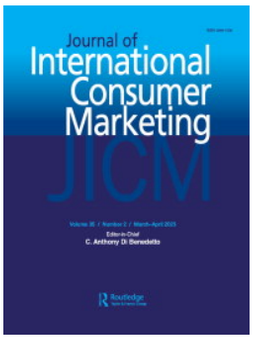

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Innovative New Product Adoption of Renewable Energy Mobility Products at the Bottom of the Pyramid The Case of *Hamba, an Integrated Community-Driven Solution*

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ABSTRACT
Current decision-making models do not cover the processes bottom of the pyramid consumers go through when selecting mobility solutions to address access challenges they face. We investigate the process these consumers go through in their complex context in adopting a community-based renewable energy mobility solution and developing a decision-making framework. Findings indicate the positive social, environmental, and economic impact of the mobility initiative on the livelihoods of the BOP consumers. The findings offer critical theoretical contributions specifically for decision making for the adoption of renewable energy-based mobility solutions for marginalized BOP consumers and social connectedness literature.

KEYWORDS
Bottom of pyramid; Covid; decision-making; mobility; renewable energy

Introduction

Extant studies in marketing and consumer behavior on how consumers make decisions on transportation and mobility-related products are predominantly focused on higher-income groups' use of services such as ride-sharing (Möhlmann 2015). Studies on consumers' decision-making process in marginalized and impoverished contexts, often referred to as the bottom of the pyramid (BOP), are still rare compared to studies on higher-income groups. Yet mobility is central to the livelihood decisions that these BOP consumers must make daily for routine and non-routine tasks, impacting their economic and social lives (Frey et al. 2021; Muthuri and Farhoud 2020). There is no prescriptive academic definition of the BOP. However, it defines people in the lowest bends on the socioeconomic ladder of a country, region, or society and lives on less than $2.50 a day (Dembek, Sivasubramaniam, and Chmielewski 2019; Muthuri and Farhoud 2020). Various iterations have evolved that classify the BOP ranging from $1 to $2.50, and the segment is predominantly in Asia, Africa, Eastern Europe, Latin America, and the Caribbean (de Brauw and Giles 2018; Prahalad 2005; Prahalad and Hart 2002; Yurdakul, Atik, and Dholakia2017). The attraction of this global segment of more than 2.7 billion consumers is in the collective market size of this segment, but marketers require a different mindset and approach to serve this market (Faria and Hemais 2017; London and Hart 2004; Prahalad 2012 Simanis and Duke 2014; Simanis and Hart 2009). The BOP in Africa is present in rural areas and urban areas, although the rural group is the majority (de Brauw and Giles 2018; Hammond et al. 2007).

The BOP is the dominant consumer group in Sub-Saharan Africa, with an estimated US$215 billion market potential covering various products (Euromonitor 2019; Hammond et al. 2007; Muthuri and Farhoud 2020). However, there are limited studies on understanding the complexities and nuances of decision making in crucial livelihood areas such as transport and mobility in Africa of the BOP. Ernst et al. noted this gap and highlighted the lack of studies on affordable

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

value innovations in emerging markets of which BOP segments are vital components. The BOP's environment in Africa is characterized by severe constraints and a permanent state of crisis caused by natural and policy-induced external shocks such as financial crises, poor strategies for coping with shocks, high macroeconomic volatility and poor (Chikweche and Shindi 2021; Euromonitor 2019; Viswanathan, Sridharan, and Ritchie 2008). These constraints affect the BOP in their lives, such as agriculture, nutrition, education, and healthcare (Muthuri and Farhoud 2020).

Mobility assumes a significant role in the BOP'S Day to day livelihoods, considering the context of these constraints. The lack of affordable, accessible, and sustainable transport for the BOP in Africa is an enormous barrier to access to social services, stunts economic growth, and reinforces social isolation and gender inequality (Chikweche and Shindi 2021; Bloemen 2019; Porter 2016; USAID 2021; World Bicycle Relief 2019a). Hence, the need and demand for affordable value innovations in transportation are emerging as potential game-changers and catalysts for better livelihoods for the BOP. The BOP in Africa must decide how to mitigate the impact of these constraints because of the overarching impact they have on their lives. For example, long distances to health facilities contribute to maternal and child mortality.

Long walks to school force children to drop out, crops rot before they get to local markets, hours are wasted collecting water, and new economic opportunities are missed (Bloemen 2019). These challenges are established. Nevertheless, there has been limited research on initiatives that have been undertaken by non-state actors to specifically address this transport and mobility gap using affordable value innovations. This is a gap addressed in this paper—the paper reports on a successful innovative renewable energy-based mobility project in rural Zimbabwe. The project is a one-stop platform that serves multiple purposes for disadvantaged BOP women. The community-based project includes social services providers such as healthcare and law enforcement. With the advent of the revolution in renewable energy and enormous global investment in electric transport, there is no reason that the world's poorest people should be bypassed in considering the use of alternative renewable energy-driven mobility options (Bloemen 2019; IEA 2019b).) . The paper aims to critically review the implementation of an innovative renewable mobility solution to understand the complex decision-making process the BOP consumers go through in adopting the innovation. The paper outlines the resultant positive social, environmental, and economic impact of the mobility initiative on the livelihoods of the BOP consumers. The paper provides empirical evidence on the decision-making complexities and nuances that BOP consumers go through when adopting affordable value innovations in routine and no-routine activities of their livelihoods, which is not covered in extant studies. This research gap is supported by Ernst, who argue that current studies are only focused on Western markets, predominantly in Europe and North America.

The emerging problem

The BOP in Africa is primarily rural, suffers from a lack of infrastructure, and faces considerable challenges in terms of mobility (Bloemen 2019; Frey et al. 2021). These mobility challenges have a gendered component since the lack of mobility disproportionately affects the ability of rural women to earn economic parity. This could be due to the limited amount of time they have, they must spend traveling to fetch water and cooking fuel, and the concerns they have for going great distances to attend out of home occupations or schooling (Baker 2020; United Nations 2021).

