



HAL
open science

Measuring the level of acceptance from the population of Guayas Province for different PaaS models: The case of the washing machine

José Armando Hidalgo-Crespo, Andreas Riel, Peggy Zwolinski, Christian Berenger WANDJI WOUAPI, Jorge Luis Amaya Rivas

► To cite this version:

José Armando Hidalgo-Crespo, Andreas Riel, Peggy Zwolinski, Christian Berenger WANDJI WOUAPI, Jorge Luis Amaya Rivas. Measuring the level of acceptance from the population of Guayas Province for different PaaS models: The case of the washing machine. 30th CIRP Life Cycle Engineering Conference, CIRP, May 2023, New Brunswick, United States. pp.462-467, 10.1016/j.procir.2023.02.078 . hal-04104583

HAL Id: hal-04104583

<https://hal.science/hal-04104583>

Submitted on 24 May 2023

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.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Measuring the level of acceptance from the population of Guayas Province for different PaaS models: The case of the washing machine.

J. Hidalgo-Crespo^{a,b}, Andreas Riel^a, Peggy Zwolinski^a, Christian Wandji^a, and J. L. Amaya-Rivas^{c,*}

^aUniv. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, 46 Avenue Félix Viallet, 38000 Grenoble, France

^bUniversidad de Guayaquil, Facultad de Ingeniería Industrial, Av. Dr. Jiménez Lince y Av. Juan Tanca Marengo, 090501 Guayaquil, Ecuador

^cESPOL Polytechnic University, Escuela Superior Politécnica del Litoral, ESPOL, Facultad de Ingeniería Mecánica y Ciencias de la Producción, Campus Gustavo Galindo Km. 30.5 Vía Perimetral, P.O. Box 09-01-5863, Guayaquil, Ecuador

* Corresponding author. Tel.: +593-4-2269295. E-mail address: jorge-luis.amaya@espol.edu.ec

Abstract

A transition towards an economy able to decouple economic growth from resource throughput is needed. An answer to this issue is the circular economy since it pushes the frontiers of sustainability by implementing value ecosystems in which products and materials are used as many times as necessary. Circular business models such as product lease and pay-per-use also called product/service systems (PSS) or product as a service (PaaS) focus on selling service and performance instead of products. The main objective of this paper is to gain more insights into the level of acceptance that the lease/share model of a washing machine can have on developing world citizens from the province of Guayas, Ecuador, a country in South America. In addition, this research aims to study which determinants could affect said acceptance. For the collection of information, this research employed a case study approach. A discrete choice experiment together with different attribute levels and other socio-demographic characteristics were analyzed. Respondents were predominantly focused on the buying market (60%), followed by the pay-per-month model (29.5%), and the pay-per-use model (7.6%). Only 3.5% of the respondents would at this point consider laundry services. The consumer characteristics that were found most important in influencing choice for a payment model were: age, income, and education level of the household head, together with the household size and socio-economic group of the families.

© 2023 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the 30th CIRP Life Cycle Engineering Conference

Keywords: PaaS; circular models; Guayas; washing machines; acceptance

1. Introduction

Current modern environmental defiance is widely understood to be a result of modern production and consumption patterns. One main form augured to be able to decouple value creation from resource usage and waste generation is the circular economy and especially circular economy business models. This is achieved by radically transforming our current production and consumption systems. The European Commission associates the move to a more circular economy with strategies such as boosting recycling and preventing loss of valuable materials, creating jobs, economic

growth, and showing how new business models, eco-design, and industrial symbiosis can move Europe towards zero-waste, reducing greenhouse emissions and environmental impacts [1]. The transformation into a circular and resource-efficient economy should be a major objective for any country, not only the European Union. Product-as-a-service (PaaS) systems, also called product service systems (PSS), potentially play a significant role in this transformation [2] though the shift, from selling products to offering “products-as-a-service” [3], or from buying products to using products [4-5].

The concept of PaaS systems can be referred to as a solution to integrate services with products through alternative product

uses and add more value to customers [6]. Its ultimate objective is to improve every company's profitability and competitiveness, as well as to satisfy customers' needs while minimizing environmental impact [7].

