and companies, there is evidence to support the identified SUs as potential services that can be provided to achieve the targets inside SDG 3.

## 7.1 Outlook for Further Research

The following lines of study are proposed for future research.

The identification of SUs to address all SDG targets that are directly or indirectly influenced by VbS. This will further increase the current database of SUs and propose a valuable tool for designers to adapt and tailor the aCar according to SU requirements and for providers to have a bigger range of possible solutions to be performed in SSA to achieve SDG goals.

Another research to be conducted would be a deeper analysis of the potential application of SUs. The current analysis shows a country-wide necessity for SUs considering both rural and urban areas. An analysis focusing on the rural areas could be beneficial to gain knowledge on the actual SU demand of each region inside a country. This will result in a better understanding of the SU that takes priority in the areas.

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# Appendix

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# Appendix A: SU Definition Iterations

The SU definition is the result of an iterative methodology. The first prototype is developed in the preliminary definition. After analyzing and applying the feedback from team meetings and the results from the focus groups, the final SU definition is developed. The prototypes of the definition obtained after each iteration are as follows:

## Prototype 1 – Preliminary definition

The service unit is the smallest, most valuable unit of a VbS. It describes the transported good or service in a unitary quantity, through which revenue for the supplier and value for the customer will be created. It can be for example 1 kg of bananas, a vaccine, or the transportation of a doctor.

Additionally, the quantity transported, frequency of transportation, and location from/to where the service is going to be performed need to be described. This will be used for the availability of the VbS.

Similarly, to the functional unit it serves as a reference, as the vehicle will be parametrized according to the functional requirements of the service unit. This means that the service unit must be defined with mass and when it is appropriate with volume, as this will influence the vehicle concept.

When the service unit is a consumable good, the type of good needs to be stated, whether it is a bulk, liquid, refrigerated good etc. This is used to add the additional components the vehicle will need to be able to transport that good. Some service units are the transportation of people. This must be stated to account for a seat for the people to be secure in the vehicle.

The following overview helps to visualize the service unit and its additional requirements.

<b>Service Unit Resources</b>	<b>Service Unit</b>	<b>Service-in-use</b>
-Type of Good -People/Partners	-What are we offering? -Mass -Volume	-Frequency -Quantity -Location
<b>Functional Requirements/Components/Service functional requirements</b>		
-What other materials/resources are required to provide this service unit? -What other materials do the final consumers of the service unit need?		
	X (mm)	Y (mm)
	Z (mm)	Connection to battery
		Orientation constraint
		Accessibility
		Non-stackable

### **Prototype 2 – Before Focus Group 1**

Similarly, to the functional unit, the service unit serves as a reference, as the vehicle will be parameterized according to the functional requirements of the service unit. This means that the service unit must be defined with mass or product unit and when it is appropriate with volume, as this will influence the vehicle concept.

Additionally, the quantity transported, frequency of transportation, and location from/to where the service is going to be performed need to be described. Knowledge of the segment to which this service is going to be served is important to understand the additional physical assets, personnel, and functions the service unit needs to be fully supplied. This will be used for the availability of the VbS, and it is stated in the VbS canvas.

The service unit can be expressed concisely through the following formula. It is composed of a verb/action that the aCar is performing, a metric that will measure the service unit and serve as a reference of what one unit of the service is, and finally the object that is supplied to the customers:

**Verb of Metric (mass/product unit) of Object supplied.**

### **Prototype 3 – After Focus Group 1**

The service unit is the simplest unit of the objects that are being transported, through which revenue for the supplier and value for the customer will be created. It answers the question “What is the offering?”

The service unit includes the movement action which is performed by the aCar and the service that the provider is giving to the customer. It serves as a reference for the whole offering and must be defined with a mass or product unit and when appropriate with volume.

Additionally, the quantity transported, defined as the maximum capacity of service units in the aCar per working day, the frequency of transportation, and the location from/to where the service is going to be performed need to be described. Knowledge of the segment to which this service is going to be served is important to understand the additional physical assets, personnel, and functions the service unit needs to be fully supplied. This will be used for the availability of the VbS, and it is stated in the VbS canvas.

From the previous description, the Service Unit can be defined as:

*“The transportation and performance action of the smallest unit of the object for which the customer is willing to pay a price.”*

The service unit can be expressed concisely through the following formula. It is composed of a verb of movement action that the aCar is performing, the action performed to the customer, a metric that measures the service unit and serves as a reference of what one unit of the service is, and finally the object that is supplied to the customers:

**Verb (movement of the aCar) and Performing action to customer of Metric (mass/product unit) of Object supplied.**

For example, in the case of a mobile medical clinic, some service units could be transportation and administration of 1 vaccine, transportation and extraction of 1 sample of blood, transportation, and performance of 1 dental check-up etc.

For the movement of goods, it can be specified as transportation and distribution of 1 kg of bananas, or transportation and supply of 1 l of water etc.

#### **Prototype 4 – After Focus Group 2**

The service unit is the simplest unit of the objects or services that are being transported, through which revenue for the supplier and value for the customer will be created. It answers the question “What is the offering that the supplier is giving to the customer?”

The service unit includes the movement action which is performed by the aCar and the service that the provider is giving to the customer. It serves as a reference for the whole offering and must be defined with a mass or product unit and when appropriate with volume.

Additionally, the quantity transported, defined as the maximum capacity of service units in the aCar per working day, the frequency of transportation, and the location from/to where the service is going to be performed need to be described. Knowledge of the market segment to which this service is going to be served is important to understand the additional physical assets, personnel, and functions the service unit needs to be fully supplied. This will be used for the availability of resources of the VbS and it is stated in the VbS Canvas [12].

From the previous description, the Service Unit can be defined as:

***“The transportation and service provided to the customer of the smallest unit of the object for which the customer is willing to pay a price.”***

The service unit can be expressed concisely by following the hereunder structure. It is composed of a verb of movement action that the aCar is performing, generally the transportation of the good or the service that is supplied, the service performed to the customer, a metric measures the service unit and serves as a reference of what one unit of the service is, and finally the object/service supplied to the customers:

**Verb 1 (movement of the aCar) and Verb 2 (service provided to the customer) of Metric (mass/product unit) of Object/service supplied.**

For example, in the case of a mobile medical clinic examples of service units could be transportation and administration of 1 vaccine, transportation and extraction of 1 sample of blood, transportation, and performance of 1 dental check-up etc. For the movement of goods, it can be specified as transportation and selling of 1 kg of bananas, or transportation and supply of 1 l of water etc.

# Appendix B: Expert Interviews

## Appendix B.1 MANA Mobility

Date of the interview: 13.02.2023

Interviewee: Toni Heigl

Celia Cuñat

A brief introduction of the project and the purpose of the project. Africa has a really low urbanization rate, and the population is distributed across the countryside. Furthermore, the population is really poor, and their main activity is agriculture. This results in a really low demand of all kinds of products and services. At the same time, supply locations for essential products are really few because of all the cost of installing the infrastructure. Our solution for this problem is to operate a fleet of vehicles providing basic needs. We built an online tool that allows stationary projects, stationary businesses to design and operate an electric vehicle capable to render SDG relevant services to remote customers. We have created a canvas based on the business model canvas to serve as a communication tool between the business and the engineering design requirements for the vehicle based services. With this interview, we really want to know your insights on the tool and analyse whether or not MANA mobility can be applied to this canvas. So first of all, to get to know you better and your area of expertise, could you please present yourself and briefly talk about what you do?

Toni Heigl

Happy to do so. Thank you very much for the invitation My name is Tony and I'm one of the Co-founders of MANA Mobility and German Ghanaian enterprise dedicated to mitigate the transport poverty problem. It's very similar to what you described about your project, but from a business perspective. We consider ourselves a social enterprise, so we're focused on working on SDG's contribution in regard to mobility, to sustainable communities, to sustainable infrastructure. And the way we are trying to do that is to bring emission free mobility to emerging markets in terms of hardware on the one side. So, vehicles in this case, which are electric bikes and also electric cars in future and on the other hand operating mobility systems. So we have a digital ecosystem and infrastructure based on a mobility App which allows customers and operators of mobility to find one another and based on emission free hardware. So, our own vehicles plus third party electric vehicles, emission free vehicles are invited to operate through our digital marketplace to create affordable and efficient mobility in those markets. That's our goal and we're in the middle of the bikes are on the on the road. The car is in prototyping mode and the app is ready to be downloaded in the in the Play Store. So we're in the middle of ramping up.

Celia Cuñat

And now, a bit about the canvas we sent to you, and you have already seen how a service unit can be applied to the canvas. We decided on a service unit that can be really understandable and easy to apply so and do you think that the canvas, depicts business model?

Inés López

Maybe we can share it, right I. If you want

Toni Heigl

So I have the one in the PDF that you do sent before with the with the example of the business case.

Inés López

What we try to do is to change a little bit the business model canvas that everyone knows and to adapt it to our idea and business model. And we think that your company really matches also this model, so maybe we can fill it together as Celia explained.

Toni Heigl

Yeah. So overall, yes, I think it's a reasonable tool to use that for depicting in general the scope that you guys are talking about. For our company and the scope that MANA mobility has there are a few use cases possible based on that, because it's quite a broad space. Our focus and our initial approach will be the last mile delivery services that we're operating through project partners which are operating those fleets. For example, food delivery services and Courier services, something like that. If we focus on that initial use case and I think, it will fit easily into that structure and into the business model canvas.

Celia Cuñat

OK, perfect. So we can use one of those cases and fill it up. OK, so for example food delivery we can do one case with that. What do you think or how do you think that MANA mobility will define the service you need? Or as we have it here, how can we apply for?

Toni Heigl

I would probably call the service unit last mile delivery organisation and execution of. Yeah, the question is that content can be very different. I mean it's like in a Courier service. So it's only limited by the by the payload of the of the vehicles, basically, but anything of cargo up to 500 kg you can put there to be very generic.