Many imported motorcycles predominantly mediate rural Africa's BOP transportation with limited durability and secondhand cars and buses (Baker 2019; Frey et al. 2021). Most countries in Africa rely on a mix of fossil fuel-dependent and often-privatised transport options (McKinsey & Company 2019). The use of these vehicles, while providing a simple solution to rural BOP Africa's mobility issues, also creates its problems. Motorcycle usage is gendered, and women often do not feel comfortable driving them using them as hired transport (Adom-Asamoah, Amoako, and Adarkwa

2020). Diesel and petrol-fuelled transportation contribute to air pollution and fail to further the decarbonization of the economy. In addition, almost all fuel in Africa is imported, with little value-addition taking place in Sub Saharan Africa countries (IEA 2019a, Newell, Raimi, and Aldana2019). Importing fuel thus reduces the foreign currency reserves of those whose economies are already susceptible to international commodities prices. On average, households in rural and urban areas spend at least ten per cent of their income on transport (USAID 2021). Mobility is a vital part of the United Nations Sustainable Development Goals since it is critical to economic and social development, which are crucial challenges at the BOP (United Nations 2021).

Solution: Solar powered electric all purpose Hamba tricycle

Mobility for Africa (MFA), a startup registered in Zimbabwe, has developed and introduced powerful, three-wheeler renewable energy charged electric tricycles categorized as electric vehicles (EV). The tricycle is called Hamba (Hamba translates to move or go in the local Shona dialect). A Community based mobility programme targeting rural female BOP consumers and institutional social services providers in Zimbabwe has been developed using the Hamba. Participants use the programme to mitigate their mobility challenges in routine and non-routine daily activities and economic entrepreneurial ventures (MFA 2021). Figure 1 illustrates the Hamba tricycle and the solar charging grid.

The tricycle is an avenue for the BOP communities to overcome their mobility challenges and contribute to dynamic local economies. Powered through community based off-grid energy supply, the e-tricycles provide the incentive for increased economic activity, creating new local markets, and enhancing rural livelihoods. The overarching goals of the programme to introduce the electric tricycle are:

1. To understand the complex decision making that rural female BOP go through in considering the adoption of alternative renewable energy mobility.
2. Unlock demand for EVs to replace fossil-fuel based transport by de-risking the rural African market for deploying these vehicles, expressly by developing community-based use cases for mobility [Community Mobility Program]
3. Unlock demand for rural energy access, and further the deployment of other productive uses of energy

The tricycle was designed in collaboration with university partners in China, where wholly knocked down kits are manufactured and then shipped to Zimbabwe, assembled by a team of mechanics whom the Chinese manufacturers trained. This was part of an open innovation ecosystem that included working with other partners on supporting issues—for example, developing a long-lasting battery suitable for the terrain. The local team also assembles and maintains the solar charging stations for the Hamba.

The electric tricycle programme provides a unique opportunity for marketers to understand the complexities and nuances that the BOP consumers go through in their decision-making process of adopting alternative renewable solutions.

Literature review

There is limited existing research on adopting affordable value innovations specifically targeting BOP consumers that focus on livelihood challenges such as transportation. There are limited studies that focus on broad emerging markets innovation adoption but do not necessarily contextualize this to the BOP (Dubiel and Ernst 2013; Lee et al. 2011; George, McGahan, and Prabhu 2012; Nakata and Weidner 2012; Prahalad 2012; Sheth 2011; Viswanathan and Sridharan 2012). Other extant studies have advocated expanding research on innovation practices that develop and test new context-specific theories (Kolk, Rivera-Santos, and Rufín 2013; Nakata 2012; Nakata and Di Benedetto 2012; Sheth 2011; Viswanathan and Sridharan 2012). Research on affordable value innovations at the BOP is an example of expanding such research. New research should propose new conceptual frameworks with

