



HAL
open science

PSS for the BoP: A Review from DfS to Sustainable Business Model

Eduardo Méndez-León, Tatiana Reyes-Carrillo, René Díaz-Pichardo

► **To cite this version:**

Eduardo Méndez-León, Tatiana Reyes-Carrillo, René Díaz-Pichardo. PSS for the BoP: A Review from DfS to Sustainable Business Model. EcoDesign 2019: 11th International Symposium on Environmentally Conscious Design and Inverse Manufacturing, Nov 2019, Yokohama, Japan. hal-02435850

HAL Id: hal-02435850

<https://hal-utt.archives-ouvertes.fr/hal-02435850>

Submitted on 11 Jan 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

PSS for the BoP: A Review from DfS to Sustainable Business Model.

Eduardo Méndez-León¹, Tatiana Reyes-Carrillo¹, René Díaz-Pichardo^{2,1}

¹ Université de Technologie de Troyes. ICD, CREIDD-HETIC. 12 rue Marie Curie, 10010, Troyes France.

² South Champagne Business School. 217 avenue Pierre Brossolette, CS 20710-10002, Troyes France.

Abstract

The domains of Design and Business have provided useful and practical information for the complex problems faced at the BoP. Autonomous propositions of innovation and strategy were respectively developed by both areas of knowledge. Nowadays, they are converging on a new and interesting research topic called Sustainable Business Model. The aim of this article, through a narrative literature review, is to understand the evolution of PSS from two different but complementary approaches as well as to identify the topics that have permanently shaped the PSS research in search of sustainable value proposals for the BoP.

Keywords:

Design for Sustainability, Sustainable Business Models, PSS, Base of the Pyramid, Value.

1 INTRODUCTION

Proposing a close relationship between nature and society, the concept of sustainability was introduced into the literature from a scientific perspective in the early 1980s by the World Conservation Union [1,2]. Despite the evolution of the subject, the term still lacks a specific meaning to date. Concepts such as sustainable development, human sustainability, social sustainability, ecological sustainability or environmental sustainability are often used to define it [3].

The current notion about sustainability is the continuity towards development, an alternative solution after understanding that social progress is positively correlated with environmental degradation [4]. Perhaps the most cited concept is that proposed by the World Commission on Environment and Development (WCDE) in 1987, which establish that "Sustainable Development seeks to meet the needs of the present without compromising the ability of the future generations to meet their own needs" [5,6].

Some perspectives suggest that sustainability could transform the current neoclassical economic model based on environmental and social aspects as well as economic ones [3]. Regarding the social dimension, especially addressing the problems in the Base of the Pyramid (BoP), it has been suggested that the development of strategies should be defined within a framework of activities that improve living conditions and offer environmental and social sustainability to scarce resources communities. Proposals to achieve sustainability in the BoP have emerged from various fields such as strategic management [7] or corporate entrepreneurship, across a range of fields including economic anthropology, international development or environmental management [8]. It is interesting to know that some of those areas are forming new fields of research seeking the so-called pragmatic solutions for the BoP context [9].

For instance, the Design has marked a milestone in the search for solutions to environmental problems. With four levels of innovation and more than a dozen strategies, the Design for Sustainability has analyzed possible changes in the processes of production-consumption through the Green Design, Ecodesign or Designs inspired by nature. Additionally, because of the recognition that sustainability has a strong anthropocentric approach, DfS has evolved and generated new proposals based on social dimensions or even in Socio-Technical Systems [10].

The "way of doing business" has not been isolated from this evolutive situation. Since the first proposals of "selling to the poor" [11], new business strategies have evolved to generate value with the BoP. Nowadays, either in practice or in academic literature, a new category of companies is recognized for the incorporation of sustainable strategies in their products or services [12]. Regarding services, recent studies have shown evidence of the growing PSS strategy that companies have adopted in order to boost their income by differentiating or adding new value propositions to their products or to address markets in developed economies usually not attended by traditional businesses models [13].

According to several authors, the PSS appears as a promising and sustainable response to problems faced by the BoP [14–16]. Consequently, because of the apparent importance of PSS strategy for poor people, this paper aims to analyze: What have historically been the contributions of Design and Business areas to the field of PSS for the BoP? Through a narrative literature review [17], this work will additionally seek to identify the most relevant issues that revolve around PSS, which we consider will continue shaping the research in PSS, not only for the BoP but also for the other areas of application.

2 PROCEDURE

Using a systematic approach, this review aims to clarify the existing knowledge of the PSS by fostering and then bringing it together in a critical way (Jankowitz, 2005 cited by [17,18]). The specific purpose of this literature review is to improve the conceptual and historical understanding of the PSS for the BoP from the area of Design and Business. A traditional literature review (narrative) has been selected to address this issue.