Celia Cuñat

Ok, for cargo.

Toni Heigl

So what I mean by organisation and execution is the digital infrastructure is organising it. So you will be able to find the driver that handles your service and the execution is basically that the hardware that we are providing. The vehicles that we are providing is being used for that. So that's basically our scope.

Celia Cuñat

The key activities that you will perform. The frequency quantity and the location.

Toni Heigl

So frequency would in a typical use case be like 10 to 15 deliveries per day. So usually a driver is in the vicinity in and even in urban setting, or if it's a rural community in a limited space in what we call the last mile which allow us to do a lot of deliveries on the on the same



day, but each of them is in kind of a limited radius. So, frequency overall would be 10 to 15 deliveries per day.

Celia Cuñat

Quantity will be.

Toni Heigl

And quantity is, yeah, any cargo up to 500 kg. That's related to the car, smaller ones could be on the on the bike as well, but I would just include that now because it's the right means of transportation, so to say we would plan be used depending on whatever the freight is. Theoretically in the car you can fit up to six people. So it's like the driver plus five more people. It could also be like a taxi service with 5.

Celia Cuñat

Well, location.

Toni Heigl

Location right now, Ghana. So the service is offered and our hub and home base is in Ghana and that's where the bikes are on the on the road already and the launch of the car will also happen in Ghana We are in the process of signing partnerships and licencing partnerships in other countries, but we can put initially Ghana later on sub-Saharan Africa.

Inés López

OK, perfect. Thanks.

Celia Cuñat

OK, the service resource system here. If there is something you don't understand, Ines will clarify to you. So the consumable products that would be carried in the vehicle.

Toni Heigl

Yeah. As I said, they can be more or less anything that fits into there. So typically limited by weight or by dimension, so anything up to 500 kilogrammes. And it's there's a flat bed. It's like a pickup configuration. So the volume is not necessarily the limit. Typically it's more the the weight that is the limiting factor, but it can be any kind of cargo.

Celia Cuñat

OK.

Inés López

Yeah, I think in the case of this service unit, we don't need to go in permanent component and everything. Maybe we can go to provider.

Celia Cuñat

And the provider in this case will. Be MANA mobility. So what are the core competencies for this?

Toni Heigl

One of the most important factors is the customer access. So basically, through the partnerships with local service providers, so the operators of that company. Just imagine like a food

delivery service and they are subscribing to our bikes and to our cars. Through that we are giving them access to the individual customers. Our setup is a B2B2C set up. Typically, there is another provider in between, but it can be directed to the customer as well. If it's a one to one, like a taxi driver operation, that's also possible, but in many cases it's another logistics company in between. The core competency on our end is to have that network of partners and customer access through those partnerships and through the presence in the market. Really to do the marketing and the customer connexion. On a technical perspective we have products, hardware products that are tailored for the market because they are manufactured locally. There are some components that are sourced from abroad, but the design and the product in implementation is really tailored to the market needs. The competence is that the engineering and the assembly is taking place on site and therefore we have the right product, the right vehicles for the market needs. Those are the most important factors I would put here.

Inés López

OK.

Celia Cuñat

You have also answered the capabilities and how do they align with the customers so we can go to the customer profile block.

Toni Heigl

Right. Who are the customers? Yeah, it's 2 levels. So on the one hand a direct customer in many cases, as I said is a logistics provider fleet operator who is subscribing onto our fleet and in a second stage it can be also the individual that is operating. It's usually not someone who's running the vehicles on for private needs, but also like a taxi service like a driver service. So you can actually describe it between one driver, slash operator up to at delivery fleet operation company, that's the scope of customers that we are interacting mainly.

Toni Heigl

And so therefore is a bit complicated to put relate demographics being because it's more a B2B setup or at least the typical one. I would limit it to that way because it would be misleading to explain what the very few individual customers are and how they are defined I would say more than 90% B2B at the moment.

Toni Heigl

The last question, the third one here, customer expectation. The main expectation is the all out of one hand, one stop shop. You really have a functioning system including hardware and software. The operation of the vehicles, together with the actual hardware that's provided, including maintenance, including an insurance pack in case of the bikes, including everything else you need in terms of equipment or a helmet and everything that the riders need to be safely on the road. That's really important for everyone to get that all handled and organised and offered. It needs to work and it needs to work really without any hiccups. That is the most important point.

Celia Cuñat

Perfect. Thank you and the interaction with the customer involved with the provider.

Toni Heigl

Very active. What we are doing is when we hand over vehicles, we're training the riders. On behalf of the operating company behind, we're inviting really the individual person that will ride the bike, in this case, car is yet to come, but it will be the same setup. They get training on all of the details on how to operate the app and the ecosystem how to handle the bike and to interact with us in case of any questions or anything, and also really on board and motivation for the delivery service itself. They get everyone all set up and ready to go and have a proper work integration in the job in general. Through all of those levels, our business customer and then the actual operator rider driver behind that. It's a very strong connexion and a very active involvement that we have here. So therefore you have the direct hotline in a communication possibility whenever it's needed for maintenance, for any kind of support and we actively moderate that and onboard them and really teach them in order to get the system working.

Celia Cuñat

The exchange is on demand I will guess.

Toni Heigl

It's basically planned up front. The onboarding and really a direct communication is really actively also pursued from our side but also on demand if there is any type of service needed they can approach us at any time. It says the subscription here, since we're operating through mobility app, it is part of the system of course that they can communicate directly with us through that channel as well. There is a possibility to call to send emails or to run the communication directly in our own app. So that explains also the interface, very direct communication with us. On these three channels.

Toni Heigl

Relationship, all of those, actually, it's of course a very reliable, trustful and solution-oriented communication that's necessary there, because on the one hand it's a supplier or customer relationship but also it's an operational kind of thing. They are dependent because they're everyday means of income and to make sure that everything is working fine and so therefore you need really fast response and ready to fix the problem kind of attitude. It's a maintenance thing as well as a customer relations.

Celia Cuñat

Thank you. And now about the cost structure.

Toni Heigl

There are different business models possible. The fleet operator has the option to buy the vehicle but usually the preferred solution is to have a subscription model so that they pay monthly fees and a commission on the activities that are being run through the App. Since we are connecting customers and operators and they are earning money through the delivery transactions there is a commission on that system and a hardware usage fee, that includes also the battery swap, and all of the operational costs are. In the typical use case, it's a time component, a subscription fee on monthly level, plus a commission-based charge for the app usage. That's the most common usage model and in order to really be customer oriented, we do modifications of that. If someone says I prefer to hold the assets and really buy the bikes straight out, we can also do that and then only do the commission on top of that. There are alternatives to that. We are open for.

Toni Heigl

That's the cost logic in in case of NGO's and and things. So since we're a for profit social enterprise but still profit generating set up, it's a custom oriented business case. So they are making profits out of the delivery service and we're working with them on a profitable scale. There might be other use cases coming later on where we have like government sponsored services and things like that. We're looking into various cases, especially when the car is ready and is on the market. There are various possibilities for services that are funded in a different way. But since we are said we only described the last mile delivery use case, customer driven standard profit model.

Celia Cuñat

And the revenue streams here.

Toni Heigl

The overall, we're providing that as a one stop shop, so including all of the services that are included there like insurance maintenance, battery swap and so on it's the same cash flow that is that is coming into that. But the revenues or the services are generated out of these different add-on features. The transportation is the base revenue case, and we have a list of add-on services which are typically in the standard offer. If a customer is accepting the full package, he will get all of the those add-on services included in the monthly subscription, insurance for rider and bike, maintenance plan, battery swaps etc. All of that is adding to the revenue stream overall.

Toni Heigl

To measure the performance on that, it's basically driven by the volume of the units that are in operation. Our main target is not to sell as many vehicles to third parties. We're doing that if that's desired, but typically we're holding the assets and really trying to keep the bikes and the cars in a as efficient as possible mode of operation. The ideal scenario is to have an efficient transportation system in a way that we you're just using as many vehicles as I really need. But keep them running all day long so that you're not generating any kind of idle time or anything. Our digital system is really working that way, that every end customer gets the transportation service they need, but that you don't provide an excess fleet into the city that's not really needed, but it that is really efficiently used and therefore the number of deliveries is our main performance target, not the number of bikes or cars sold or manufacture.

Celia Cuñat

It's social company, social based. So what are the benefits? For what benefits is the customer really willing to pay?

Toni Heigl

The most important point here is I already said that there are number of services and what they need in order to get that running but that's more of the details of the of the pack. The crucial point for the for the business case is that going to emission free mobility is not only a carbon motivation and a sustainability motivation here, especially in Africa, that's not really the main focus of the of the discussion but is really affordability. The point that we are talking about here is that with the fuel costs ever rising, most of the drivers and operators of such services using petrol cars or bike really have a business case problem because their fuel

cost is just taking away a too large share of their of their revenues. In their total cost of operation, switching to electric is a major benefit in terms of their own driver case. And that's the main motivation. Of course that's what they are looking at and where the willingness to pay for our services and our products is coming from. It all pays into the scenario that we're looking into really low cost type of solutions and a subscription model solution that it's not being ruled out again that it's in the end more efficient, but you cannot afford the upfront payment or the down payment or anything. We're not taking that, we're doing that on subscription level, so that we're making it affordable and accessible and that's actually the key point here and that's how we get the willingness to pay. But because, it's a big benefit for the customer in the end. And last one preference of payment means Ghana has a quite a high share of mobile money payments. So there is still a large chunk of cash payments but the digital payments are rising steeply and compared to many other countries. Ghana is, I think, our #2 world worldwide in the share of mobile money payments. That's definitely the most important one. The other digital transactions credit cards and other systems. For that type of transaction, especially when I'm talking about the individual right, not the monthly payment might be a different one, but the individual rights are paid either in cash or through mobile money. But on the level between our business customers and our company. And also other types of digital transactions are needed so bank transfers, credit card transfers and so on. But mobile money I would really point out that this is a key factor to also make it transparent to make it easy to handle to have it accessible and also commission free for private customers that are using it. Very important factor.