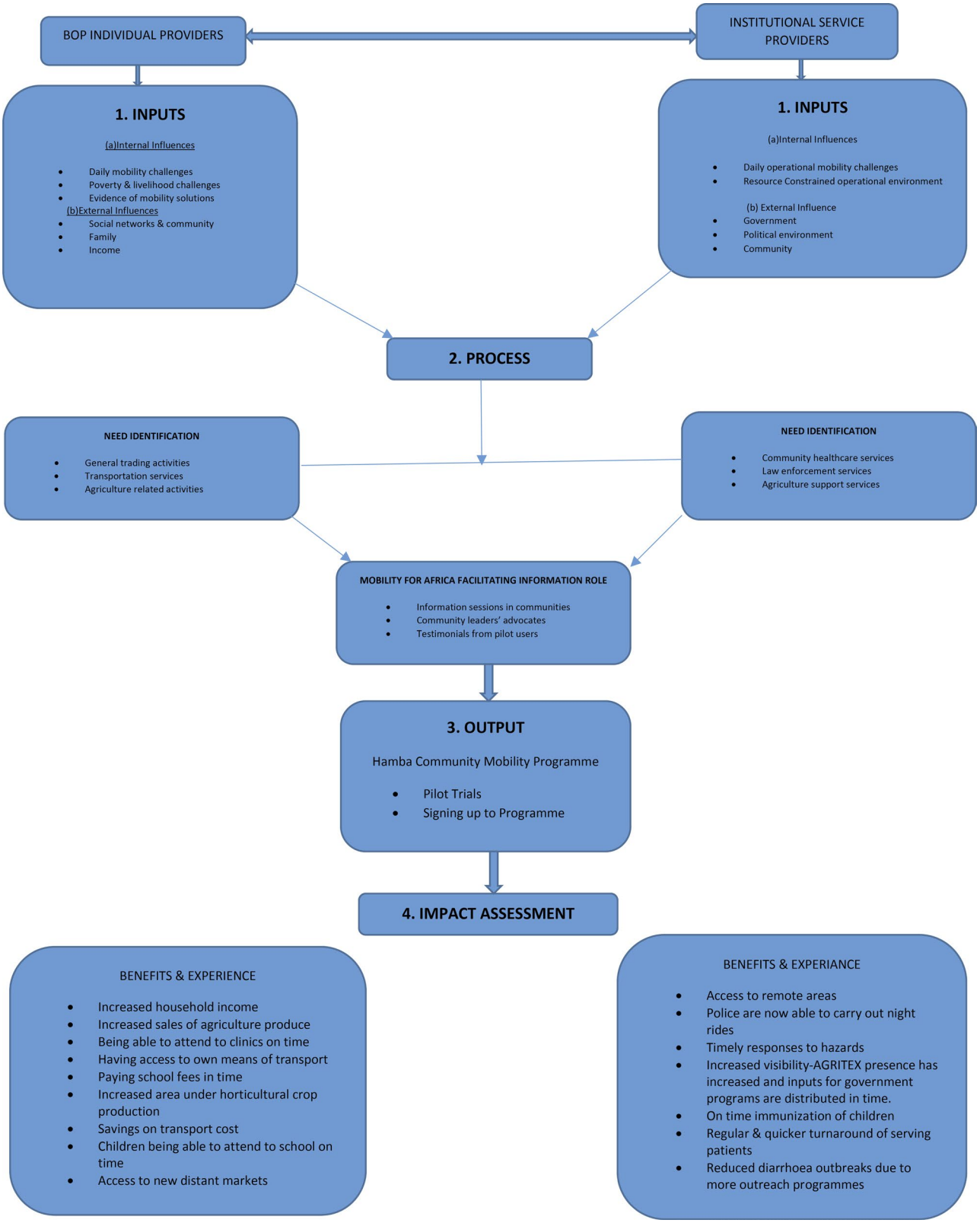

Figure 1. The Hamba tricycle and solar charging grid.

local relevance but the potential for replication across BOP markets.

Our paper addresses this gap by explicitly focusing on adopting an affordable renewable energy transport solution at the BOP, investigating the complexities and nuances of the BOP consumers' decision-making process. These extant studies have some key insights relevant to studying the adoption of value innovations at the BOP. For example, the studies reinforce the need to develop affordable, innovative new products that offer the BOP customers value and enhance their livelihoods.

The importance of local embeddedness

A critical gap in extant studies on innovation in emerging markets identified by Ernst is the lack of connection and relevance to local nuances and complexities. Considering the established contextual constraints typical at the BOP in Africa, effective innovation practices will need a deep understanding and appreciation of the local context. This should be integrated into any new product development initiatives involving multiple partners such as the BOP communities, local non-governmental organizations and firms (Anderson, Markides, and Kup; Ansari, Munir, and Gregg 2012). This is a crucial focus of our paper: a collaboration of multiple partners, with the BOP communities being the central focus of the process.

The importance of bricolage

The resource-constrained environment common at the BOP presents a unique opportunity for affordable value innovations to be influenced by bricolage. Bricolage enables innovators to creatively utilize scarce resources to develop locally embedded affordable products George, McGahan, and Prabhu 2012; Senyard et al. 2014). The challenge for innovators at the BOP is bound to be centered on navigating the various resource and environment constraints and the demand for affordable value innovations that can affect livelihoods (Prahalad 2012). By utilizing bricolage, innovators will be better positioned to reduce costs of new product development and delivery of value using alternative, unconventional but creative solutions. This approach is relevant to our study since the innovative renewable transport innovation is unconventional but effective in addressing various livelihood challenges the BOP faces.

Mobility and transportation challenges in Africa

African economies have a severe scarcity of resources and poor infrastructure. Their BOP consumers typically rely on and are active in the informal economy and look for affordable value innovations to help them mitigate the constrained environment (Halme et al. 2012; Mair, Marti, and Ventresca 2012; Prahalad 2012; Sheth 2011; Williamson2010). The infrastructure constraints outlined by Muthuri and Farhoud (2020) and Euromonitor (2019) reinforce the importance of accessible and affordable mobility options for the BOP to conduct their routine and non-routine activities, which influence their livelihood. The cost of fossil fuel and cars remains out of reach for most BOP and therefore is not a sustainable solution to the mobility challenges (Porter 2016; Bloemen 2019). On average, households in rural and urban areas spend at least ten per cent of their income on transport (Frey et al. 2021). In many parts of rural Africa, neither regular energy supplies nor petrol is available (USAID 2021).

Most transport is expensive, often unreliable and does not reach many rural off-road areas. The growing availability of low-cost renewable energy and the vast investment in battery technology to drive vehicles means there is potential to transform rural areas (Bloemen 2019; Porter 2014). Like with the advent of digital technology, Africa can leapfrog its development to benefit from these new technological opportunities (Bloemen 2019). Extant studies on alternative mobility options for the rural BOP have primarily focused on using traditional bicycles to enhance access to education, health, and entrepreneurial activities (Porter 2014; World Bicycle Relief 2019a, 2019b). Motorbikes are also an alternative but are mostly out of reach for the BOP both in terms of cost of buying and maintenance. However, challenges such as inefficiencies and wear and tear due to poor roads have rendered

such interventions less impactful, thereby creating opportunities for other opportunities that go beyond the primary bicycle mode. Frey et al. (2021) moderate the benefits of traditional bicycles as mobility solutions at the BOP by outlining some key challenges for a sustainable reliance on bicycles. These include "cost, lack of access to credit, high transportation costs, high tariffs and taxes, government regulations, social and gender norms, safety concerns, the design of bicycles, difficult terrain, availability and affordability of spare parts and aftermarket service, and organizational capacity, among others" (Frey et al. 2021, 8).

Improved gender norms

Extant studies in BOP markets in Asia indicate that the use of enhanced access to bicycles improved gender norms in the community and led to female empowerment, although this might assume a different perspective in Africa, where traditional bike use is still gendered (Fiala et al. 2018; Muralidharan and Prakash 2017). Women in Indonesia and Thailand often use bicycles to participate in productive income-generating activities, although they reported practical limitations of using a traditional bicycle. A study in Indonesia noted that women also used bicycles for social tasks such as shopping, recreation, and visiting family and friends (Song, Kirschen, and Taylor 2019).