This type of review allows us to synthesize areas of conceptual knowledge that eventually contribute to a better understanding of the issue and to establish the parameters for subsequent systematic analysis [17]. Following the recommendations of Jesson [17], a logical and systematic way to develop the arguments and the history of the PSS was done taking into account reviews in this nature about the DfS [10] and BoP literature.

3 BACKGROUND.

3.1 Business Development: Different ways to mitigate poverty.

The concept of the Base of the Pyramid is associated with the concept of poverty. Since the publication of *"The Fortune at the Bottom of the Pyramid"* by Prahalad and Hart [19], the concept "The Bottom of the Pyramid", also known as "Base of the Pyramid", appears in the literature as a sector that refers the last category within the global income pyramid. It is believed that there, there are at least 4 billion people with annual per capita income less than \$ 1,500 U.S. and a billion people with per capita income less than \$ 1 per day [19,20].

Although, the complex problems (lack of income, low educational level, economic, cultural or social deprivations) in the BoP [20,21] require adapted solutions instead of commercial/economic strategies that work in the developed country markets [22]; the first proposals to alleviate poverty were oriented towards the Business Development strategy.

"Selling to the poor" strategy, also known as BoP 1.0 [7], set up a trend in the Business area either in theory or in practice, nevertheless, some critics suggested that their results do not improve the BoP context. According to Karnani [23], the real way to alleviate poverty is by increasing the real income of the poor. Consequently, new ways of "do business" were explored, in which it is mandatory not only to get profits but also to improve the living conditions of poor people through their participation in some or all phases of products or services production.

With the publication of *"The Base of the Pyramid Protocol: Toward Next Generation BoP Strategy"*, the BoP 2.0 strategy arrived in the field of business. Its postulates are based on co-creating with the BoP, taking advantage of the deep knowledge of the BoP context, their interests, preferences, and needs. Some real examples of

how companies address the needs of the BoP through this strategy can be observed in this work [8].

Currently, the postulates of the old 1.0 protocol continue to be susceptible to changes. Recent publications show the constant progress in the subject [24,25]. According to them, BoP strategies have reached stage 3.0, which tries to integrate the environmental sustainability concerns along with a stronger triple bottom line perspective (society-environment-economy). Even so, strategies that mitigate poverty seems not to have theoretically defined a specific course to offer holistic solutions to the BoP. The alliance of two disciplines could generate more adapted or integral solutions to problems faced by society.

A clear example of this situation is the support that Design provides to the Business area. Design Thinking, as an innovation tool, suggests an approach in which necessities can be satisfied with a "business,-engineering- and design-led innovation". This circumstance implies that using a design approach can be addressed not only technological system constraints but also the socio-cultural system because it concerns an innovation focused on the human being [26].

As a result, Design Thinking has already shown some results in the innovations process of business models. Helping to create additional forms of value and including new stakeholders in the value proposition, Design Thinking helps companies to improve their performance and to be more sustainable [27]. It is possible to assume that this type of hybrid approaches will continue emerging in the search for sustainable solutions for society. For instance, not long ago the eco-design was recognized to be a crucial element in the race for green technology, simultaneously; Design discipline was increasingly recognized as a relevant factor in the business competition [28].

In the next section, we explore the concept of DfS to understand the variety of approaches, the interactions and how they have been partially integrated with the concept of "business development" for the BoP.

4 DFS: APPROACHES FOR THE BOP IN DIFFERENT LEVELS OF INNOVATION.

Considering that sustainability is based on an anthropocentric approach to development, the need to create new ways of growth for society has permeated towards different academic fields. In the last three decades, Design has been recognized for its active collaboration in the industry by solving environmental and social issues, since then; new approaches emerge for radical transformation and replace the traditional model based on optimization [10]. Expressing its own identity beyond the ideology of consuming standardized mass products, DfS include; social, economic, environmental and institutional aspects to respond to the transition challenge towards a sustainable society [29].

Within the quasi-chronological work of Ceschin and Gaziulusoy [10] that explores the evolution of the different approaches developed in the last decades by Design for Sustainability, four levels of innovation are identified: a) Product Design innovation level, b) Product - Service innovation level, c) Spatio-Social innovation level and d) Socio-Technical System innovation level.

The latest two levels are considered the most advanced suggestions for achieving sustainability. For the time being, it is not possible to identify approaches that propose specific BoP solutions, so we will pay more attention to a) and b) approaches.

One circumstance is important to point out in the paper of Ceschin and Gaziulusoy [10], despite all the approaches can be used in different contexts, most of them are associated or they are the evolution of previous approaches. In line with this interpretation, we argue that the Product Design innovation level and Product-Service System innovation level are complementary approaches for the BoP and they clearly are linked with business development strategy.