Celia Cuñat

OK. Thank you. So we have completed the canvas now and well a few questions about the whole canvas. When how easy or difficult was it for you to apply your value position for the canvas?

Toni Heigl

I think that was pretty straightforward, so it's matching quite well. I'm fine with that. So I wouldn't see any need for changes in in our case. So it I think it fits into the scheme very well.

Celia Cuñat

That's good news for us. So how does it like meet your needs or solve a problem for you in this canvas.

Toni Heigl

I think it describes well the business setup and the service logic. It would not really define further details on the requirements of the vehicle itself, so we're not really coming to the point: Is the is the vehicle the right fit for the type of need? I mean you have a little bit like locations frequency and so on. But probably in order to reflect are we on the on the right track and defining the right vehicles for these specific use case, you probably need one level more in terms of requirements management and tend to reflect that, but it's probably also not the purpose of that logic, but that would be for me. The next question when the definition of services versus products is being brought.

Celia Cuñat

The last question is now that you have learned more about the project and how we are conducting and creating a tool. Could you tell us your thoughts on it on? The whole project on the tool on everything.

Toni Heigl

My main thought or my interest, would as the next step be the aggregation of the type of services that that you're putting into those canvases. That would be interesting to really summarise and aggregate. What is the overall uh feedback in into that? I don't know if that's possible or if you will publish or share any kind of analysis when moving forward so that would be the most interesting thing, the process I think sounds pretty, pretty good and pretty straightforward for me.

Inés López

As a conclusion, if you had to evaluate the Canvas according to the following parameters, what score would you give from 1 to 5. 5 is the maximum.

Toni Heigl

Nice. Yeah. Looking forward to that, keep me in the in the loop. Very, very interesting topic. Overall, your work and the scope of the overall project. And so always too happy to hear news and yeah share whatever kind of findings you have and how this will develop.

Learnability	5
Flexibility	4
Robustness	4
Efficiency	5
User Satisfaction	4

Inés López

OK, perfect. Thank you so much for your time.

Toni Heigl

Sounds good. All the best. Good luck with. You're welcome.

## Appendix B.2 AUARA

Date of the interview: 14.02.2023

Interviewees: Gabriela Herrero and Luis de Sande

Inés López

Good morning, nice to meet you. First of all, thank you very much for your time. We have invited you to this interview because we believe that your experience as a social enterprise developing water projects in Africa can be very useful to us.

As you know, many people in Africa do not have access to basic services. This is not only because of their low income, but also because mobility in the most remote areas is very difficult. Our project arises from the desire to improve mobility in a sustainable way. We have created a modular electric car capable of providing different services in rural areas of Africa. The car can be adapted to the services you want to obtain, for example: an ambulance, a portable school, transport of goods... Currently what we are looking for is to link through a methodology the modular design of the car with the feasibility of the service. For this we have created a Canvas based on the Business Model Canvas. We would like to ask your opinion about the Canvas and if you think it could be adapted to your business model and value proposition. Before that, if you want, you can start by introducing yourselves and explaining your company.

Luis de Sande

Auara's model is a bit different. But I have seen something similar to your idea in India, where they have created an ambulance service. In India there is a saturation and a very high demand for ambulances and the low-income people, let's say, do not have them. So, what they do is to combine the offer of service to high-income people and with the income they get, they give bonuses to low-income people. The idea is to make their social action to favor those who do not have access to this service.

In our case, at Auara, what we do is sell a bottle of bottled mineral water in a developed market. It allowed us to get off to an easy start, because what we were selling was water. We didn't have to explain the taste. And it's a habit. What we were looking for ways to convince with a commodity product and make it a habit, to convince people to transform the habit they are already in the habit of doing, and to emit values so that they would do it with a social purpose. That they would help us with the purchase of this bottle so that we could build wells to provide access to drinking water to people who did not have it in the countries where they needed it. Then try to involve people with this habit that is powerful because it is routine, and it is a habit to teach them to use it as a tool for change. The fund serves for Auara, but we also teach that it serves for everything. If you change your habits little by little, then let's say that you are very powerful and you help us all to transform the world into what we need. We focus on social and providing access to drinking water because we understand that there are many people who do not have access and that not having water is not having life, the right to life. That is the beginning of everything and that is why we focus there. Now we are entering, and I am talking a lot. Now we are entering a very cool area that we love, and it consists of giving the orchards access to drinking water, access to water for irrigation,

for orchards and generating products and selling those products to make them more economical. Gabriela, do you want to add anything else?

Gabriela Herrero

Let's see what I can tell you. I think that the needs must be told in the countries where you are. And then it is very, very, very, very important that you find organizations that are serious and that are honest. Very important, very, very, very, very important, because that is the basis for the project to work. You really need serious and honest organizations that work well. And it's complicated, whether in Ethiopia or Côte d'Ivoire. Once you have those organizations, I would try to focus and try to do what Luis said. You know about the ambulances in India? To take advantage of the fact that you have cars that can transport people that can transport things for X days a week and use them the rest of the days for social purposes.

Inés López

Yes, you are right, we rely on three pillars in our project. On the one hand the university in Germany, then the GIZ, and also the local university.

Luis de Sande

I understand that part of the business model refers to the route and the design of the car, batteries and all that. Then, focusing on who you are targeting is also important. But don't you have any market analysis of the service demanded in any country, maybe that could be useful for you.

Celia Cuñat

Currently, services have been derived from the Sustainable Development Goals to try to meet all needs. Gabriela: I would not base it on the Sustainable Development Goals. I would base it more on what exactly in the country you are going to work in.

Luis de Sande

So, you can invent many things, but I mean, look at the real need that exists in that locality or that is to implement the end-of-service prototype and for sure you are going to have an impact. If you come across three or four services, what you can do is choose them by their most important impact. In the end the demand and the impact lead you to the service, because the other one is the economic one. You must combine it. When we were telling you about India, since it is in high demand at high impact, they are willing to pay a lot of money. Let's say that the shareholder or the operator reverts it. Shareholders do not want to receive anything for their work or for being shareholders. We want everything to flow to social, because it is a way of betting. Another thing is that you have to charge for the service you offer because if you don't, people don't value it. Right? You can never give it away at zero. For example, if you are transporting merchandise, let's say that it has a price, a value, because they are going to receive money and therefore, they can pay you a little or a lot for the service. Depending a little bit on where you want to help, they have to pay you, because otherwise it is not a viable business. It must always have that component.

There are some levels, maybe of poverty and so on that you don't charge because you can't charge, but they are super important and necessary. That is segmenting the business, the services and the needs, some service needs can be paid, and others cannot. And when you segment by different clients you will get what each one can pay and when they need it. You are tracing a little the route, because normally market days are in the weekend, therefore, I have the week to make more commercial services and the social ones are more in the



weekend. Well, it will depend a lot on the operator. If the operator has a rest during the weekend, then he is really screwed. You know, it depends. It depends, of course, if it is complex, it is hard, it is very cool.

Gabriela Herrero

It's very cool, but you have to know more or less where you want to focus in terms of function. You have a plan, in my opinion, and you have a very cool plan but it's very scattered, in the sense that you don't really know where you have to go.

Luis de Sande

I am also thinking that you have to do a risk analysis to see which risks can be assumed by the end customer and which ones you have to keep and which ones you have to solve in another way.

Inés López

Thank you very much, can you think of anything that you think is missing that should be reflected in the business model?

Luis de Sande

The only thing is what Gabriela is saying about alliances. The structure of parts and local development is key in that sense for business and for reliability. I mean, they are complicated countries to develop, they have a lot of taxes, a lot of history, a lot of regulation. I mean, you can't go to Ethiopia, I guess, and create a cab network because the cabs are already created. It is always very relevant when you want to create a new business, but you have to have that license and above all you have to get it approved, you know? The social issue is to look for the perfect ally there locally. I see that your Canvas reflects well the commercial and the social part. And I think that in the social part you are missing the NGOs or institutions that are established and that must work with you.

Gabriela Herrero

That. If you find the right partner locally, then create the company and receive some funds to develop it and the necessary licenses to do so.

Luis de Sande

It is good that you give importance to the economic aspect because it is what reflects the viability of the project. You should contact ACUMEN, which has many business models and can give you new ideas.

Inés López

Thank you very much for the suggestion. We can finish as we don't want to take up any more of your time. Thank you very much for everything, it has been very useful.

Celia Cuñat

Yes, thank you very much for your time.

Luis de Sande

Perfect, if you have any more questions, you can send us an email and we will put you in contact with more people. Keep up the good work, you are doing great.

Gabriela Herrero

Yes, congratulations, girls. See you later.

## **Appendix B.3 Solar E-Cycles**

Date of the interview: 21.02.2023

Interviewee: Roger Christen

Celia Cuñat

OK, so I will start with a brief introduction of the project and then we can go on to some questions and to complete the canvas that we sent you. Africa has a really low urbanisation rate, and we know that all the population is distributed along across the countryside. Furthermore, the population is really poor, as the main activity is agriculture, so there is a really low demand of all kinds of products and services. At the same time, supply locations are really few because of the cost of installing all the infrastructure needed to supply it. Our solution to this problem is to operate a fleet of vehicles providing basic needs. We built an online tool that allows stationary businesses to design and operate electric vehicles capable to render SDG-relevant services to remote customers. Ines and I, we have created a VbS canvas based on the Business Model Canvas to serve as a communication tool between the business and the engineering design requirements. The aim of this interview is to collect your expert insights on our tool and on the project. To get to know you better and what you do, could you present yourself and briefly talk about what you do?