A PaaS system is about how product content and service content are interconnected and bound together from the designing table to the final use and even further on [8]. There are three types of PaaS systems: result-oriented, product-oriented, and use-oriented [2, 9, 10]. In result-oriented PaaS systems, companies sell results or competencies rather than tangible products [11], as a cyber-service. In product-oriented PaaS systems, a tangible product is sold, and its ownership is transferred to the buyer, however, additional after-sales services are offered to guarantee the correct functionality and durability of the product, as in the case of a motor 10-year warranty for fridges. The use-oriented PaaS systems are generally acknowledged in the access-based service or sharing economy research field [2, 11]. In this last type of system, the service providers sell the accessibility and use of the specific products, but they keep the ownership and share some responsibilities to keep the equipment going, such as maintenance and moving services.

Use-oriented PaaS systems, such as leasing, are often suggested as a way to reduce material usage and environmental footprints of electrical and electronic equipment, such as washing machines [12, 13]. Yet, these types of models are still virgin territory for third world developing countries, namely Ecuador, especially for domestic appliances, due to the ease of access to local financing from retailer companies. One main reason behind the lack of these models being applied could often be the reluctance of customers to adopt PaaS systems [14]. In fact, previous studies have shown that the reluctance of consumers regarding the acceptance of PaaS systems is one of the major barriers to their success [15-16]. For instance, it is mentioned that the lack of ownership can significantly affect consumers' interest in PaaS systems [17].

In this context, the main objective of this paper is to gain more insights into the level of acceptance that the lease/share model of a washing machine can have on developing world citizens from the province of Guayas, Ecuador, a country in South America. In addition, this research aims to study which determinants could affect said acceptance. The rest of this paper is presented as follows. Section 2 shows the materials and methods undertaken to gather the necessary information. Section 3 presents the main results together with the determinants. Finally, section 4 concludes and discusses the subject to offer alternatives and future perspectives.

2. Materials and methods

2.1. The study area

For this particular research, Guayas province was involved, since it is the most populated out of the 24 provinces of the country, with approximately 4.5 million inhabitants, containing 24.5% of the total population. It is located in the southwest of the country and it is the largest commercial, economic and industrial center of Ecuador. The four biggest cities belonging to the province were sampled, namely Guayaquil,

Samborondon, Daule, and Durán. Together these four cities sum up a total of 3.03 million people, representing 67.33% of the province of Guayas.

2.2. Sampling and data gathering

To determine the minimum number of samples needed to obtain reasonably accurate data, the central limit theorem was used, also applied by [18-19]. The following equation (1) was used for the calculations:

$$n = \frac{k^2 * p * q * N}{\varepsilon^2 * (N - 1) + k^2 * p * q} \quad (1)$$

where n is the minimum number of samples, k is a constant that depends on the level of confidence, ε is the sampling error, p is the proportion of inhabitants that possess the characteristic we seek, and q is the number of inhabitants that don't possess it (normally, 0.5 for each one). For the collection of information, the research employed a case study approach.

Almost 390 students from two local universities participated in the project for the measurement of acceptance of PaaS models. First, the project and its objectives were explained. Second, each interested student registered a total of 10 households to confirm their participation. Third, the registered students were capacitated into the concepts of the survey. Fourth, each student interviewed their 10 registered households through an online questionnaire using the survey characteristic of the Geographical Information System (GIS). Household head was interviewed in every household and informed consents were signed accepting that the information could be used for research purposes always keeping the identity of the interviewed hidden.

2.3. Discrete choice experiment

A discrete choice experiment (DCE) is a type of survey-based quantitative technique, used especially for eliciting individual preferences [20-21]. It has been used in a variety of disciplines, such as marketing, psychology, environment, and economics [22]. In our DCE, respondents selected their preferred option out of a predetermined set of alternatives, which were described by their main characteristics [20]. These characteristics were obtained by inspection of the websites of the principal retailer companies in the country. Specifically, respondents were asked to select their most preferred washing machine based on characteristics such as brand, type (Manual, Semiautomatic, Automatic), capacity (pounds), integrated inverter (yes/no), type of loading (top/front), number of washing cycles, control panel (knobs, digital, knobs-digital). Additionally, five different business models were presented: (1) buy-cash, (2) buy-credit, (3) PaaS-Pay-per-Month, (4) PaaS-Pay-per-Use, and (5) PaaS-Laundry-Service. The buy-cash model is the traditional model which buys directly the product from the retailer. The buy-credit model buys the product from the retailer with a direct 18-month credit, normally with high-interest rates meaning paying double or triple the cost of the product in the end. For the three PaaS models, we followed the approach of Simon Rombouts [23].