Mobility and access to education

Increased use of basic bicycles in rural areas effectively enhances access to education for the girl child, reducing travel time when using bicycles (Fiala et al. 2018; Muralidharan and Prakash 2017; Räber 2014). These studies focus on Asia and require expansion into Africa. The impact of bicycles also requires further investigation considering the potential use for recreation instead of going to school. Extant studies indicate that impact of bicycles programmes is more evident when it is part of a broader targeted inclusive community programme. This ensures that recreational activities do not substitute for the educational usage of bicycles (Amoako-Sakyi and Owusu 2012). However, there are challenges to the sustainability of the use of bicycles, considering the poor road network in the rural areas in Africa.

Mobility and income generation

There are various studies documenting the impact of bicycles in facilitating income-generating projects and agriculture activities at the BOP (Frey et al. 2021; Shirazi 2020). In agriculture, studies indicate that more than half of the untapped potential for cultivation in sub-Saharan Africa is located more than six hours from a significant market. Less than 40 per cent of rural Africans live within 2 kilometers of an all-season road—by far the lowest level of rural accessibility in the developing world (USAID 2021). Bicycles have played a key role in enhancing access to agricultural markets, but the wear and tear and resultant replacement cost of bikes have made this an unsustainable option at the BOP (Frey et al. 2021; Peter 2015).

Consumer behaviour and decision-making process

Models of consumer behavior establish how and why consumers behave in a particular way (Schiffman and Kanuk 2014). The basic traditional buyer behavior model is a systems model. This analyses human behavior as a system of inputs that stimulates a response (Lazer 1962). This, in turn, results in a set of outputs that make up the behavior (Lazer 1962). This model is built around psychologists' black box models. This explains human behavior from an input and output perspective (Engel, Kollat, and Blackwell 1973). Various scholars expanded the original basic systems model to illustrate the relationships between inputs and outputs (Macinnis and Folkes 2010; Schiffman and Kanuk 2014; Howard and Sheth 1969; Nicosia 1966). Decision-making theory studies transcend various disciplines, primarily economics and psychology, led by pioneers such as Sigmund Freud (1856–1939). Freud's work on consumer motivations and the influence of symbolism on decision-making has contributed to the extant literature on decision-making theory (Mittal and Sheth 2004). A critical gap between the existing

and modified models is their lack of understanding of the nuances and complexities of buyer behavior and decision making at the BOP. These models focus on high-income segments in developed markets. This is further complicated when considering decision making at the BOP related to transportation and mobility.

The emergence of potential renewable energy-driven mobility options in the electric vehicle category, such as MFA's solar-powered tricycle, presents marketers to investigate the complexities of the decision-making process BOP consumers are likely to go through when considering these options. There are no extant studies that focus on this process, which is a crucial gap this paper addresses. Extant studies on purchase decision making and the factors that influence the process at the BOP have been covered in consumer behavior studies and international marketing (Blocker et al. 2013; Chikweche, Stanton, and Fletcher 2012; Kolk and Lenfant 2015; Mathur, Mehta, and Swami 2020). Choudhury, Mukherjee, and Datta (2019)'s study outlines a framework for the decision-making process that BOP consumers go through, identifying vulnerability as a moderating variable and indicating how BoP consumers resort to bounded rationality to cope with their cognitive misery resource leanness and lack of literacy' (178). The study's focus on the micro or individual consumer differs from family decision making frameworks such as Chikweche, Stanton, and Fletcher (2012), thereby expanding the scope of understanding. However, there are still some gaps in exploring the decision making of transport mobility-related consumption at the BOP.

Social comparison theory

Social comparison is the practice of comparing themselves within their ecosystem or with people above them in economic status (Ames and Iyengar 2005). At the BOP, the social comparison assumes an essential role because social networks influence BOP consumers' behavior. For example, they compare themselves to their peers. Social networks are a key influencer in BOP consumers' decision-making by influencing group decision making and sharing information (Chakravarti 2006; Chikweche and Fletcher 2014). Community opinion leaders act as key reference sources on the direction BOP communities take in engaging with external factors such as firms (O'Malley and Prothero 2007; Hamilton 2009; Shubin 2007). They form a basis for how citizens relate to each other and the environment outside their communities (Chikweche and Fletcher 2012). Trust, creation, and retention of long-term relationships are key pillars of the social fabric of communities in BOP markets (Kirchgeog and Winn 2006). BOP consumers participate in various formal and informal social networks that cover different aspects of BOP consumers' social and business life (Michailova and Worm 2003).

The extant studies reviewed provide insights on decision making from the perspective of buyer-seller relationships in diverse retailer forms, which do not capture the decision making process BOP consumers go through in making choices for transport and mobility solutions. This is a gap that this paper addresses by identifying the factors that frame the decision making process the BOP go through in the adoption of community mobility programmes that utilize renewable energy, such as the Hamba.

Methodology

In-depth qualitative interviews were conducted to collect data from BOP consumers and social services providers in the Wedza rural area in Zimbabwe. This was complemented by ethnographic studies completed this process by the researchers spending time living in the community to gain a real-world experience of the livid challenges and experiences these consumers and service providers face regarding mobility. Quantitative data was collected to support site selection. The researchers spent more than six weeks at the site to develop a pilot run for the project. Five hundred applications were received, from which 124 participants were selected and were active in various activities. These are detailed in the participant profile section. Ten social service providers were interviewed and screened after the site selection had been completed.

Site selection methodology

The site selection methodology that was used to identify sites in rural areas where BOP consumers and service providers were invited to participate in the Community Mobility programme is determined through the following steps of analysis that involve both primary and second data collection:

A. Establishing rural population density away from paved roads [GIS analysis]
B. Establishing the need for mobility services [GIS analysis, verified by site visit]

   a. Determining distance of homestead to farms, economic centers, schools, wells.
   b. Extent of paved roads locally.