4.1 Product Design innovation level.

Also associated with the concept *Design for the Environment* (DFE) [30,31], the Product Design innovation level contains the next approaches: Green Design, Ecodesign, Emotionally Durable Design, Design for Sustainable Behavior, Cradle to Cradle Design, Biomimicry Design and Product Design for the Base of the Pyramid (DfBoP).

Despite the multiple approaches at this level of innovation, all strategies are directly linked to the product. Redesign of products, development of new products based on green behavior, life cycle analysis to reduce the environmental impact, strengthening and extension of emotional bond with the product and mimicking nature in product design, are just some product tactics [32,33].

Concerning low-income economies, designing should be an effective task because the lack of knowledge about suitable designs can have a direct effect on the final product and in the life of poor people [34]. Despite the evident value proposition in the DfBoP approach, its level of innovation is aligned with the BoP 1.0 strategy, in other words, it is a "market-based solution" [10,19]. Facing the obvious need for better solutions, product strategies addressing the BoP necessities should additionally consider the social and environmental dimensions.

Regarding that, the advanced Product Design research expounded an integrated product development approach for the BoP, in which the next four inter-related clusters in the product design should be taken into consideration: Desirability, Feasibility, Viability (reliable financial model) and Sustainability (environmental and social impacts). This proposal highlights the incorporation of Viability and Sustainability elements that imply the

introduction or improvement of a new product or process into a specific cultural context [35,36].

The idea referencing "selling products to poor people does not necessarily improve their well-being" continues shaping the product innovation level in DfS, highlighting the importance to be enhanced. Some authors in the domain suggested that improving the product, as well as the services connected to it, and even developing entirely new functional products and services systems could be appropriated options [35].

4.2 Product-Service innovation level.

Although product approaches are associated with consumerism ideology, which some authors suggest is a cause of the current environmental crisis [9], they were very popular a few years ago and even today they continue shaping current research. Inevitably, DfS has evolved to address some social problems.

Apparently, some works, that come from product-level innovation, determined the present course of DfS and BoP research. For instance, with a merge of the "4 Ps" of Design for Sustainability and the "4 As" of developing successful business for the BoP, Diehl and Christians [37] conceive a new framework for the BoP to obtain a clear understanding of the needs, the context of the people and the interactions with the materials. With these contributions, the understanding of the economic and socio-cultural world was suggested to be a basic starting point for successful product innovation in the BoP.

The relatively new DfS approach, that unifies the previous business and design elements, is the Product-Service innovation level. Even though it is true that PSS Design for the Base of the Pyramid, Eco-efficient PSS Design and Sustainable PSS Design are included in this level, it is also clear that all of them allude to the Product-Service System strategy. One of the differences that characterize this system is the incorporation of the social sphere in the innovation of business model [10].

We consider the notion that not only the product innovation and the product-service innovation are complementary but also PSS emerges as a result of social and business integration in the product innovation. Our first argument is supported considering that certain publications use the clusters of design requirements for the BoP when characterizing the PSS [36].

More concretely, the co-creation and the environment play an important role in PSS. As suggested by the *BoP as a business partner strategy* (BoP 2.0), people in this type of approach can be involved in the co-invention / co-creation of the business. The simultaneous convergence of products, services and the network of actors result in a positive economic, social and environmental impact [8,38].

In brief, in these two sections, the relationship that the DfS maintains with the Business Development strategies suggested for the BoP was clarified. The different

Business Development strategies to mitigate poverty seems to be associated with two DfS approaches. However, the following sections offer a more extensive description of the PSS to outline the way in which the PSS proposes a Sustainable Value and identify which concepts have allowed its propagation to the Sustainable Business Model domain.

5 THE PRODUCT-SERVICE SYSTEM AND THE BOP.

Although there is a wide debate about what is the most appropriated conceptualization, specific principles can be enlisted in some cluster of ideas in order to understand what a PSS is:

1. In the PSS strategy, the customer demand is met by the sale of its satisfaction instead of a product [39,40]. The satisfaction mentioned here is based on a mixture of tangible products and intangible services, designed and combined so that they can satisfy the client's needs [41].

2. Servitization. As the main goal in PSS, Servitization is an evolution from a product approach to a proposition where the material component is inseparable from the service system [42]. In other words, a strategy where products are jointly offered with a specific service. One example is a product that can be dematerialized by including services that reduce the number of materials consumed in its life cycle not only in its creation but also in its use, reuse, and recycling [43]. When this strategy is set up in a firm some authors describe it as the Function Oriented Business Model [41], Service-Oriented Business Models [44] or Result Oriented Business Models [45].