Payment Model	Buy - Cash	Buy - Credit	Pay-per-month	Pay-per-wash	Laundry Service
Brand	SMC	SMC	LG	-	-
Capacity (pounds)	24.2	24.2	48.4	-	-
Type	Semiautomatic	Semiautomatic	Automatic	-	-
Cost	\$195.83	\$459.18 (18 fees of \$25.51)	\$25.00 per month	\$0.50 per pound	\$4.00 per wash of 8 pounds
Control Panel	Knobs	Knobs	knobs and Digital	-	-
Wash Cycles	1	1	14	-	-
Inverter	Yes	No	Digital	-	-
Load Access	Upper	Upper	Front	-	-
Product Class	Basic	Basic	Upper	Middle	Middle
Contract Period (cancellable per month here after)	-	-	12 months	-	-
Circular / Sustainable Product	No	No	Yes	Yes	Yes
Services	-	-	Yearly Maintenance & Free moving service & User-Advice & End of Life Handling	No extra services	No extra services
Energy Label	A	A	A++	-	-
Image					
	SELECT <input type="checkbox"/>	SELECT <input type="checkbox"/>	SELECT <input type="checkbox"/>	SELECT <input type="checkbox"/>	SELECT <input type="checkbox"/>

Figure 1. Example of DCE for washing machines.

The pay-per-month model demanded monetary monthly compensation for the lease of the washing machine. The pay-per-use model considered the availability to bring one’s laundry to centralized washing machines and use them directly. The laundry-service model considered giving away the laundry to a company specialized in cleansing services. The laundry solutions (or options) were given several (alternative specific) attribute levels. These attribute levels were operationalized by means of literature, and real-life offerings, and refined through the authors’ expertise, such as product class (basic/middle/upper), contract period (minimum/cancellable every month after this), circular product (yes/no), services (none/yearly maintenance/user advice/free moving service), and energy label (A/A+/A++/A+++). For the prices for both the buy-cash and buy-effective, we reviewed the prices from the retailer’s websites. We decided to also offer the price value of the pay-per-month offered washing machine to increase the level of consciousness of the benefits of this model. One example of the DCE is shown in Figure 1.

2.4. Survey design

In order to collect information from the sampled population towards acceptance of PaaS models in Guayas, an online survey through the GIS software was developed. This survey consisted of four parts asking about 1) socio-demographic characteristics, 2) socio-economic level, 3) discrete choice experiment, and follow-up questions regarding certain psycho-social variables for further research. The survey questions, including the DCE, were taken in one-hour face-to-face sessions done by each of the 390 participating students. The survey was administered

during a time-lapse of one month from August 15th to September 15th. For the DCE, the respondents were given 10 different choices with different attribute levels. The respondents were then asked which of these options they would choose considering the “utility” they obtained from their attributes. They were also able to go for a none-option if in fact they, wouldn’t choose any of the presented options.

The respondents were consecutively asked to fill out a new choice task (ten in total) but then with different attribute levels. The researchers observed with options the respondents preferred and if changes occurred when different attribute levels were presented. By implementing this approach, in a very objective way, it was found what consumers truly valued in each option and what they are willing to pay. For the socio-demographic characteristics, previous research has found age, income level, education, and size of the family as important determinants for different waste disposal behaviors [22-24]. Since this is the first time this type of research is being done for the country, we took these characteristics also to be important variables to influence PaaS model acceptance. For the measurement of the socioeconomic levels, we used the same principles used in [22], and stratified each household into five different socio-economic: low (LSEG), middle-low (MLSEG), middle (MSEG), middle-high (MHSEG), and high (HSEG).

3. Results

3.1. Description of dataset

A total of 3,805 surveys were achieved during the project, representing a 99% of confidence level and 2.09% of margin

error, using equation 1. Additionally, the different characteristics of the sampled population can be seen in Table 1.