C. Establishing extant availability of mobility services [desk research and site visit]

   a. cost and type of mobility services available

D. Sizing of the Available Market [desk research and site visit]

   a. Analyze the potential for agricultural value addition
   b. Analyze the level of extant modern energy use
   c. Determine the extent to which there are already female and youth groups with capacity
   d. Determine the availability of local partners (e.g., energy generators, energy off-takers, micro-enterprise partners)

E. Risk Analysis
   a. Regulatory Risk

      i. VAT, Duties
      ii. Necessity and availability Licenses

   a. Weather Risk (e.g., seasonality of agriculture, the usability of unpaved roads in the rainy season)
   b. Political Risk (piloting during election-related unrest)
   c. Legal risk

      III. Repatriation of profits

Profile of participants

The Hamba Community Mobility Program is currently operational in Wedza rural area covering five districts and two other ongoing pilot sites in Chipinge and Domboshawa in Zimbabwe. The Zimbabwean BOP market is divided between rural and urban-based BOP, with at least 75% residing in rural areas. The rural BOP group's traditional main economic activity is subsistence farming and associated agricultural value chain activities. Gradually due to the influence of rural to urban migration and the reverse migration caused by the worsening economic conditions in towns, which resulted in job losses, these consumers were diversifying into some informal small-scale enterprises and small-scale mining. Women play a central role in enhancing sustainable livelihoods in rural areas despite the numerous challenges. Participants in the Community Mobility program using the Hamba were divided into individual users and social service providers. These are detailed in Table 1. The individual users were part of self-help groups who engaged in general trading, agriculture-related activities and provision of transportation services. The social services providers included community health providers, the police and agriculture support services.

Participation criteria: the business model

Participation in the Hamba Community Mobile Programme involves evaluating flexible criteria for long-term financial sustainability. The business model is a flexible approach to establishing a community of EV users and a network of charging stations to promote gender parity and economic development through the development of mobility infrastructure and off-grid energy access. The MFA Hamba model is based on the viability of leasing models for rural women and the cost of battery charging. The idea is to offer different leasing payment options that factor in increased income generation from the mobility, the income from charging batteries and using the charging stations as a center of economic and social activity. This includes internet/business services, delivery/transport hub and maintenance/repairs.

Table 1. Profile of the individual and institutional service providers in Wedza.

Individual BOP Consumers who are part of groups	Number of Hambas EVs	Service Providers	Number of Hambas EVs
General Trading Purposes	11	Health Sector	4
Agriculture Value Chain Activities	20	Agriculture Extension support	2
Transportation Services	10	Police	2
Total	41		8

For the mini-grids and micro-grids to qualify as community projects, these projects should provide electricity to nearby communities, community projects, health facilities and educational institutions. Further, these projects should get the approval of at least sixty-six per cent (66%) or two-thirds (2/3) majority of the local population before beginning work on the project.

What does mobility for Africa provide?

MFA assembles the Hamba EV and provides the following for the participants:

1. Use of Hamba during the testing period and after signing on
2. Driving lessons for service providers at a central point in Wedza. Lessons last for five days
3. Back up services and maintenance of the tricycle
4. GPS tracking and data collection on use, activities accomplished, challenges and Opportunities for scaling up.
5. Shared community solar battery charging port. Battery capacity (travel maximum +/- 50km on one fully charged battery; battery takes about 6-7 hours to charge fully, mainly on the grid)

In return, the participants must provide information on the model of operation they use to accomplish their daily duties. They are required to submit data on the use of renewable energy in various activities periodically. Service providers utilize the tricycle to conduct tasks and regularly submit data on renewable energy use in multiple activities. They also must keep up with their agreed repayments for the Hamba in line with the leasing model they would have selected. Both qualitative and quantitative data are collected to measure the programme's impact. This is collected in the form of case studies as part of the impact assessment.

Findings and general discussion

Implementation of the Hamba model- lessons on the decision-making process

It is evident from extant literature on consumer purchase decision making at the BOP is still developing and does not necessarily cover all key consumption categories. Although scholars such as Choudhury, Mukherjee, and Datta (2019) have narrowed this gap by proposing a decision-making framework, this is still very limited due to its narrow focus on the retailer and consumer interactions in saving transaction costs. The other modified models were not developed to build the BOP theory. However, these traditional models provide a basis for exploring the relevance and application of their components at the BOP in the decision-making process that consumers go through when considering the consumption of a critical service such as mobility. Figure 2 summarizes the decision-making framework that the BOP individual participants and social service providers went through. Notably, the framework is informed by local embeddedness and bricolage principles (Senyard et al. 2014). The framework draws on tested components from previous models but is specific to the BOP and considers the potential differences between individual and institutional providers. The core components that emerge are; (1) inputs, (2) process, (3) output and (4) impact reflection. The framework is discussed below.

Decision-making framework

Inputs

Internal and external factors influence and shape the decision making of both the individual BOP

Figure 2. Decision-making framework.

providers (IBPs) and the institutional services providers (ISPs).

Individual BOP providers

For the IBPs, critical internal factors that influence their decision making when looking for solutions to their mobility challenges are primarily the day-to-day realities of not having transport for routine and non-routine tasks such as going to the clinic. These challenges reflect the general poverty and livelihood challenges these BOP consumers are driven by a lack of disposable income (Frey et al. 2021). The only mobility solutions they were aware of before the Hamba were the traditional bicycles and, in some cases, motorbikes that were out of reach in their view and consideration of their income. Exposure to alternative solutions such as the Hamba changed their perception and thinking around what could be possible for them even with their limited, constrained context. For the external influencing factors, family, social networks, community values, and income were vital for the IBPs. The use of mobility solutions is often a community values-driven process that considers the appropriateness of the solutions. For example, bicycles and motorbikes were regarded as more suitable for males than females, which influenced attitudes and perceptions of any alternative mobility solutions available. The Hamba was designed to address these perception worries by being a tricycle. This was more acceptable for use by women. Social networks were critical in influencing decision making on mobility solutions as part of the highlighted community values. Engagement with the various social networks was central to the whole methodology. This is how potential participants were identified from the different self-help groups of BOP consumers. These were mainly savings clubs, income-generating co-operatives and agriculture activities clubs. These social networks were important for the Hamba Community Mobility programme to function. It was a leasing model that required community input in areas such as maintenance and protection of the EVs and the solar charging portals. The extended benefit of the solar charging portal to the whole community also meant that community leaders were influential in the decision-making process for participation. They guaranteed safety and protection of the equipment, now a community asset.