3. Productization. Being another variant of the PSS, it is considered an evolution of services component to include a product or a new service component marketed as a product [42]. In other words, services, that are jointly offered with a specific type of product, can be categorized here [45,46].

In fact, PSS can be considered as a convergence of both strategies where many possibilities may appear from the mixture. The economic and sustainable value propositions between both limits are divergent, if the PSS is designed at the threshold closest to Servitization (Function Oriented), PSS can offer a greater potential to solve many contrasting situations related to the environment. The main and secondary PSS categories are historically based following the logic of interaction between pure products and pure services [41,47].

4. The social aspects within the PSS: Stakeholder as a pivotal element. The PSS is built on attraction forces where objectives, goals and problem-solving encourage the participation of people inside a "co-production process" [42]. In an ideal scenario, all types of stakeholders can receive Value by collaborating. According to Manzini and Vezzoli [39], the eco-efficiency potential of PSS implies new relations or alliances with

stakeholders; a complete system that considers even the stakeholder communication and new organizational forms based on a social and viable sustainable perspective.

The multiple stakeholders participate in the business models in order to obtain profits but within the context of low-income countries, the concept "business" does not necessarily imply the pursuit of economic objectives. In addition, the business concept is also relevant for organizations that try to maximize the public welfare also called social value [48].

Perhaps, the PSS promising perspective for the BoP lies in offering a suitable solution not only for socioeconomic but also for ecological problems because it brings satisfaction and other types of value to all the members involved in the system. Recently categorized as a Sustainable business model, the PSS seek to go beyond delivering economic value and include other forms of value for a broader range of stakeholders, particularly the environment and society [49].

To sum up, we argue that the four previous elements are the core characteristics of PSS. But, in order to go beyond exploring the PSS from the point of view of business, we adopted the PSS definition of Goedkoop et al. (1999 cited by [43]): *"A Product-Service System is a system of products, services, networks of players and supporting infrastructure that continuously strives to be competitive, satisfies customer needs and has lower environmental impact than traditional business models"*.

In this definition, a different perspective and new research area are identified in the PSS literature: by articulating the design of products/services with the strategic areas of a company, the PSS can develop a sustainable value for the BoP.

6 PSS AS A SUSTAINABLE BUSINESS MODEL.

6.1 Business Model implications for the PSS.

As regards the aforementioned description, support networks stand out from other elements in the PSS. They concern some social implications, for instance; stakeholders' relationships or a long-term relationship with the client [45]. Social aspects have motivated the multidisciplinary condition of the PSS; business developers, designers, consumer scientists, and system innovation specialists could contribute to this service-oriented standpoint [47].

To illustrate the interdisciplinarity, academic papers, that analyze the transition from consuming economy to service economy, have identified the PSS as a Business Model (BM) with high implications in companies' activities [43]. In general terms, BM is conceptualized as a graphic representation of strategic areas in a company, an analytic tool that is useful to distinguish the most important company components and to understand the interaction between them.

Among many, the CANVAS Business Model, which has been developed with a design perspective in mind, stands out from all existing classifications of what constitutes BM [50]. This proposal suggests the following 9 strategic components that any business models should have. The rationale behind these components is to understand how an organization creates, delivers and captures value [51].

Aligned directly with an economic orientation, the CANVAS model is suitable to identify the potential impacts of business model activities, which would meet the possible DfS market approach but not the sustainable PSS promising proposals. In contrast, the precedent to understand how to implement and transform a model able to connect social and environmental elements is located in the Business Model Innovation (BMI) [52,53].

From a nexus between the concepts of Business and Innovation, BMI is conceptualized either as the design of novel BM for newly formed organizations or also the reconfiguration of existing BM [53]. Precisely, as a compatible result in both activities; Sustainable Business Model (SBM) arises from the imminent need to incorporate sustainability into organizational activities.

Some examples of sustainable innovations in both perspectives can be found in the literature. Gebauer and Saul [48] suggest that innovations in cost structures, water payments, business diversification, and distribution channels represent a starting point for driving new business model innovations for water services in low-income countries. Identified as innovations based on the reconfiguration of the business model, the authors conclude that they could lead to increase the success likelihood of business models, and support organizations to establish hybrid models that combine social and economic goals in water services for poor people.

The Triple Bottom Line, a relatively novel model that considers an economic, environmental, social and conceptual framework for the organization, is another example of BMI that helps to design business models to support more sustainable action [54]. Although this triple bottom line innovation is an extension/complement of the "economic" CANVAS BM, the social and environmental layers maintain the original Value component. The value in this tool is recognized as essential, they respectively adopt the name of Social Value and Functional Value in this version of CANVAS.