Roger Christen

OK, so very quickly. I've been working in Africa for about 35 years. I did a lot of work with The World Bank on different projects in different countries and in 2015 we started a project that's very similar to what you want to do. The solar e-cycles, we were looking at creating a vehicle that would be autonomous for 50 to 100 kilometres a day. That would be a tricycle with a payload of about 200 kg. We've raised some grants for developing this solution, today we have a project in Kakuma refugee zone and we're also operating in Nairobi. We're at the startup level. We don't have many customers yet. We have a fleet of 15 electric motor-cycles now. We've evolved in our business model we're doing trying to do this similar to what you are doing is to provide electric transportation to small farm holders and targeting really the agricultural logistics segment. That is essentially bringing supplies to the farmers and bringing their produce to market. We also are looking at having our hub or our stationary service hub would also be a place where you can recharge your electric vehicles. You can get maintenance done on them, lease them and eventually some storage facilities, whether it's just for atmospheric storage or cold storage. The concept is we would be a central point of reception of goods from the farmers for eventually aggregating the orders to that ship to where the markets are. We were very interested in looking at your solution for this second phase where once the product is aggregated from the small older farmers to then transport to larger market areas. So we're we have an agreement in exploring a pickup service with Sandy, you may know who sandy from in Nairobi. In Kenya. Sandy is a transportation company, it's a commercial Uber, if I might call it that. So we're really at the initiation stage of our project where we're startup without very much commercial activity for the moment.

Celia Cuñat

OK. Thank you very much. So do you want to add anything?

Inés López

No, thank you. OK, so we can go on and fill up the canvas.

Celia Cuñat

With service, right? I'm gonna share my screen.

Roger Christen

I understand you've designed and you've this this vehicle, the EVUM I think it's called. And you have two projects, one in Ivory Coast and another elsewhere. What are you doing? How many vehicles do you have on the road in these projects today?

Inés López

Two in each country. So four in total.

Roger Christen

What is your business model in the countries today? You are just exploring what opportunities your vehicle could have in the economic environment, is that it?

Inés López

Currently what we are doing is evaluating the first prototype. So the car is there and it is under the property, or loaned to a local. He was selected by the programme and also the German agency. We want to evaluate how he operates it. He can do as much as he wants to make it profitable. We also provided the installation of the solar panels. He uses it for business like taxi or transport of goods. It depends on the needs and the service that it's required on this moment.

Roger Christen

So the people you're dealing with at the moment are just individuals that are in the transport business. You're not looking at enterprises that are already established with internal combustion engine vehicles, you're not looking at a substitution strategy.

Inés López

Yes, yes we are. But this is more for the long term. For now what we wanted is to test the vehicle and how it worked and how it could be operated.

Roger Christen

No, I understand. We went through this process ourselves. We drove our tricycles for 12,000 km before we completely redesigned it. But you have vehicles who are operating in Europe?

Inés López

No, the vehicle was designed in Europe with EVUM, and then it was transported there, but it's completely a design which is customised for this project. It's doesn't exist in Europe.

Roger Christen

OK, OK. And but I haven't really looked at this. There's several videos about the EVUM vehicle and I seem to understand and correct me if I'm wrong, that the manufacturing process is very simple. You've created the small production lines that can be scaled up. We

have a partner who is operating a collection of macadamia nuts. They have 7000 small-holder farmers, and we'd like to explore whether we can use those your vehicles for that kind of operation. It was not in the call available. To participate in our call, but it's something we'd like to explore with you and especially maybe building a factory in Kenya for people Sendy organisation. There are several groups that are really focused on delivering material from one customer to another. As I was mentioned, the commercial Uber, it's called Sandy and there is a company called Tika Foods, which is expanding extremely quickly. Their focus is in connecting the smallholder farmer to either restaurants or users of the agricultural products. Just there's a lot of opportunities in that area.

Inés López

Yes, of course we can put you in contact with maybe more correct persons.

Roger Christen

The task today is to fill out the business analysis chart that you have.

Celia Cuñat

I will share the screen. OK. So when we start first with the service unit, that's the main focus of the canvas

Roger Christen

So basically, our service unit today is a leasing of electric and motorcycles and tricycles.

Celia Cuñat

OK. And well here we use this formula, so it would be like leasing and transporting right? Kind of a load what people want.

So the frequency. This will be on a daily basis, like every day.

Roger Christen

So basically, what we're we are focusing on today is to provide an electric motorcycle on a daily rental basis. For use in Kenya, we call them Boda Boda. The motorcycle Boda Boda association. So we're working with the associations to provide some of their members with an electric vehicle and we monitor the use of the vehicle where we're actually in the exploration phase as we. Looking at where do they go? How frequently do they go? How frequently do they have to replace, recharge their batteries now? For the moment, we have one location in Nairobi and we're opening up another location in the Kakuma refugee zone.

Celia Cuñat

And the quantity of deliveries that could be done in a day, more or less.

Roger Christen

Yes. Our initial research shows that they people can drive between 200 and 400 kilometres in day and doing a multitude of errands, but we don't have any firm statistics from our own customers at the moment

Celia Cuñat

As well as it's for just transport of goods. And based on agriculture, we don't have to enter a lot in detail in the service resource system because it's just the driver and the space to carry the load right or do.

Roger Christen

Yeah, that's right.

What we found in this market it's, the level of revenue for in Nairobi for the motorcycle drivers with Cindy is about a dollar a delivery, one \$1.00 per delivery. So it's a very small remuneration, we know that. In our surveys, the motorcycle drivers, it might cost them up to \$10 a day to lease and operate their gasoline motorcycles. So that's the revenue i doing 10 deliveries in the days quite a bit. Deliveries can be 20 to 30 kilometres at most. And what we're looking to prove out is that the electric motorcycle is less expensive to operate in terms of energy cost to electricity compared to petrol. We understand that about of drivers, they spend about four or \$5 a day on petrol.

Celia Cuñat

Well, we have talked a bit about the revenue and we can continue with that. The key performance metrics for the business success. In your case are?

Roger Christen

The challenge with electric motorcycles is the distance. Of course, the range that you have to drive. And we've noticed that the drivers are swapping their batteries, even if there's almost like almost more than 30% of energy left in the battery there's this level of confidence that is not there yet in in the limited testing we've done, so they try to swap their batteries early. So one of the metrics is how many swaps they need and what is the range that they can travel with one battery.

So it's a very competitive market. Whoever's has to pay the least amount of cost for the for leasing and maintaining and the energy cost of the motorcycle. Whoever can show that the leasing cost, the overall cost of driving this, that the electric motorcycle is the lowest is going to generate a trend. The difficulty with electric motorcycles. Is the ability to recharge their motorcycles anywhere? It's not at the moment we only have swapping stations and people can have their own charge or if they have a connexion at home. But in the case of the customers that we're dealing with, they don't necessarily have an electrical connexion.

Celia Cuñat

I have read in the web page that it is the. Pay as you go. And could you explain a bit on that?

Roger Christen

We have not installed the PAYGO system on our vehicles for the moment. It's as I said, we're we have several motorcycles operating in Nairobi, and we haven't launched our project in Kakuma yet, but the basic would be a monthly lease and eventually getting into the pay go.

What's interesting in your model and we've seen this in, in our studies in Kakuma refugee camp, just owning the motorcycle for the you know personal use for transportation is not the real driver of this market. People are looking for opportunities to earn revenue. So it's the transportation of people, transportation of goods and an application that can link that the service demand with the service provider is really what is going to, you know, expand the service. Rural communities and we've seen this in other projects like the mobility for Africa project in Zimbabwe. The drivers or the users of the vehicles are in a constant lookout for opportunities to earn a little revenue, so you need to get the data through Internet connexion

to the drivers so that they and you have a system where they can identify opportunities to pick up goods, pick up people, drop them off. Similar to the Uber approach to passenger transport, but expanding that into products, services and cargo.

Celia Cuñat

The partners here. Like what? Like the provider of the service is.

Roger Christen

The provider of our service, our service is leasing and maintenance of electric of electric vehicles. But we're trying and we're not very far advanced in this, either in identifying what are the service needs of our target customer population, which is the small older farmers in rural areas. What are their needs? Now what seems to be an area of interest is also looking at the opportunities of using the electric power for other uses in the home either for lighting or for pumping water, powering up the television or the radio. And of course, everybody is charging their phones, so those are value added services that can come from the electric vehicle.

Celia Cuñat

Thank you. Talking about the main customer in this case.

Roger Christen

Well, our customer is the Boda Boda driver but we are building our project in Kakuma to give more attention to what the end user, the smallholder farmer will need. In terms of logistics services and how we can make this economic environment between agricultural logistics, storage, transportation and service to the smallholder farmer create a synergy between those 3 sectors.

Celia Cuñat

OK, So what with the interaction?

Roger Christen

The interaction with our drivers is well at every opportunity for swapping the battery. We are trying to create this link with the and with the smallholder farmer. But today the interaction basically is a daily review of what their mileage is. We have tracking units and we're collecting data on where they've gone to. So we're trying to. You get a little more knowledge of what their delivery activities are and what they use the motorcycle for. But as I said we're very much at the start of our project.

Celia Cuñat

Well, overall you are also at the start of the project and you need to describe a business model. So do you think this canvas depicts business model?

Roger Christen

Yeah, I think your business model is interesting. I'm not sure to what extent it will be viable in extreme rural urban areas, but it certainly has the opportunity for a link between the farmers and the markets and in both directions. We have had a lot of trouble in getting people interested in our electric tricycles, even if the rental, the daily rental we were targeting was \$3 a day we weren't getting very much attraction with our solar powered tricycle. We thought that the advantage of having electric power, mobile electric power. But it's not a real driver for the month. We've reoriented towards providing service of electric vehicles and not for the

real market today, which is the Boda Boda drivers, the electric, the two wheel vehicle drivers. There's a massive amount of youth that are working as taxi drivers with these motorcycles. We're trying to expand that into more cargo and with an eye on the agricultural dimension, the agricultural logistics which is where we think the money is. Just because people have to eat, it's the cost of food is very important in everybody's budget and there's a lot of opportunity for reducing waste. I think that the date is half, half the food is way. Between the farm and the user, I think your idea of working in rural areas on agricultural products makes a lot of sense. Now we can have another conversation if you'd like with our team on site who are working with the Sandy and are leasing if you would like we can organise that at some point.