The influence of social networks confirms findings from other studies at the BOP. This reinforces the critical role these groups play in influencing purchase decision making (O'Malley and Prothero 2007; Hamilton 2009; Shubin 2007; BOP (Kirchgeog and Winn 2006; Michailova and Worm 2003). However, our findings are set within a different context of adopting a renewable energy solution not covered in previous studies. Family

dynamics were also fundamental in determining whether BOP consumers participated in the Hamba project. This, in part, was also part of the community values consideration because the notion of family in this community involved considering the well-being and benefit of the extended family rather than immediate family only. IBPs considered the opportunity to use the Hamba to assist their extended families as a key motivating factor.

Institutional services providers

The internal motivating factors for the three categories of ISPs, namely healthcare, agriculture support and law enforcement are different from the IBPs, although the service benefits final BOP citizens. Internally, all three providers are motivated to seek alternative mobility solutions to address the daily operational mobility challenges they face because of operating in a resource-constrained environment. Nurses require transport to visit patients, deliver medication, bring pregnant patients to the clinic, immunize children, or conduct awareness campaigns, as was the case during the Covid pandemic. The service was also crucial in the rollout of testing facilities in these remote areas, given the limitations of the Ministry of Health in reaching remote outlying areas. Police need transport to attend to crime scenes on time and patrol areas at night to ensure peace and security. The agriculture support technicians need transportation for on-call farm visits, conducting field days, distributing government inputs and mitigating natural hazards. Before Hamba, all these tasks were complex due to a lack of mobility solutions.

In some cases, there was a motorbike shared by all the service providers, but this was not sustainable due to shortages of fuel and funds to maintain the bike. Unlike the IBPs, the ISPs' external influences were mainly the role of their superiors in government and the general political environment. They required authorization from their managers to participate in the Hamba project. Partnerships with private actors such as MFA are subject to government policies. An important external factor influencing the ISPs' participation was their relationship with the community. Endorsements from the community were critical in ensuring the ISPs were signed up. The symbiotic relationship between the ISP's needs and the community was important in justifying the provision of a Hamba. This is a new finding on the relationship between public sector social services providers and private sector players moderated by the community.

Process

Once there was a definitive matrix of both internal and external motivating factors for mobility solutions, the actual process of identifying and mapping the exact needs of both the IBPs and ISPs became more apparent. The motivating factors for initiating the process ultimately framed how these actors identified their needs.

Individual BOP providers need mapping

The IBPs' needs were primarily for general transportation services in routine and non-routine tasks like going to the clinic, taking children to school, or going to the field. Before Hamba, these were onerous tasks because participants had to travel long distances. The second central point of need was for use in trading and income-generating activities of buying and selling wares. Before Hamba, this was a difficult task considering the distances between places and potential markets and the challenges of stock storage whilst moving. The last category was for agriculture-related activities whereby participants had a distinct need to travel to file days where they could learn new techniques from the agriculture support technicians. There was also a need for transporting inputs from distant points of distribution, and last, there was a need to move produce to both homesteads and markets for sale.

Institutional services providers need mapping

ISPs' needs were linked to their final service provision for the community that has been outlined in the inputs section. For example, transportation of patients and visits to patients for immunization or information awareness campaigns on common

communicable diseases in the area like malaria. The service assumed an essential role in spreading awareness about Covid and monitoring the protocols that were in place to minimize spread. Police's needs were mainly to enhance their service coverage in the area and quicker turnaround to crime scenes. The agriculture support services team provided an important service that was central to the main economic activity of farming and had a similar need to the police for enhancing service coverage.

Mobility for Africa's role in information provision to facilitate decision making

Motivating factors and need mapping for both IBPs and ISPs were shaped by the availability of helpful information from MFA. Considering the relatively new concept of EVs to this community, the availability of well-packaged information was an essential aspect of how the IBPs and ISPs eventually decided to sign up for the Hamba Community Mobility programme. MFA provided targeted information sessions to provide detailed information about the programme. This was key in converting prospects to sign up because of re-assuring information on key aspects. These included training support services for maintenance of the Hamas and community benefits of the solar charging portals. Information was available through the community leaders who acted as ambassadors for MFA and were vital reference points. Participants in the trial pilot programmes provided testimonials on their experience as a key referral source.

Output

The key output for both the IBPs and ISPs was the opportunity to participate in a pilot or actual signing up for the Hamba Community Mobility programme. This is essentially the purchase stage in a traditional purchase decision-making process when prospective customers decide to purchase or not to buy a product or service based on the inputs and process experience they would have undergone. In this case, this was symbolized by the participants" decision to sign up for the programme.

Impact assessment

The experience and benefits from participation by both the BOP consumer and institutional service providers sum up the post-purchase experience. This confirms a positive experience for both. This is outlined below.

Individual BOP providers

Confirmation of positive experiences and benefits are evident from the three categories where the well-being of women was significantly improved. This is important considering that these rural BOP women are traditionally marginalized. Participants recognized the overall feeling of empowerment that came with the ownership of the Hamba and participation in the different economic activities. For those using the Hamba for general trading and transportation services, key benefits included access to transport, shorter traveling distances to clinics, new household income sources and payment of school fees on time. Children were attending school more regularly since they did not walk long distances, which further enhanced the empowerment of the girl child. These findings are supported by reflections from the mini case studies outlined below (Figure 3).

a. ***HAMBA in income-generating projects Mini Case***

Participant N harvested 32 Hamba-loads of onions since joining the scheme as part of a community agriculture group. 'I enjoy driving Hamba because it helps me take my produce to the market on time and sell it in season… I can now reach other markets, as far as 16 kilometers. I used to take manure to the garden by the head. I would carry one bucket and walk 5km, but these days I just load my Hamba cargo with manure and go.' She explains how the Hamba and the income it generates has changed her life and the lives of her family and community: 'In my community, whenever I take my kids to school, I also carry the kids around too. As a group, we can now make our savings and buy groceries and kitchenware for each other every month. We are also buying blankets and

Figure 3. HAMBA in income –generating project.