Table 1. Socio-demographic characteristics of sampled population (N=3,805)

Socio-Demographic Variable	N	Percentage (%)
Gender of Household Head		
Male	2,541	66.78
Female	1,264	33.22
Age of Household Head		
< 26	297	7.81
26 – 36	704	18.50
37 – 47	1126	29.59
48 – 58	1124	29.54
59 – 69	436	11.46
> 69	118	3.10
Education of Household Head		
None	37	0.97
Primary (PM)	359	9.43
High School (HS)	1701	44.70
Technology (TC)	400	10.51
University (UN)	1088	28.59
Post grade (PG)	196	5.15
Other	24	0.63
Income of Household Head		
No Income	151	3.97
< \$420.00	1,689	44.39
\$421.00 – \$840.00	986	25.91
\$841.00 – \$1,260.00	642	16.87
\$1,261.00 – \$1,680.00	183	4.81
\$1,681.00 – \$2,100.00	74	1.94
> \$2,100.00	80	2.10
Household Size		
1	127	3.34
2	452	11.88
3	885	23.26
4	1,058	27.81
5	773	20.32
6	305	8.02
> 6	205	5.39
Socio-economic Level		
LSEG	19	0.50
MLSEG	522	13.72
MSEG	1,562	41.05
MHSEG	1,340	35.22
HSEG	362	9.51

3.2. Attribute level counts

Although only representing a kind of descriptive statistics, counts analysis is still an interesting form of results. Counts provide a quick and automatic calculation of the amount a

certain payment model or attribute level was chosen. It calculates the amount of ‘wins’ for each level, based on how many times an option including that level is chosen of the number of times it appeared in a choice task [23]. In table 2, the counts of the primary attribute, the payment model, are shown. The total of the count’s values adds up to one because the primary attribute was shown in every option (not alternative specific). A score of 21.40 means the attribute level ‘Buy-Credit’ was chosen 21.40% of the time it was shown. All respondents together choose the buy-cash and buy-credit options 38.05%, and 21.40% of the time, respectively, adding up to 59.45% for the traditional linear model. The different PaaS models added up to 40.55%, being pay-per-month option the most selected model with 29.45%, followed by pay per use option with 7.58%, and finally the laundry services option with 3.52%. Many of the respondents are thus oriented on the buy-option, however, at the same time, respondents do have an eye for the service-based options. It is notable that the interest of respondents declines when the options become more service-oriented. Table 2 also shows the choices depending on the gender of the household head, being very similar for all five models. Females slightly prefer the buy-cash option, pay-per-use, and laundry services, while males slightly prefer the buying-credit option and pay-per-month PaaS model.

Table 2. Counts of the payment model

Payment Model	Percentages (%)	Male (%)	Female (%)
Buy-Cash (Option A)	38.05	37.66	38.84
Buy-Credit (Option B)	21.40	21.88	20.40
Pay per Month (Option C)	29.45	29.90	28.52
Pay per Use (Option D)	7.58	7.30	8.18
Laundry Services (Option E)	3.52	3.26	4.06

3.3. Important consumer characteristics

Cross-tabulations on the counts of choice of payment model were performed. In this analysis the choice for payment model was investigated over all other questions involved in the survey (consumer characteristics variables). These questions provide insight in the different aspects of consumers that need to be addressed to increase consumer acceptance of PaaS models. The full cross-tabulations are provided in the following tables to measure the influence of socio-economic level, household size, level of education of household head, age of household head, and level of income of household head.

Table 3. Counts of the payment model – Socio-economic group (%)

Option	LSEG	MLSEG	MSEG	MHSEG	HSEG
A	39.20	38.49	38.62	37.79	36.00
B	20.80	22.75	20.34	22.47	20.07
C	19.20	23.07	29.42	30.39	35.08
D	11.20	10.48	8.01	6.30	6.48
E	9.10	5.20	3.60	3.05	2.37

In table 3, there are significant differences between high and low socio-economic groups. We can observe that the buy-option decreases with the social level while the pay-per-month acceptance increases. Also, and very interestingly, both the pay-per-use and laundry services PaaS models decrease with the augmentation of social level.

Table 4. Counts of the payment model – Household size

Option	1	2	3	4	5	6	> 6
A	30.48	36.40	38.00	39.06	38.19	36.05	43.10
B	13.90	18.65	22.65	21.92	22.68	20.66	19.49
C	33.48	31.11	27.93	29.13	28.91	32.37	29.65
D	14.65	9.11	7.88	6.84	7.10	7.47	5.02
E	7.49	4.74	3.54	3.04	3.12	3.44	2.75

In table 4, we can observe that the buy-cash and buy-credit options increase while the three PaaS models decrease with the augmentation of the number of people per household. This can be because with higher household size, we can expect more working people per household.