Inés López

Yes, yes, of course we will talk to our team as well. And then when they are back and they have time and connexion, we can organise another call.

Roger Christen

So I'd like to discuss with the people who are with the macademia nut operation. That's a massive operation. It's really if we can it's maybe specialised product but it's an area where we could get a lot of insight on what the farmers need and how you get the product to market with bigger vehicles like yours.

Inés López

Yeah, it was really useful. And yes, As said for now, like we are kind of a research project. So it means our scale and scope is smaller. As a conclusion, if you had to evaluate the Canvas according to the following parameters, what score would you give from 1 to 5. 5 is the maximum.

Roger Christen

Hope it was useful. I would recommend you talk to the people at Sandy. We can help you set up a connexion with them and with Tika Foods, which is really these are getting to be very big companies that are in the middle of your business strategy I'm sure.

Learnability	4
Flexibility	4
Robustness	3
Efficiency	5
User Satisfaction	4

Inés López

Thank you.

Roger Christen

Thank you. Have a good day.

Celia Cuñat

You too. Thank you for your time.



## Appendix B.4 eWaka Mobility

Date of the interview: 22.02.2023

Interviewee: Celeste Tchetgen Vogel

Celia Cuñat

I will first do a brief introduction of the purpose of the project and then we can start the questions to fill out the canvas. So well, Africa has a really low organisation rate, and the population is distributed across the countryside. This population is relatively poor and their main activity is agriculture. This results in a low demand per area of all kinds of products and services. At the same time, supply locations for essential products and services are few because of the cost that the installation of all the infrastructure has. Our solution for this problem is to operate a fleet of vehicles to provide basic needs. We built an online tool that allows stationary businesses to design and operate electric vehicles capable to render SDG relevant services to remote customers. We have created a canvas based on the business model Canvas to serve as a communication tool between the business and the engineering design requirements for the vehicle system. The aim of this interview is to collect your expert insights on our tool and on the project. To get to know you better and what you do, could you present yourself and briefly talk about what you do?

Celeste Tchetgen Vogel

I am a lawyer. By education and profession, I've worked in the financial and engineering industries for 20 plus years. Mainly leading projects in the regulatory and financial space. I have a Bachelor of Arts in Economics and International Studies and a law degree from Northwestern University in Chicago. I started eWaka together with my partner a year and a half ago. In September of 2021.

Celia Cuñat

And what does eWaka do?

Celeste Tchetgen Vogel

eWaka is an electric mobility platform that seeks to address frustrating and disruptive mobility experiences in the urban environment. We offer sustainable solutions. We have a range of electric 2 wheelers and our goal is really to increase connectivity in closed spaces and commuter experiences within urban areas with a an additional focus delivery and logistics in the city.

Celia Cuñat

We contacted you because we think eWaka matches the scope of our project. So if we could fill out the canvas and see how your value proposal can apply to our canvas together.

Celeste Tchetgen Vogel

OK.

Celia Cuñat

First of all, we can start with the service unit. So what is the offering?

Celeste Tchetgen Vogel

Access to Electric 2 Wheelers for personal use and for commercial purposes.

Celia Cuñat

From our definition of the service unit we could do 2 service units, one for commercial and another service unit for personal activities. We can focus on commercial and delivering and complete the canvas based on that idea.

Do you sell or lease the bikes?

Celeste Tchetgen Vogel

We do everything. We rent them, we lease to own with partners, financing partners. We are not the financing partner and then we also do outright sales, although that's not a very common way to sell at the moment, but it will come. So there are various options.

Celia Cuñat

So in case of a lease or a sale, what is the frequency of use that a person would do to make a delivery

Celeste Tchetgen Vogel

So we have different packages. We have daily rentals, we have weekly rentals. We have monthly rentals. We have quarterly rentals and annual rentals.

Celia Cuñat

Where are you located? Or where do you work like in the same country or in different countries?

Celeste Tchetgen Vogel

At the moment we are in Kenya in just one country, but we aspire to expand to other countries.

Celia Cuñat

Moving on to the service resource system section, the bikes generally are equipped with the driver. Do they have any extras?

Celeste Tchetgen Vogel

Yeah. So depends on the vehicle as we have various vehicles. So we have the E-scooter which is, like a kick scooter, the stand scooter. We have an electric cargo bike, an E bike. And then we have a moped and we have a motorcycle. So I think for commercial purposes we can focus maybe on the E-delivery bike, we call it the shujah.

Celia Cuñat

OK, perfect.

Celeste Tchetgen Vogel

So that one has a carry weight of 5kg. It carries 15 kg in the front and 50 kg in the back.

Celia Cuñat

OK. OK. Thank you. The provider of the service would be eWaka mobility, but also what kind of partners do you have? The financing partners you told me about?

Celeste Tchetgen Vogel

Yeah, we have financing partners. Those are our key partners and of course our customers, if they are cooperates are partners as well.

Celia Cuñat

Which are the core competencies that define eWaka?

Celeste Tchetgen Vogel

So first, a good understanding of the technical aspects of the vehicles that are needed. Then in terms of providing, we put it all under customer service. We have training of riders. Electric vehicles are not common in the market yet, so we have a partnership also with a riding school that helps people to learn how to ride the electric bikes. We conduct training of technicians so we have mobile technicians that can go to the riders if there's a problem, and we also have our own workshop where they can bring the bike for maintenance or repair. The core competency that we would want to promote as we grow in the market is really that we enable our customers to do business all the time, we keep the bikes on the road. That's the customer service piece.

Celia Cuñat

And let's talk about the customers, who are the customers and what are the segments that you try to focus on?

Celeste Tchetgen Vogel

Yeah. So if we focus just on the commercial use and the E bike, the customers range from individual riders who use the bike for commercial purposes. So it's a productive asset for them. And also we have corporates, we define corporates as any organisation that requires delivery in order to perform their core business. So for a restaurant for example, their core business is to provide food but they need delivery services in order to take the food to the clients. We also have platforms like your Uber eats, et cetera, who basically provide a platform for riders to register.

Yeah. And then, yeah, ultimately, probably also governments. Although we're not yet there.

Celia Cuñat

And for the platforms like you would contact the platform and say, we offer this and then they search for riders or does an individual lease the bike and then contacts the platform.

Celeste Tchetgen Vogel

No, that doesn't work like that. The ideal situation would be that together with a finance partner, you contact a platform. Most of the platforms don't purchase the vehicles themselves, so they have bikers or riders that are registered with their platform. And they will make the opportunity available to those riders.

Celia Cuñat

OK. So the platforms are like a connexion between riders and you?

Celeste Tchetgen Vogel

Exactly.

Celia Cuñat

From what you have described, there are different types of interaction between the customer and you. In general, the exchange between you, it's by subscription. You have the different plans as you have told me. Am I right?

Celeste Tchetgen Vogel

The corporate is not the one paying. If it's the platform, it's the rider that is actually the client, the corporate is an enabler. If it is a corporate like a restaurant, it could be that the restaurant wants to own the bikes and they want to hire their own riders. In this case we exchange with the restaurant. It could be that the restaurant comes to us and then says we want you to provide a full logistics solution: the platform, the rider and the vehicles, which we can also do. There the restaurant is the one that pays us. It could be that the restaurant says we will only pay you per delivery. So we require a minimum number of deliveries in order to have some expectation of revenue. And it could also be that the rider is freelancer and he's the one who pays us and then works for the restaurant. So there are various models. I mean there's, it's and those are just the main ones. There's probably other combinations as well.

Celia Cuñat

Thank you. OK. And the cost structure here like what are the fixed cost of renting a bike?

Celeste Tchetgen Vogel

Depending on which plan you have. \$4 a day if you have an annual plan. So you're tight for one year, so you can pay \$4 a day. And depending on the plan it can vary to \$6, 5.5\$. So we have different rates, but that's the daily rate.

Celia Cuñat

For you as the provider of the service. What else is valuable do you get apart from revenue? What are your motivations or your values in in the company?

Celeste Tchetgen Vogel

In terms of our values, our tagline is that we aspire to make last mile transport effortless across the continent. The bottom line is that we want to be able to offer commuters and workers alike, a solution that allows them to basically move effortlessly in our very congested cities across the continent. We're looking for a Green 0 carbon choice for this. About 40% of the pollution is actually caused by transportation, so reducing this while offering economically viable solutions to clients is what we do. We are also trying to create a community. You have a lot of people who are interested in electric vehicles. Sometimes it seems very expensive, expensive to them, so we offer solutions that allow, for example, for paper use in some states, in some parks, in some hotels. We have the technology that allows this to be possible. To sum it up, we are making last mile transport effortless, but also in leading the transition to green transport continent.

Celia Cuñat

That's really inspiring. And your key performance metrics, like how do you measure success of the company?

Celeste Tchetgen Vogel

So, the number of users. We are working on a way to measure the actual CO2 savings. At the moment it's a calculation that we do based on how many ICE vehicles we actually take

out. So a lot of the clients that we target are clients that would be would have been using an ICE vehicle. This is still done like manually, but we count the number of vehicles that we take out and so we can say what CO2 savings we have.

Celia Cuñat

OK. And what is the method of payment?

Celeste Tchetgen Vogel

Yeah. We have an app and that depends on the vehicles. On the scooters we have an app that allows the users to pay directly using their mobile money. We are working on an integration with our website, so people can actually go to the website and make the purchase of the rental plan. But you can also you know do a wire transfer or pay with a credit card, but the most common way to pay is really by using mobile money.