Figure 4. HAMBA solving mobility issues.

three-legged pots for ourselves. We can now pay school fees for our kids, and thus, we are very proud of ourselves.' (Figure 4)

b. ***HAMBA solving mobility issues Mini Case***

Participant A runs a taxi service using the Hamba. It speeds up and makes easier the journeys that members of her community would previously have had to walk. Her taxi improves the mobility of fellow rural women, but she also earns an income this way. Transport was very scarce here in the Zana area; the coming in of Hamba has eased the burden.

Agriculture is the primary source of livelihood for BOP consumers in rural areas, and ownership

Figure 5. HAMBA in agriculture.

of the Hamba has several direct and indirect benefits. These included access to more markets that would typically be out of reach due to long distances and diversification to other horticulture and cash crops they could now sell in many markets. There was a significant reduction in post-harvest losses, increased sales of commodities and livestock improved household income. Improved household income improved food and nutrition on security at the household level. These reflections are supported by reviews from the mini case studies outlined below (Figure 5).

c. ***HAMBA in agriculture mobility issues Mini Case***

Days have been busy for Participant AN, a 64-year-old mother and grandmother. She spends most of her day; she tends to chickens that lay eggs, which she sells in the community. With her 70-year-old husband after a stroke, a 14-year-old daughter still in school and two of your grandchildren staying with her, she depends on the extra income to keep the family fed. She and her husband also secured 6 hectares of land about.5 km away from their home in Chipikiri, where she grows her maise and vegetables and has banana trees.

Institutional service providers

Weak infrastructure and poor service provision of critical social services such as health and security are common challenges at the BOP. (Chikweche and Shindi 2021; USAID 2021) The extension of the Hamba Community Mobility programme to include institutional service providers in health, law enforcement and agriculture support have a significant measurable impact on improved service provision for the BOP in Wedza. This is part of MFA's broad corporate social responsibility in these rural areas. Service providers get free access to the Hamba Ev.

Healthcare sector

The health sector was accessed at three levels, the village health workers, the local clinic, and the district hospital at the Wedza growth point. The training was provided to representatives who carry out different duties in the health delivery system on behalf of the community. These include nurses, village health workers, environmental health technicians, general hands, and nurse aids. Before participating in the Hamba Community Mobility programme, village health workers traveled on foot, accompanying sick patients to the clinic. Births were delivered at home due to limited transport; health personnel only carried out occasional home and community visits. This influenced follow up of patients with communicable diseases such as Tuberculosis and those with AIDS who required regular access to antiretroviral drugs. Children missed necessary immunization

Figure 6. HAMBA in Healthcare service delivery.

treatment. The introduction of Hamba has contributed to significant improvements in health service provision. For example, village health workers and other allied health professionals can now visit patients regularly; nurses can directly deliver necessary medication such as family planning and HIV antiretroviral drugs. Turnaround times for attending to home-based care patients improved. Public health officials also carried out more outreach campaigns, especially during the Covid pandemic that required awareness campaigns about the disease and the protocols to minimize community infections. These findings are supported by reflections from the mini case studies outlined below (Figure 6).

d. ***HAMBA in Healthcare Service Delivery Mini Case***

Participant CM is a 39-year-old community nurse based at the local clinic who works with the community to conduct birth deliveries, immunize children, and HIV testing and counseling. Hamba lessens the burden of walking long distances, especially seeing pregnant women and elderly people, which was a challenge because of the shortage of transportation options. CM has been using the Hamba to make follow-ups on patients who would have tested positive for malaria. She is also using Hamba to supply for malnourished children in the community. Hamba has been very useful in spreading awareness about the Covid pandemic and educating residents about the various protocols to minimize spread. As a result, we did not have high rates of community infections. This would have been very difficult to achieve without Hamba.

Law enforcement sector (police)

Police officers with different ranks and mandates were recruited into the Hamba Community Mobility programme. These included responsibilities in ant-stock theft, victim-friendly unit, public disorder, rural post awareness and administration. Eight police officers, including four females, were trained as drivers, and two EVs were allocated. Service provision by the police has improved due to their access to the Hamba. Police can now attend to accident scenes faster, stock theft cases have declined, and police can conduct community outreach sessions at least twice a month. They are also conducting night patrols to improve citizens' security and safety. Police were also able to monitor lockdown restrictions introduced to stop the spread of Covid. This complemented the awareness campaigns by the healthcare teams. These findings are supported by reflections from the mini case studies outlined below (Figure 7).

e. ***HAMBA in Law Enforcement Service Delivery Mini Case***

Police officer T reports that five or more cases can now be investigated due to the use of the Hamba,

Figure 7. HAMBA in Law Enforcement Service delivery.

which was impossible before since they had to walk long distances. The Hamba has now made it possible for the police officers to attend crime scenes timely and as six or seven persons since they now have transport. This has enabled them to avoid dismissing cases caused by time delays.

Agriculture support services

Small-scale agriculture activities are the primary source of livelihood for BOP consumers who rely on agricultural support services from government agricultural extension technicians. However, like other social service providers, these support personnel face similar challenges, such as a shortage of transportation. This, in turn, influences their ability to provide appropriate and timely training for farmers. Attendance of field days and requests for on-call farm visits and implementing government agriculture programmes improved. With the introduction of the Hamba Community mobility programme, these technicians now have access to reliable transportation, enabling them to serve the community with more on-call visits, field days, and timely responses to natural hazards that affect BOP farmers. These findings are supported by reflections from the mini case studies outlined below (Figure 8).

f. ***HAMBA in Agriculture service delivery Mini Case***

Participant KM (37) is an agricultural extension officer who advises farmers on efficient farming methods and animal production which suit the climate. She has over ten years of working in the Hwedza community. She reports that they use the Hamba to conduct meetings with community farmers and conduct farm visits. KM says their punctuality to meetings has improved, and visit frequency has increased to an average of five trips per week since the Hamba was introduced. They can now attend from as far as thirteen kilometers away, distances that they used to travel on foot or use costly taxis.