Table 5. Counts of the payment model – Level of education

Option	None	PM	HS	TC	UN	PG
A	37.84	40.65	37.55	37.55	38.56	35.23
B	32.16	22.19	32.79	22.03	19.71	23.10
C	18.11	25.85	29.07	28.12	31.02	34.92
D	6.22	7.85	8.09	8.33	7.10	4.52
E	5.68	3.46	3.50	3.79	3.60	2.23

In table 5, we can see that respondents who have a higher education level will choose the pay-per-month option more often compared to the respondents that have a primary or high school as their highest education. However, respondents with lower level of education or none slightly prefer pay-per-use models or laundry services. Older and younger generations are more likely to use pay-per-use and laundry service models than the adult generation (Table 6). In the case of pay-per-month, the younger (under 26) generation is more willing to access to this PaaS model.

Table 6. Counts of the payment model – Age

Option	< 26	26-36	37-47	48-58	59-69	> 69
A	34.42	38.67	37.20	39.51	39.14	33.96
B	18.91	22.41	22.58	20.21	21.13	21.10
C	32.58	27.85	29.30	29.87	29.19	29.78
D	8.93	7.95	7.31	7.23	7.06	10.11
E	5.16	3.12	3.52	3.19	3.49	5.05

In table 7, we can see an increase in the acceptance of all three PaaS models with the increment of the level of income and a decrease in the buy-cash option. This table also shows the good perception of buying in credit for the Guayas population since the acceptance values remain the same across the different income levels. Regarding the laundry service, lower incomes chose that option more. This could be because they do not have the initial investments for purchase.

Table 7. Counts of the payment model – Income

Option	No Income	< \$420	\$421-\$840	\$841-\$1,260	\$1,261-\$1,680	\$1,681-\$2,100	> \$2,100
A	33.96	37.67	37.15	34.73	35.60	38.90	32.98
B	17.23	23.01	22.52	23.11	21.31	20.26	22.34
C	31.34	27.55	28.14	28.22	32.40	29.17	31.61
D	12.73	8.07	8.19	10.08	6.68	7.62	8.66
E	4.76	3.70	4.00	3.86	4.01	4.05	4.41

4. Discussion and Conclusions

This research aimed to explain the level of acceptance of different PaaS models for washing machines in a third-world development province in Ecuador, a country in South America, together with what types of characteristics determine or influence the population’s acceptance, by assessing their most important attributes, how these attributes are valued by consumers and how these consumers are segmented according to their preferences. It addresses the research gaps in the body of literature knowledge on the consumer acceptance of PaaS models for the developing world and the reasons for (non-) adoption.

We can conclude from our analysis that different business models have different predictor variables. This shows that there is indeed a difference in preferences based on the differences in the circumstances of a respondent (the consumer characteristics). Hence often a segmentation of the respondents is made. This segmentation is useful for interpretability because retailers or marketing people can tailor business propositions toward different segments of consumers. Further research could try to segment the market using a Latent Class Analysis and descriptive statistics as was done by [25].

The consumer characteristics that were found most important in influencing choice for a payment model were: age, income, and education level of the household head, together with the household size and socio-economic group of the families. Respondents are predominantly focused on the buy-market (60%), followed by the pay-per-month model (29.5%), and the pay-per-use model (7.6%). Only 3,5% of the respondents would at this point consider laundry services.

There are multiple implications for companies currently providing PaaS (or PSS) or companies that want to put these systems on the market. Literature has stated that there is currently a low consumer acceptance for PaaS systems. However, paradoxically this study found that there is quite a high percentage of consumers potentially interested in PaaS. The counts’ analysis showed that the buy option will remain the most important model in the future (>50% of the market), but there is a large legitimate market for PaaS. Especially the pay-per-month and pay-per-use options are forecasted to have a large portion of the current market. Based on this research pay-per-month will have a slightly higher acceptance among consumers than pay-per-use. Laundry washing services seem to have the lowest acceptance of all options. However, with the current trend from ownership to usage, this could well change in the future.