Celia Cuñat

Thank you. So overall, we have answered all the questions of the canvas. And now Some general questions. So, well, what do you think about our project and how we want to address it?

Celeste Tchetgen Vogel

So just to be clear and I understand what you're doing. So you're basically building this communication tool. Is that what you're doing that that's the business?

Celia Cuñat

What I'm doing inside the project is building the communication tool. The business is to create a software that allows people to use electric vehicles that we will also manufacture and send to different countries in Africa to use them to provide services. Like now we have 4 cars, 2 in Ivory Coast and two in Ethiopia and there is one person that is in charge of them and uses them to test them and see how the vehicle can be profitable like it's he's using it as a taxi, as a truck to transport food etc. It's there for testing and to people to get to know it.

The focus is to have it in rural areas mainly. And with the car, it's like modulable. You can add any requirement that you want. That's the idea, like have a bed and transport someone that needs to go to a hospital.

Celeste Tchetgen Vogel

It's like a truck?

Celia Cuñat

Yes, it's like a truck, with different modules that we you can easily move to provide the service you want. Like if someone when I said if someone wants to have like a portable clinic, you can have a bed, you can have lights inside, batteries to have electricity or it can be for transport of water and have a tank inside to transport water. That's the idea.

Celeste Tchetgen Vogel

Ok, now I understand better, so what do I think of the product? I mean costs, this is a very price sensitive market. I was, for example at the Eurobike in Germany last year and you have amazing vehicles they just are not affordable, right? Like so the Tesla is great, it's

probably the best car in the market in terms of electric vehicles, but it doesn't make it the ideal vehicle for the African market. I love the idea of having my modular car. I love the idea of having the batteries to provide electricity while you are on it, but I'm just asking myself, is this going to be used in Africa? By whom?

Celia Cuñat

That's why it's now in prototyping. And so it's not only like individuals that use it. It is also for a company. For example eWaka, you will say this is the service I want to provide so I will pay for a fleet of I need X cars to provide this service. It's more of like an intermediate between the final customer and us.

Celeste Tchetgen Vogel

But even that I think the price matters, right? Because, I mean, unless you're like let's say selling it to a clinic or something, and then the clinic is using it, but we have for example, we are partnering with the clinic that does urgent care. And we have sold them our bikes. The scooters, the actual mopeds for the doctors and nurses to go to see patients. They need two years to pay them and this is just this is just a moped. The clinic is doing quite well, but it's just that it is a market with low purchasing power rights for the for the majority. I think that the price is an integral part of the question, but you know, as far as the product goes, I think it's fantastic. I think we need that. I am quite interested in the technology as well. We put a lot of technology in our bikes and it's going to take a while to recuperate that, but we know that in the future, this is what's going to allow the scalability.

Celia Cuñat

Thank you very much for your insights on explaining what you do. That's really helpful for us to learn more and to see what we is out there and how we can apply it. Working on things that are already there and maybe we need to do some modifications. If you had to evaluate the Canvas according to the following parameters, what score would you give from 1 to 5. 5 is the maximum.

Celeste Tchetgen Vogel

Learnability	4
Flexibility	4
Robustness	4
Efficiency	5
User Satisfaction	5

Yeah. So let me know if you ever want to come to East Africa and, you know, would be happy to talk some more.

Celia Cuñat

OK. Thank you. Bye

## Appendix B.5 FABIO

Date of the interview: 22.02.2023

Interviewee: Najjiba Katesi

Inés López

First of all thank you very much for your time and for granting me this interview. I know that you have researched about the aCar project and that you have many doubts. Hopefully we will solve them in the next few minutes. If it is ok with you, I will start by introducing the project. Then you can introduce yourself and FABIO. And finally if you answer some questions. If you agree, I will start recording the interview. My name is Ines and I work in the aCar project. It is a cooperation project between TUM, GIZ and local universities in CI and Ethiopia. The aim of the project is to address the accessibility problem in the rural areas of Africa. As you know in this case transportation is key because the scarcity of mobility means that many people do not have access to basic services. Our proposal is to design customizable electric cars. These cars can be adapted to different services such as ambulances, cabs, goods transport... For each business model the car can be equipped with the necessary features. For this we have designed a Business Model Canvas that links the car designs with the business designs. I have seen FABIO's recent milestone in launching electric bikes that can be used in different business cases. I think it is a similar model to our car. I am interested in your knowledge as a mobility expert to validate our Business Model Canvas and to see what aspects you took into account in the case of electric bikes. If it is ok with you, tell me a little about FABIO and your experience and then we can analyze the Canvas.

Najjiba Katesi

First of all, I am happy to learn about your project and to know you are working in different African contexts to test your prototype. Ethiopia is a little closer to Uganda, not too much, but a little closer. FABIO works in Uganda for 20 years now. Our objective is to help communities to access social-economic services. Initially it was more about the social aspect of helping the people in need and now with the E-bikes we are trying to make economic sense not only for the organization but also for the people that we try to serve as an NGO. We tried to test the E-bike with different use cases to see how people react and how we can make money out of it. Currently we are trying to deliver services, this can be the delivery of food to restaurants or different people. With this we target mainly young people who are using this as an opportunity to earn a living. What we discovered is that it makes sense to build more cargo related services because currently we are having issues with fuel transport that makes transport really costly. E-mobility comes then as a key answer to address this problem and then many people can go for this solution. That is one business model that has high potential also for women that sell different goods in urban or semi urban areas for higher price. In this case transport is really expensive, and as they cannot pay for it we also have to develop different payments methods. Maybe they can pay for it in a longer period of time, like 3 years, or just renting the bike. Another service that we tried to test is the E-tourism. That is also supporting us as an organization and the sustainability of the NGO. We have people that rent out this bike for a day and take them around our area. We also offer tours with our bikes and show different places. A bike tour can cost something like 20\$ per day, so from the perspective here it is quite a lot. And a rent can go for around 10 to 15\$ per day.

Then we have another case, I would not call it a business case but we are trying to test it now. It is the delivery of water in the areas who don't have access to safe water. We distribute and sell the water in places where they don't have. The money that the provider makes with this service is kept by them to make a living. Finally we also have the E-taxis. The operators are able to earn money out of transportation of people with bikes. Something that we will want to explore at some point, and that motorbikes already do it is to rent the bikes with an online tool. This could also be useful for commuting services. For example here we have tourist in hotels that what to bike to go from the bike to somewhere else. In terms of health, of course the need is there. However the people that need this can't afford our service. Woman would rather give birth at home than paying for a bike. I think in this case cars would work better, but also I think more in urban areas. What now it is more successful is the commuting services, the delivering services and the eco-tourism. Those are the main 3 areas where we receive the most success in our activities.

Inés López

Thank you so much. I think the project it is really interesting and has a lot of similarities with our project. If you want, I could share my business model and we can try together one of the use cases you explained.

We can focus on the E-taxis and complete the canvas for transport and arrival of one passenger for one taxi ride. In this case, what are the necessary resources?

Najjiba Katesi

Here we just provide the drivers of the bicycle and the electric bike.

Inés López

Ok, moving onto the logistical activities, could you answer the questions in that block?

Najjiba Katesi

Of course, so the frequency I would say is daily. The drivers transport people everyday in their bikes. Then the number of SU in a car depends on the demand. Normally I would think the maximum is around ten rides per day.

Inés López

Ok, and the location?

Najjiba Katesi

Yes, the next questions. So, the location is mainly between rural and semi-urban areas. The drivers transport the people in those areas, yes. The distance travelled it depends on the destination, but it is between 2 and 10 km. And finally, the duration it also depends on many external factors, but I would say, it can take maximum an hour, but usually is less.

Inés López

Perfect, thank you. The next block is the partners.

Najjiba Katesi

In this case the provider is the driver, right? And then we are the partners?

Inés López



Yes, I would say so. The driver is who has the contact with the customers. And what are the core competencies and capabilities of the provider, in this case the driver?

Najjiba Katesi

So the basic competencies the driver has are the ability to drive safely through the different areas. Also, they are trained with the safe practices, in order to ensure safety of the passengers. They are also local so they can communicate with the passengers and know where they must take them. This also is helpful to ensure that the customers trust them and that they will be able to transport them.

Inés López

Thank you. The next block is the customer profile. Could you describe how them?

Najjiba Katesi

So, the customers can be anyone, workers, women, children. We are the cheapest way for transport, so people who use the E-taxi services usually don't have a high income. As I have said before, we want to make transport affordable.

Inés López

So how is the interaction between the provider and the customer?

Najjiba Katesi

So, the E-taxis have a fixed place where they are parked, and the people who want to use the services go there and ask for a ride to their destination. It can also happen, in some cases, that the customer and the driver have an agreement and they can be on demand. The driver will go to where the customer wants and then that is on demand, right?

And the relationship is not very strong. Just a passenger and their taxi driver. Although in the case of having on demand, there can be some kind of relationship.

Inés López

Ok, thanks. Moving onto the cost structure and revenue streams. Could you tell me more about it?

Najjiba Katesi

Yes, so in this case there is only fixed costs, which is the cost of the bike. It is around 1000\$ for the E-bikes for transport. We assume the costs, or with finance from an NGO organization, and then we lease it to the drivers.

We measure the business success on the number of trips, the more trips, the more revenue. And also the provider provides mobility and transportation to those who need it. In case of creating a relationship, it is better for the driver because they will do more trips for one customer.

And the revenue streams come from the customer. The payment is done after the trip and is usually 2 or 3\$ per trip, I don't know exactly. As it is that amount of money and the driver is just on the bike, the customer normally pays in cash.

SO, the benefits to the customer is to be transported and arrive at their desired location.

Inés López

Thank you. We have now completed the Canvas. Could you tell me what is your opinion about the Canvas? Could you think of something important that we should add or something that should be deleted.