Concerning PSS for the BoP, information about innovation in this model can also be located. As a result of an exploratory and qualitative study, Costa Junior and Diehl [40] identify PSS potential guidelines to design sustainable PSS. Improve the relationship with the customer, build unique relationships with clients, create added value throughout the stakeholder value chain and fulfill customer needs with minimal material use and emissions are just some examples that were identified for the energy sector in an emerging market.

Likewise, in the research about what are the roles of sustainable and innovative business models in supporting decentralized technologies for improvements in drinking water quality in a low-income context, Sousa-Zomer and Cauchick [55] conclude that PSS can allow close integration with customers and help to change their unsustainable behavior when it has a social component (a relevant reconfiguration in the model).

From these examples of business innovation, we can distinguish that the social and environmental elements have a significant influence on the innovation process. As described in the previous section, the four PSS clusters tackle the same social and environmental elements so that several authors have located it within SBM category [12,25,49,56,57].

The following definition of Schaltegger et al., [58] will be helpful to clarify the position of two additional elements when considering a PSS as SBM:

"A business model for sustainability helps describing, analyzing, managing, and communicating a company's sustainable value proposition to its customers, and all other stakeholders, how it creates and delivers this value, and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries. "

Firstly, between different points of view about a mandatory adoption because of strict regulations or the voluntary adoption due to consumer preference for environmentally-friendly products [31,32,59], sustainability has been positioned as an alternative to improve the competitive advantage of organizations [25,27,60]. From the viewpoint of companies, the competitive advantage in the PSS emerges through the co-creation and co-production of activities among PSS providers, customers and value network partners [25,38].

Secondly, we recognize that Value plays an important role either in the PSS or another variety of sustainable business. Even though the design of novel BM and the reconfiguration of existing BM have been illustrated, the innovation of "rethink the value proposition" is indispensable to radically improve sustainable performance [49]. The PSS Value proposition, not only for the BoP, is constituted with important premises:

- 1.- It reflects a business-society dialogue about the balance of economic, ecological and social needs as such values are temporally and spatially determined [61], and:
- 2.- It additionally includes the environment as a new stakeholder [49,62].

7 DISCUSSION

This review provides a general perspective on how the postulates of PSS for the BoP has emanated from different domains in literature. The first foundations of this novel theme are in the literature related to the development of

businesses at the BoP, however, DfS research has given important elements in its actual course.

Among the different sections of this text, we can identify that the postulates of Design Thinking, a novel source of innovation, have allowed this transition and its influence continues to shape the search for new technical and social proposals for the solution of sustainable problems [26,27].

Although the links between strategies of Design and Business Development do not seem evident, a comparison of inquiries reflects important interactions between the general domains; the bonds of DfS innovations of products for the BoP and the BoP 1.0 strategy [37,63] or the PSS postulates of co-creation and co-production and the second generation of BoP strategies [64] could be evidence.

On this matter, the SBM is currently intervening and collaborating with the deployment of strategy 3.0 for the BoP [25]. Both concepts appear to be harmonized because it addresses most of the previous precepts: product innovation, active business models design, simultaneous co-creation by the client and the supplier, as well as the incorporation of environmental and social interests, are combined for the creation of sustainable value for BoP.

Basically, the BM tool exposes the strategic areas of a company but in a broader sense, it also allows to analyze the effects that value has on them for potential and renewed value structure. To achieve this task, in this review we have distinguished that innovation has played an important role in the PSS chronicle. From BMI or DfS, innovation always has been present in the formulation of sustainable objectives [10,50,52,61].

This idea is confirmed by looking for research trends. The results of a recent study, that aims to delineate the thematic landscape of PSS research by identifying latent topics from a large amount of scholarly data, shows that the topic "PSS as a Business Model for Value Creation" is the second hottest topic in the literature. In spite of the PSS continues to contribute to sustainability, it is now perceived as a new business that creates more value for customers [65].

Considering the relevant task of designing a BM, we highlight the role that value plays in the formulation of an SBM for the BoP. Research has proved that value proposition, value creation, value delivering, value capture and value exchange are the essential elements in any sustainable business model [27,52] however, they must be adapted according to the specific users' needs, Value should be understood as value-in-social-context [66].

In this regard, we agree with two arguments in the work of Dembek et al., [25] about the value in the search to understand how a sustainable business works in the context BoP:

Firstly, Value is embedded in the collaborative stakeholders' relationship and is not a result of an independent driver of value creation. In view of this

suggestion, it is possible that PSS for the BoP can have multiple means to create value, the more stakeholders participate in the System the greater the forms of value creation can improve the well-being of poor people.