Emerging new marketing opportunity

The project is constantly reviewing new product extensions for the project. Key extension areas include developing partnerships with firms to develop entrepreneurship ecosystems for marginalized women and youths. Pilot ventures in potential partnerships for Hamba as part of distribution channels for firms that market products such as foodstuffs and other essential day-to-day hygiene products have started. The various buying and selling groups are already fulfilling this role of being part of the extended distribution channels for marketers. This impacts improved product availability for BOP consumers since Hamba's women groups can buy products in bulk and distribute them in their communities, thereby enhancing market reach for marketers.

Theoretical and practical contributions

This research has significant theoretical implications for decision-making for adopting renewable energy-based mobility solutions for marginalized

Figure 8. Hamba in Agritex Services.

BOP consumers and social connectedness literature. This has been achieved through a context-immersed examination of rural BOP consumers in their natural world. This has enriched prospects for drawing new insights into how their complex and nuanced context influences their decision-making in identifying and adopting solutions for their mobility challenges. First, we propose a theoretical decision-making framework that provides insights into how the individual BOP consumers (IBPs) and institutional service providers (ISPs) decide to adopt alternative renewable mobility solutions to address the severe mobility constraints they face at the BOP.

To our knowledge, this research is the first empirical attempt to develop a decision-making framework for the adoption and purchase of a comprehensive community-centered renewable energy-based mobility solution. The study contributes to understanding the diverse forms of purchasing decision-making models prevalent at the BOP established in the literature. Extant studies focus on models that focus on western developed markets and do not consider the nuances and complexities of the BOP. We demonstrate how the varied internal and external inputs components motivate the IBPs and ISPs to develop positive attitudes and perceptions toward adopting a solar-charged EV. This is not covered in previous studies on mobility solutions at the BOP. Second, we demonstrate the positive impact and benefit of the BOP's adoption of the community based renewable energy mobility solution.

Empirical evidence that illustrates how this innovation improved access to mobility for the consumers and service providers using renewable energy is provided. This potentially contributes to the United Nations' Sustainable Development Goals. This finding has important implications for enhancing the BOP consumers' well-being and improvement of social services provision at the BO. This is an on-going discussion in the literature on the inclusive impact of firms' engagement of the BOP as a viable market segment. Third, we build a link between the successful introduction and adoption of mobility solutions and social connectedness by designing and implementing the solution around substantial inputs from social networks active in the community. In other words, we demonstrate that successful adoption of the Hamba depends on the high levels of social connectedness in the Wedza community in the different social network groups the BOP is active in. The community owns and maintains the solar-based charging portals. Their influence extends to institutional social services sectors of health and agriculture.

The strength of social connectedness between the communities and social service providers has been central to successfully adopting the solution and its subsequent impact on social service delivery. This is another area of study not covered in previous studies on the complex relationship between the private sector, BOP, and public sector in improving service delivery in critical areas of the BOP's livelihoods. Participants' various emerging social networks create opportunities for marketers to utilize these networks in their integrated marketing communication strategy. There is scope for more cost-effective direct marketing with the final consumers when buying and selling products from firms. The Hambabu provides opportunities for expanded distribution of products by firms in cases where the women are buying and re-selling products from firms to their communities. This finding also reinforces understanding of the theory of bricolage and local embeddedness that has been covered in studies in emerging markets but not specific to the BOP. The success of the innovation supports the prediction of local embeddedness and bricolage as antecedents for the successful development and implementation of affordable value innovations.

Insights from this research have important practical implications. The Hamba Community Mobility programme offers a practical, sustainable, and affordable solution to mobility constraints at the BOP. Specifically, our study demonstrates that private sector actors can work with communities to develop mobility solutions that have a diverse impact on their livelihoods, as evident from the multiple uses of the Hamba. The innovation also provides practical implications on how the public sector can work with the private sector to enhance access to public social services such as health and policing. This was particularly important in the management and control of the spread of Covid in rural areas. The joint work by the police and healthcare workers using the Hamba was vital in spreading awareness about the disease and protocols to minimize spread. The participation of these institutional providers was important in gaining trust and cooperation from the community to spread the correct message and comply with lockdown restrictions. This joint effort was vital in minimizing community infections. The study also provides a template for site selection and the development of a framework for replication in other BOP markets.

Limitations and future research

Notwithstanding the project's success, some important lessons on challenges that have emerged from the project can help improve its replication in other markets. The key ones relate to technical issues such as improving the capacity and longevity of the solar battery and modification of EV to include an overhead cover in case of bad weather. Other non-technical problems include the need to introduce basic entrepreneurship courses on running a business. This would be very important in assisting participants in managing their cash flows and keeping up with their payments for the lease. Other areas could be developing business partnerships with firms active in the various agriculture value chains that can open new opportunities for the Hamba entrepreneurs. Last, there is a need to scale up through angel investors' investment to facilitate MFA's expansion of the programme beyond the current sites.

Future research directions that can be explored by researchers that emerge from this study include the following:

- An expansion to other African countries with significant BOP populations to study similarities and differences in these markets in terms of the mobility challenges. A key part of future research in different markets should explore whether the decision-making framework outlined in this study is similar. What are some of the potential differences, and how do these impact the possible implementation of the renewable energy solution?. Further studies should investigate perceptions and attitudes on renewable energy-based solutions. Besides African markets, studies can be extended to other markets with substantial BOP markets, such as India, China, and some Latin American countries.

- Future studies could also establish intra-country BOP differences in decision-making since the BOP is not a heterogeneous segment across different markets. An extension of future studies could explore the potential extension of social services that can potentially benefit from this community mobility model. These studies should also explore the influence of the central government in the participation of the satellite providers, who often must make decisions to participate independently with limited consultation. This could be further useful in informing policy design to support mobility initiatives that can be useful in the achievement of Sustainable Development Goals.
- Further studies should explore different business models that can be used to implement such community-based mobility programmes besides the leasing model used in Hamba. Investigating the variables or factors that can facilitate the scaling up of these events is also an area for future studies.

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