Najjiba Katesi

I think something interesting could be the final destination. If the customer is going to the hospital, to the market... this can help you to also identify the customer. In our case for example we identified that many customers what to transport good from agriculture to the market. So we decided to locate the parking spots next to markets. This really changes the context. Then, I don't exactly know where but I also think you should also add payment options. We are observing that now the rent is payment and there are groups of customers that start using credit cards. However there are also customers stuck in cash payments, so I think this I also important. Especially for cars.

Also, maybe if they pay by subscription, or split payments... because many customers cannot afford a full payment and therefore won't use the service. In revenue streams also the tax structure, because in Africa it is really complicated and affects directly the revenue. For example we are trying to get some tax exemptions as we are an NGO. For the other things, I like the frequency, I like the location, I like the duration. I think they are quite important specially location. Then I would also add security because I know that there are places to which you don't want to go. I think from my side that would be all.

Inés López

Yes, as a conclusion, if you had to evaluate the Canvas according to the following parameters, what score would you give from 1 to 5. 5 is the maximum.

Najjiba Katesi

Learnability	5
Flexibility	5
Robustness	4
Efficiency	5
User Satisfaction	5

Inés López

Thank you,I don't want to take more of your time as we are already over the schedule. I really want to thank you for your time, it was really helpful. I think your project is amazing and I am really interested in how it develops. If you have any questions you have my contact so feel free to write me. Thank you so much!

Najjiba Katesi

Thank you, I hope it was helpful and good luck with the project.

## Appendix B.6 E-Trails

Date of the interview: 31.03.2023

Interviewee: Ward Tanghe

Inés López

OK, so I will start with a brief introduction of the project and then we can go on to some questions and to complete the canvas that we sent you. Africa has a really low urbanisation rate, and we know that all the population is distributed along across the countryside. Furthermore, the population is really poor, as the main activity is agriculture, so there is a really low demand of all kinds of products and services. At the same time, supply locations are really few because of the cost of installing all the infrastructure needed to supply it. Our solution to this problem is to operate a fleet of vehicles providing basic needs. We built an online tool that allows stationary businesses to design and operate electric vehicles capable to render SDG-relevant services to remote customers. Ines and I, we have created a VbS canvas based on the Business Model Canvas to serve as a communication tool between the business and the engineering design requirements. The aim of this interview is to collect your expert insights on our tool and on the project. To get to know you better and what you do, could you present yourself and briefly talk about what you do?

Ward Tanghe

Well, project is not much, my wife is Kenyan. I've always been playing around with electric bicycles, basically, like long before. I have a rental and now I also sell electric bicycles. So I do think I have like a lot of valuable knowledge, but at the same time. I don't know if I'm going to continue with it because like you don't like build out a startup when you're with one leg in another country. So yeah, we'll see. I'll just keep it small scale and my guess is that many of the startups are going to die. Anyway, because they have a lot of money and very few ideas like the biggest right now in the markets is just like trial and error. That's EB. I don't know if you know, EB, Kenya. They're really big. They have a lot of money. But they don't have a clue what they're doing. Because of all the mistakes they made, you get like, there's so many things they could have, avoided. Much of what happens in Africa around electric mobility depends entirely on someone, somewhere in Europe deciding whether or not it's a good idea.

The one serious one in Kenya would be Rome. But even Rome has like some. Very heavy funding and then you always come to the point of where you question like, like immobility can be made sustainable, like it is a cost effective alternative in many cases. But unfortunately if a project is heavily funded with donations. Sustainability no longer becomes an issue, so Rome, for example, does a really good thing, but they just give an extra battery for free to every rider you get. So basically, no, it's it's different. I once made a cost calculation wholesale price of the two batteries they give with every motorcycle. The wholesale price of 1 battery was more or less the price that they were selling the whole package for. So motorcycle +2 batteries. So then you also won. And like. What's the sustainability of this? And I think that's exactly what we want to avoid because we of course a business model that is feasible in Europe is not feasible in Africa, so that's why we want to adapt it .

Inés López

And now, a bit about the canvas we sent to you, and you have already seen how a service unit can be applied to the canvas. We decided on a service unit that can be really understandable and easy to apply. For Example in the case of E-Trails, the service unit would be the rent of a bike, right?

Ward Tanghe

I have gone through the canvas already and I've seen the example of that from Ivory Coast, yeah. I made a few remarks. Let me see. It's OK, I've seen it. I feel it is here and there. It's like and when it comes to sustainability. And also, maybe the opportunity cost is missing.

Inés López

Ok, so you think some things should be added. What particularly are you referring to?

Ward Tanghe

So maybe the first thing is what you would call opportunity cost. What I mean is there is always an alternative. So it's very important in any model to see what the alternatives are because even the most remote area in Kenya or Ethiopia, it is going have alternatives. Maybe if you have a good business model, let's say a mobile ambulance, the same ambulance service might be funded by another donor or by the Ethiopian or Kenyan government. We need to go for the cheapest or the almost cheapest. Like if your price difference is twice as much there's nobody who's going to continue it, whatever you're doing. Then there's when you look at sustainability like more in general maybe you need to consider what is going to happen in 5 or 10 years from now I would try to integrate that element of durability? For example, what about spare parts like?

Inés López

OK. Yeah. I see. So you are referring to competitor analysis and maybe to a long term strategy?

Ward Tanghe

The thing is, durability is really bad in general. When you remove the funding, the whole framework falls apart. Nobody thinks about the long-term consequences, like in 10 to 15 years. And we're creating piles of e-waste. The immobility sector does more harm than good, creating garbage everywhere. For example, someone imported containers of jump bikes with batteries that were almost finished, and now we have hundreds of useless bikes all over Nairobi. Your model seems to target institutional customers only, but I've never seen a business model that survived on them alone. It's important to consider what happens beyond funding. I've worked in NGOs for 15 years, and anything can be accomplished with a lot of money. But the big question is, what do you do afterwards?

I've seen NGOs pay farmers to work in their own gardens, and it works as long as they're paid. But once the money is gone, the garden becomes a jungle. You do more harm than good in the long run. I've always been concerned with sustainability. You need to look at alternatives and feasibility. Even if you have a great model, someone else might be able to do the same thing for half the price. The Chinese and Indians have models that work in settings similar to ours, but in Europe, we focus too much on customization instead of profitability.

Inés López

Is there anything else we should consider?

Ward Tanghe

The two most important aspects are sustainability and feasibility. You need to consider the long-term consequences and the environment you're operating in. Even if something is subsidized, there's still competition and the subsidy might disappear eventually.

Inés López

What is your overall impression of the Canvas apart from those aspects?

Ward Tanghe

Well, it is easy to understand that is for sure. My concern is, it misses some essential parts. I good add an analysis of the environment as I mentioned before, that for sure. So, you know how sometimes there are factors outside of your control that can affect your situation? Like the environment you're in or the circumstances you're dealing with? Well, when you're talking about long-term plans or the costs of missed opportunities, that's what you mean. It's like the world around you, and in business, it's a big deal.

You gotta make sure everything is working together and that you're not ignoring what other companies are doing. Even if you're getting help from the government or something, there's still competition to think about. The point is, you can't just focus on your own thing and pretend like nothing else matters.

Inés López

You're totally right. It's always difficult to have the balance the theoretical background with the operational practicability. It also needs to have some research and science in addition to the practicability. But thank you so much, your inputs were really interesting. Could you apply this framework to your startup? What do you think?

Ward Tanghe

I'm still trying to figure things out here. I've got this awesome business model that I think could work really well, but I'm not sure if it makes sense to go all out on it. My bikes are way better than anything else out there, and they're also cheaper and more durable. Of course, I'm not making a ton of money from it right now, just enough to have some fun and keep improving. That's because I'm using my own money, which is something that most big institutions can't do since they're on a tight schedule. But anyways, my model involves converting regular bikes into electric ones, which is something that's really taken off in Europe. The cool thing is that it's also super sustainable since we don't have to make new custom frames and batteries like other e-bike companies do. So yeah, that's what I'm up to these days.

So basically, we gotta adapt to the situation here and not just blindly copy European ideas. I don't know if you're into engineering or not, but in Europe, they're all about mid drive motors for ebikes. They're all about that cycling experience, you know? It's like an extension of your pedals, so people love it. But in Africa, nobody cares about that. And the mid drive is a lot harder to fix. When I first started with E bikes, I was all about mid drives, thinking they were the best, but that's just a European thing. After a year or two, you start having little issues with the mid drive and you realize how tough it is to fix.

Inés López

Yes, as a conclusion, if you had to evaluate the Canvas according to the following parameters, what score would you give from 1 to 5. 5 is the maximum.

Ward Tanghe

OK. Thank you too for calling me. I'll send you a few names of immobility startups in Kenya.

Learnability	5
Flexibility	4
Robustness	3
Efficiency	3
User Satisfaction	3

## Appendix B.7 OAN

Date of the interview: 17.03.2023

Interviewee: Daniel Alfaro

Inés López

I will start with a brief introduction of the project and then we can go on to some questions and to complete the canvas that we sent you. Africa has a really low urbanisation rate, and we know that all the population is distributed along across the countryside. Furthermore, the population is really poor, as the main activity is agriculture, so there is a really low demand of all kinds of products and services.

At the same time, supply locations are really few because of the cost of installing all the infrastructure needed to supply it. Our solution to this problem is to operate a fleet of vehicles providing basic needs. We built an online tool that allows stationary businesses to design and operate electric vehicles capable to render SDG-relevant services to remote customers. Ines and I, we have created a VbS canvas based on the Business Model Canvas to serve as a communication tool between the business and the engineering design requirements. The aim of this interview is to collect your expert insights on our tool and on the project. To get to know you better and what you do, could you present yourself and briefly talk about what you do?

Daniel Alfaro

I'm Daniel Alfaro, and I'm the President of the International NGO that was founded back in 2014. Our goal is to create a new model for International Development Cooperation that's based on social entrepreneurship. Since we started, we've launched a bunch of ventures such as seed stores, solar panel stores, and general merchandise stores in Nikki, Benin. The main objective is to prove that development cooperation can be more sustainable if it includes profit-generating activities and economic models.