Although the author emphasizes an economic value, others identify that Value takes the form of Use Value or Exchange Value [67]. Therefore, in a general conception within BoP context; the purchase of a product, the provision of a service, the revenues, the stakeholder alliances, the generation of jobs or the improvement of the poor living conditions could fit both assumptions.

Lastly, the sustainable scope of a BM for the BoP can be determined with the relationship that exists between the creation of value and the mechanisms of value capture. Organizations with strongly sustainable business models do not harm, and create positive social, environmental and economic value and thus sustain "the possibility that human and other life can flourish on this planet forever" [68].

In a broader sense, authors associate the value creation with the income, which does not necessarily increase the well-being of poor people but along with appropriate mechanisms of value capture, it could ensure a social benefit for the participants by differencing the value. This link is in line with what is argued about the nature of value: Value is a subjective perception of the user, hence Differentiating value for stakeholders is an important task in PSS for the BoP.[67,69].

8 CONCLUSION

The integration of sustainability, in the solutions for low-income people, is identified as one factor that has determined the PSS research. In the beginning, the strategies proposed by businesses to mitigate poverty had an economic bias. Today, society and environment also play an important role in the design of business models. To answer our question, we argue that Design and Business fields have contributed to the current PSS proposals for the BoP, being more specific; the constant transformation is linked with the DfS, Design Thinking, BoP strategies, and Business Model Innovation.

The dynamic articulation of products, services and the interests of various stakeholders (including the environment) build a business model that addresses sustainability and competitiveness at the same time. From the innovative and strategic perspective, it has been identified that the value proposition is perhaps the key concept of the PSS. The well-being of the BoP communities and the interests of the stakeholders will be achieved as long as various value paths are created in the system. From this review, we conclude that future research should focus on improving the understanding of the value in PSS and especially on understanding how the value created improves the living conditions at the BoP.

9 ACKNOWLEDGMENTS

This research is supported by the Mexican National Council for Science and Technology (CONACYT) through scholarship No. 708007.

REFERENCES

- [1] Kates RW, Clark WC, Corell R, Hall JM, Jaeger CC, Lowe I, et al. (2001). Sustainability Science. *Science* (80-). 292(5517):641 LP – 642.
- [2] Westing AH. (1996). Core values for sustainable development. *Environ Conserv*. 23(3):218–25.
- [3] Stubbs W, Cocklin C. (2008). Conceptualizing a “sustainability business model.” *Organ Environ*. 21(2):103–27.
- [4] Bendul JC, Rosca E, Pivovarova D. (2017). Sustainable supply chain models for base of the pyramid. *J Clean Prod*. 162:S107–20.
- [5] Nations U. (1987). Report of the World Commission on Environment and Development: Our Common Future. United Nations.
- [6] Hart SL, Milstein MB. (2003). Creating sustainable value. *Acad Manag Perspect*. 17(2):56–67.
- [7] Schrader C, Freimann J, Seuring S. (2012). Business Strategy at the Base of the Pyramid. *Bus Strateg Environ*. 21(5):281–98.
- [8] Simanis E, Hart SL, Duke D, Enk G. (2008). The Base of the pyramid protocol: Beyond “basic needs” business strategies. Cornell University. 2008.
- [9] Arnold DG, Williams LHD. (2012). The paradox at the base of the pyramid: Environmental sustainability and market-based poverty alleviation. *Int J Technol Manag*. 60(1–2):44–59.
- [10] Ceschin F, Gaziulusoy I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Des Stud*. 47:118–63.
- [11] Prahalad CK, Hammond A. (2004). Selling to the poor. *Foreign Policy*. 142:30–7.
- [12] Bocken NMP, Short SW, Rana P, Evans S. (2014). A literature and practice review to develop sustainable business model archetypes. *J Clean Prod*. 65:42–56.
- [13] López AM, Musonda F, Sakao T, Kebir N. (2017). Lessons Learnt from Designing PSS for Base of Pyramid. *Procedia CIRP*. 61:623–8.
- [14] Widmer T, Tjahjono B, Bourlakis M. (2018). Defining value creation in the context of circular PSS. *Procedia CIRP*. 73:142–7.
- [15] Schenk SA, Rösch C, Mörtl M. (2014). Literature study on factors influencing the market acceptance of PSS. *Procedia CIRP*. 16:98–103.
- [16] Vezzoli C, Ceschin F, Diehl JC, Kohtala C. (2015). New design challenges to widely implement ‘Sustainable Product–Service Systems.’ *J Clean Prod*. 97:1–12.
- [17] Jesson J, Matheson L, Lacey FM. (2011). Doing your literature review: Traditional and systematic techniques. London: Sage; 2011.
- [18] Westbrook L. (2015). ASIS&T addressing missed information opportunities and victims’ information agency in the fight against sexual human trafficking. *Proc Assoc Inf Sci Technol*. 52(1):1–16.
- [19] Prahalad CK, Hart SL. (2002). The Fortune at the Bottom of the Pyramid. *Strateg + Bus*. (26).
- [20] Landrum NE. (2007). Advancing the “base of the pyramid” debate. *Strateg Manag Rev*. 1(1):1–12.
- [21] Karnani A. (2009). The bottom of the pyramid strategy for reducing poverty: A failed promise. DESA Working Paper #80. New York, USA: University of Michigan, Ross Business School; 2009.
- [22] Prahalad CK, Di Benedetto A, Nakata C. (2012). Bottom of the pyramid as a source of breakthrough innovations. *J Prod Innov Manag*. 29(1):6–12.
- [23] Karnani A. (2007). Fortune at the Bottom of the Pyramid: A Mirage. How the private sector can help alleviate poverty. *Calif Manage Rev*. 49(4):90–111.
- [24] Kuo TC, Hanafi J, Sun WC, Robielos RAC. (2016). The Effects of National Cultural Traits on BOP Consumer Behavior. *Sustainability*. 8(3):272.
- [25] Dembek K, York J, Singh PJ. (2018). Creating value for multiple stakeholders: Sustainable business models at the Base of the Pyramid. *J Clean Prod*. 196:1600–12.
- [26] Gruber M, De Leon N, George G, Thompson P. (2015). Managing by Design: From the editors. Vol. 58, *Academy of Management Journal*. 2015. p. 1–7.
- [27] Geissdoerfer M, Bocken NMP, Hultink EJ. (2016). Design thinking to enhance the sustainable business modelling process – A workshop based on a value mapping process. *J Clean Prod*. 135:1218–32.
- [28] Spangenberg JH. (2013). Design for sustainability (DfS): Interface of sustainable production and consumption. *Handb Sustain Eng*. 18(15):575–95.
- [29] Bagheri A., Hjorth P. (2007). Planning for sustainable development: A paradigm shift towards a process-based approach. *Sustain Dev*. 15(2):83–96.
- [30] Sroufe R, Curkovic S, Montabon F, Melnyk SA. (2002). The new product design process and design for environment. *Int J Oper Prod Manag*. 20(2):267–91.
- [31] Ramani K, Ramanujan D, Bernstein WZ, Zhao F, Sutherland J, Handwerker C, et al. (2010). Integrated Sustainable Life Cycle Design: A Review. *J Mech Des*. 132(9):091004.
- [32] Chen C. (2003). Design for the Environment: A Quality-Based Model for Green Product Development. *Manage Sci*. 47(2):250–63.
- [33] Johansson G. (2002). Success factors for integration of ecodesign in product development: a review of state of the art. *Environ Manag Heal*. 13(1):98–107.
- [34] Whitehead T, Evans M, Bingham G. (2016). Design Tool for Enhanced New Product Development in Low Income Economies. *Drs2016*. (June 2016):1–16.
- [35] Castillo LG, Diehl JC, Brezet JC. (2012). Design considerations for base of the pyramid (BoP) projects. In: *Proceedings of the Northern World Mandate: Culumus Helsinki Conference*. 2012. p. 24–6.
- [36] Costa Junior J da, Diehl JC. (2013). Product-Service System Design Approach for the Base of the Pyramid Markets: Practical Evidence from the Energy Sector in the