Although we also take on traditional cooperation projects like constructing water pumps and building toilets, we always try to ensure that every project has a business model at its core. One of the coolest projects we've got going is Nikarit, which is a cosmetic group that sells shea butter and other cosmetic products made by women from Niki's rural villages. These women work to meet the high-quality standards required for export to Europe. It's really rewarding to see how much they've accomplished, even without going to college or having access to a lot of resources. The best part of the project is that when we purchase the products from these women, we empower their cooperatives economically. All the profits are reinvested into the business, which makes it an excellent example of development. This model benefits all parts of the chain, from the women in the rural villages to the consumers who purchase the products. We're also striving to become a plastic-free company, and although we're not there yet, we're making progress by using only vegan, certified, natural, and organic ingredients in all aspects of our production. It's a project that's really important to us, and we're committed to getting it right. If you have any questions, don't hesitate to ask.

Inés López

Okay. Great and then, for example, on the shea projects, the income that these women receive is based on what they sell. Or it's like a fixed salary?

Daniel Alfaro

No, it is not, it is based on what they sell. We have agreed with them on a payment methodology, financing so that it is more beneficial to them at the time of harvesting the nuts. We buy the nuts from them, they store them. This helps them to have the financing to make and finish the field, because they can make the transformation of the mackerel, so let's say that they have income in several stages of the production. When the tools and machines break. They also ask us for pre-financing. It's a bit of a strange supplier-customer relationship, because we try to support them in whatever they need. So we are very flexible and the objective is to dignify the work a little bit.

Inés López

Now we can try to fill it with the service you mentioned.

Daniel Alfaro

So for my understanding, Are you building a model? In other words, a canvas, to be able to understand your business model, right? And you have structured this canvas in this way.

Inés López

Yes, exactly.

Daniel Alfaro

Because your business has different characteristics. On the one hand, if you have decided to put logistical resources, is it how your product is consumed, logistical activities? The Service Unit thing is not really clear to me, but I guess it is for what you are basically going to get paid. Regarding the development model, it is important to consider the context in which it will be implemented. In West Africa, the population is highly entrepreneurial, 90% of the people I have met having set up businesses on a small, medium, or large scale. They are used to receiving loans and managing financing, which is positive in the sense that they control the process. However, they rarely receive support for women and there is little assistance from banking structures, whether in the form of loans, microfinance, or vouchers. While setting up a model in Ivory Coast would require local partners, it is not necessary for it to be a hub. Financing is easily available through the European Union, which has programs for developing countries. Spain, Germany, and France are some of the countries that participate in development plans in Ivory Coast, with a focus on water and energy. This kind of funding is available to NGOs as well as private sector companies. In Ivory Coast, people are used to using mobile phones for payments, the options available are Orange Money and Wave. While these are American companies, they are popular in Ivory Coast.

Inés López

And do you have examples in OAN where you use mobile services, and a car would be necessary?

Daniel Alfaro

Yes, here we use it to transport shea butter. We also use it for transport people to the villages. Are we can also use it to transport bicycle pumps. Well, as a method of transportation, I don't know if it's for merchandise or raw material, but those are models that would work for



you. Our cars have no special configuration, The need is to put as many things as possible in the car and man times it exceeds the weight limits.

Inés López

What is the route you normally do?

Daniel Alfaro

From rural villages to city, Nikki. The roads are usually very bad.

Inés López

Do you sell it in the capital to cooperatives or who is your customer?

Daniel Alfaro

We sell it to cosmetics produces and we export to Europe.

Inés López

And who drives the car for the nuts transport?

Daniel Alfaro

We have a logistics manager who helps us with all this dynamic, the first step, the journey of the villages.

Inés López

And what is the distance you must travel?

Daniel Alfaro

Less than 30 km mostly, it is done in 1h30 more or less.

Inés López

How many times are the nuts collected?

Daniel Alfaro

The production takes place once a year and each village and cooperative produces it at different times. Multiple trips are necessary to collect the batches from the 5 cooperatives, typically requiring 10 trips per year. The collected goods are transported to Nikki for processing.

Inés López

Yes, as a conclusion, if you had to evaluate the Canvas according to the following parameters, what score would you give from 1 to 5. 5 is the maximum.

Daniel Alfaro

Thank you so much and if you have more questions don't hesitate to contact me.

Learnability	5
Flexibility	4
Robustness	5

Efficiency	4
User Satisfaction	4

## **Appendix C: Cluster Classification**

The following section represents the classification of the SUs according to the cluster categories (Table B. 1).

Table B. 1: SU Cluster classification.

SU	Type of service	Additional Staff	Refrigerated good	Medical equipment	Other equipment	Consumable product	Service duration	Frequency
Transport and performance of a post-partum check-up	Treatment	Doctor		yes			30	1
Transport and attendance to a woman during labor	Treatment	Doctor and nurse		yes			180	1
Transport and performance of an abortion intervention	Treatment	Doctor and nurse		yes			60	1
Transport and attendance to a woman during pregnancy	Treatment	Doctor		yes			30	4
Transport and performance of a post-natal check-up	Treatment	Doctor		yes			20	1
Transport and performance of a pediatric check-up	Treatment	Doctor		yes			20	1
Transport and administration of a newborn vaccine	Treatment	Nurse	yes	yes		vaccine	15	1
Transport and delivery of 1 insecticide-treated bed net	Delivery					insecticide-treated bed net	5	1
Transport and delivery of an antiretroviral medicine	Delivery	Nurse				antiretroviral medicine	5	1
Transport and performance of 1 Hepatitis B test	Treatment	Nurse	yes	yes			15	1
Transport and delivery of 1 box of antibiotics	Delivery	Nurse				antibiotics	5	1
Transport and performance of 1 rapid diagnostic test for malaria	Treatment	Nurse		yes		rapid diagnostic test	20	1
Transport and delivery of 1 box of antimalaria treatment	Delivery	Nurse		yes		antimalaria medicine	5	1
Transport and performance of a cardiologic consultation	Treatment	Doctor		yes			30	1

## Appendix

SU	Type of service	Additional Staff	Refrigerated good	Medical equipment	Other equipment	Consumable product	Service duration	Frequency
Transport and performance of an oncologic consultation	Treatment	Doctor		yes			30	1
Transport and performance of a pulmonological consultation	Treatment	Doctor		yes			30	1
Transport and delivery of 1 box of 10 kg of basic food and hygiene products	Delivery					box of basic food and hygiene products	5	1
Transport and performance of an informative talk on drug and alcohol abuse	Treatment	Counsellor					60	1
Transport and attendance of a therapist	Treatment	Doctor					60	1
Transport and attendance of a counsellor	Treatment	Counsellor					60	1
Transport and performance of an informative talk on safe driving practices	Treatment	Counsellor					60	1
Transport and delivery of 1 bicycle helmet	Delivery					bicycle helmet	5	1
Transport and delivery of 1 motorcycle helmet	Delivery					motorcycle helmet	5	1
Transport and delivery of 1 seatbelt	Delivery					seatbelt	5	1
Transport and performance of 1 consultation with a family planning specialist	Treatment	Counsellor					30	1
Transport and insertion of 1 IUD	Treatment	Doctor and nurse		yes		IUD	60	1
Transport and delivery of 1 box of condoms for women	Delivery					box of condoms	5	1

## Appendix

SU	Type of service	Additional Staff	Refrigerated good	Medical equipment	Other equipment	Consumable product	Service duration	Frequency
Transport and delivery of 1 box of condoms for men	Delivery					box of condoms	5	1
Transport and performance of an obstetrician consultation	Treatment	Doctor		yes			30	1
Transport and delivery of 1 box of birth control pills	Delivery					birth control pills	5	1
Transport and supply of 1l of water	Delivery				yes	water	5	1
Transport and delivery of 1 water tank	Delivery					water tank	15	1
Collection and disposal of 1l wastewater	Delivery				yes	waste water	5	1
Transport and performance of an informative talk on tobacco use	Treatment	Counsellor					60	1
Transport and delivery of 1 box of nicotine patches	Delivery					box of nicotine patches	5	1
Transport and administration of 1 DPT vaccine	Treatment	Nurse	yes	yes		DPT vaccine	15	3
Transport and administration of 1 HPV vaccine	Treatment	Nurse	yes	yes		HPV vaccine	15	2
Transport and administration of 1 BCG vaccine	Treatment	Nurse	yes	yes		BCG vaccine	15	1
Transport and administration of 1 Rotavirus vaccine	Treatment	Nurse	yes	yes		Rotavirus vaccine	15	3
Transport and administration of 1 hepatitis B vaccine	Treatment	Nurse	yes	yes		hepatitis B vaccine	15	3
Transport and administration of 1 Polio vaccine	Treatment	Nurse	yes	yes		Polio vaccine	15	3
Transport and administration of 1 Measles vaccine	Treatment	Nurse	yes	yes		Measles vaccine	15	2
Transport and administration of 1 Cholera vaccine	Treatment	Nurse	yes	yes		Cholera vaccine	15	1

## Appendix

SU	Type of service	Additional Staff	Refrigerated good	Medical equipment	Other equipment	Consumable product	Service duration	Frequency
Transport and supply of 1 box of medicines	Delivery	Nurse				box of medicines	5	1
Transport and performance of a dental check-up	Treatment	Doctor		yes			30	1
Transport and attendance of a primary care doctor	Treatment	Doctor		yes			30	1
Transport and extraction of 1 sample of blood	Treatment	Nurse	yes	yes			15	1
Transport and performance of a training on health emergency	Treatment	Counsellor					60	1
Transport and supply of 1 medical PPE kit	Delivery					medical PPE kit	5	1
Transport and arrival of 1 person	Delivery				seat	person	60	1