- Brazilian Context. Proceeding Int Conf Micro Perspect Decentralized Energy Supply. :48–51.
- [37] Diehl, J.C; Christiaans HHC. (2007). The first learning experience of designing for the BOP. *Fac Ind Des Eng Delft*.
- [38] Barquet APB, de Oliveira MG, Amigo CR, Cunha VP, Rozenfeld H. (2013). Employing the business model concept to support the adoption of product-service systems (PSS). *Ind Mark Manag*. 42(5):693–704.
- [39] Manzini E, Vezzoli C. (2003). A strategic design approach to develop sustainable product service systems: examples taken from the ‘environmentally friendly innovation’ Italian prize. *J Clean Prod*. 11(8):851–7.
- [40] Fagnoli M, Costantino F, Di Gravio G, Tronci M. (2018). Product service-systems implementation: A customized framework to enhance sustainability and customer satisfaction. *J Clean Prod*. 188:387–401.
- [41] Tukker A. (2004). Eight types of product-service system: Eight ways to sustainability? Experiences from suspronet. *Bus Strateg Environ*. 13(4):246–60.
- [42] Morelli N. (2006). Developing new product service systems (PSS): methodologies and operational tools. *J Clean Prod*. 14(17):1495–501.
- [43] Beuren FH, Gomes Ferreira MG, Cauchick Miguel PA. (2013). Product-service systems: a literature review on integrated products and services. *J Clean Prod*. 47:222–31.
- [44] Qu M, Yu S, Chen D, Chu J, Tian B. (2016). State-of-the-art of design, evaluation, and operation methodologies in product service systems. Vol. 77, *Computers in Industry*. 2016.
- [45] Vasantha GVA, Roy R, Lelah A, Brissaud D. (2012). A review of product-service systems design methodologies. *J Eng Des*. 23(9):635–59.
- [46] Mont OK. (2002). Clarifying the concept of product-service system. *J Clean Prod*. 10(3):237–45.
- [47] Tukker A, Tischner U. (2006). Product-services as a research field: past, present and future. Reflections from a decade of research. *J Clean Prod*. 14(17):1552–6.
- [48] Gebauer H, Saul CJ. (2014). Business model innovation in the water sector in developing countries. *Sci Total Environ*. 488–489:512–20.
- [49] Bocken N, Short S, Rana P, Evans S. (2013). A value mapping tool for sustainable business modelling. Lenssen, Mollie Painter, Aileen Ion G, editor. *Corp Gov*. 13(5):482–97.
- [50] Spieth P, Schneckenberg D, Ricart JE. (2014). Business model innovation – state of the art and future challenges for the field. *R&D Manag*. 44(3):237–47.
- [51] Osterwalder A, Pigneur Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons; 2010.
- [52] Nosratabadi S, Mosavi A, Shamshirband S, Zavadskas EK, Rakotonirainy A, Chau KW. (2019). Sustainable business models: A review. Vol. 11, *Sustainability (Switzerland)*. 2019. p. 1663.
- [53] Massa L, Tucci CL. (2013). Business model innovation. *Oxford Handb Innov Manag*. 20(18):420–41.
- [54] Joyce A, Paquin RL. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *J Clean Prod*. 135:1474–86.
- [55] Sousa-Zomer TT, Cauchick Miguel PA. (2018). Sustainable business models as an innovation strategy in the water sector: An empirical investigation of a sustainable product-service system. *J Clean Prod*. 171:S119–29.
- [56] Matos S, Silvestre BS. (2013). Managing stakeholder relations when developing sustainable business models: the case of the Brazilian energy sector. *J Clean Prod*. 45:61–73.
- [57] Evans S, Vladimirova D, Holgado M, Van Fossen K, Yang M, Silva EA, et al. (2017). Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models. *Bus Strateg Environ*. 26(5):597–608.
- [58] Schaltegger S, Hansen EG, Lüdeke-Freund F. (2016). *Business Models for Sustainability: Origins, Present Research, and Future Avenues*. Vol. 29, *Organization and Environment*. 2016. p. 3–10.
- [59] Gilles N, Christine LC. (2016). The Sustainable Value Proposition of PSSs: The Case of ECOBEL “shower Head.” *Procedia CIRP*. 47:12–7.
- [60] Porter ME, Kramer M. (2011). Creating shared value. *Harv Bus Rev*. 89:62–77.
- [61] Boons F, Lüdeke-Freund F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *J Clean Prod*. 45:9–19.
- [62] Geissdoerfer M, Vladimirova D, Evans S. (2018). Sustainable business model innovation: A review. Vol. 198, *Journal of Cleaner Production*. Elsevier; 2018. p. 401–16.
- [63] Jagtap S, Larsson A, Hiort V, Olander E, Warell A, Khadilkar P. (2014). How design process for the Base of the Pyramid differs from that for the Top of the Pyramid. *Des Stud*. 35(5):527–58.
- [64] Jagtap S, Larsson A, Chakrabarti A, Prakash R V. (2013). Design of Product Service Systems at the Base of The Pyramid. In: *ICoRD’13*. Springer; 2013. p. 581–92.
- [65] Lee H, Seo H, Geum Y. (2018). Uncovering the topic landscape of product-service system research: From sustainability to value creation. *Sustain*. 10(4).
- [66] Edvardsson B, Tronvoll B, Gruber T. (2011). Expanding understanding of service exchange and value co-creation: A social construction approach. *J Acad Mark Sci*. 39(2):327–39.
- [67] Lepak DP, Smith KG, Taylor MS. (2007). Value Creation and Value Capture: A Multilevel Perspective. *Acad Manag Rev*. 32(1):180–94.
- [68] Upward A, Jones P. (2016). An Ontology for Strongly Sustainable Business Models: Defining an Enterprise Framework Compatible With Natural and Social Science. *Organ Environ*. 29(1).
- [69] Ambrosini V, Bowman C. (2000). Value creation versus value capture: towards a coherent definition of value in strategy - an exploratory study. *Br J Manag*. 11:1–15.