This research has several limitations. Firstly, it could be the first time that most respondents have done a DCE survey. The

method is quite complex and cognitively demanding, and for some options, it could be the first-time respondents had ever seen PaaS model options (like pay-per-month and pay-per-use). This could lead to extreme response behavior as unknown options are often less desired. Furthermore, there is the possibility that attributes could be misunderstood, although a very elaborate explanation page was given to counteract these effects, they are not completely eradicated. Secondly, the data gathered was restricted to the Guayas respondents only. Although a balanced sample was enabled throughout the study, differences are expected between the coast and mountain regions of the country, this still makes the generalizability of the results to a nationwide population difficult. Further research should analyze the experiment for other types of domestic appliances, such as dryer machines, and refrigerators. Also, test different psychological theories to better understand the population's choices.

Acknowledgments

This research has been supported by the SCANDERE (Scaling up a circular economy business model by new design, leaner remanufacturing, and automated material recycling technologies) project granted from the ERA-MIN3 program under grant number 101003575 and funded by the project partner countries' national funding agencies. This initiative has been co-funded by the French ADEME (Ecologic Transition Agency) under contract number 2202D0103.

References

- [1] European Commission, Moving towards a circular economy. Available online at: <http://ec.europa.eu/environment/circular-economy/> (accessed September 2022).
- [2] Tukker, A. (2015). Product services for a resource-efficient and circular economy – a review. *Journal of Cleaner Production*, 97, 76–91. <https://doi.org/10.1016/j.jclepro.2013.11.049>
- [3] Oliva, R. and Kallenberg, R. (2003), "Managing the transition from products to services", *International Journal of Service Industry Management*, Vol. 14 No. 2, pp. 160–172. <https://doi.org/10.1108/09564230310474138>
- [4] Lawson, Stephanie J.; Gleim, Mark R.; Perren, Rebeca; Hwang, Jiyoung (2016). Freedom from ownership: An exploration of access-based consumption. *Journal of Business Research*, 69(8), 2615–2623. <https://doi.org/10.1016/j.jbusres.2016.04.021>
- [5] Daniel Brissaud, Tomohiko Sakao, Andreas Riel, John Ahmet Erkoyuncu. Designing value-driven solutions: The evolution of industrial product-service systems, *CIRP Annals*, Volume 71, Issue 2, 2022, Pages 553–575, ISSN 0007-8506, <https://doi.org/10.1016/j.cirp.2022.05.006>.
- [6] Lieder, M., Asif, F. M. A., Rashid, A., Mihelič, A., & Kotnik, S. (2018). A conjoint analysis of circular economy value propositions for consumers: Using “washing machines in Stockholm” as a case study. *Journal of Cleaner Production*, 172, 264–273. <https://doi.org/10.1016/j.jclepro.2017.10.147>.
- [7] E. Manzini; C. Vezzoli (2003). A strategic design approach to develop sustainable product service systems: examples taken from the ‘environmentally friendly innovation’ Italian prize. , 11(8), 851–857. [https://doi.org/10.1016/s0959-6526\(02\)00153-1](https://doi.org/10.1016/s0959-6526(02)00153-1)
- [8] Schmidt, D.M., Bauer, P.F., & Mörtl, M. (2014). Product-Service Systems for Influencing Customer Barriers and Customer Acceptance. <https://10.7763/JOEBM.2015.V3.321>
- [9] Baines, Tim & Lightfoot, Howard & Evans, Steve & Neely, Andy & Greenough, Richard & Peppard, Joe & Roy, Rajkumar & Shehab, Essam & Braganza, A & Tiwari, Ashutosh & Alcock, Jeffrey & Angus, James & Basti, M & Cousens, A & Irving, Phil & Johnson, Mark & Kingston, J. & Lockett, Helen & Martinez, Veronica & Wilson, Hugh. (2007). State-of-the-art in product-service systems. *Proc IMechE Part B: J Eng Manuf. Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*. 221. 1543–1552. <https://doi.org/10.1243/09544054JEM858>.
- [10] Tukker, Arnold. (2004). Eight Types of Product-Service System: Eight Ways to Sustainability? Experiences from Suspronet. *Business Strategy and the Environment* 13: 246 - 260. *Business Strategy and the Environment*. 13. 246 - 260. <https://doi.org/10.1002/bse.414>.
- [11] Piscicelli, Laura & Cooper, Tim & Fisher, Tom. (2015). The role of values in collaborative consumption: Insights from a product-service system for lending and borrowing in the UK. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2014.07.032>.
- [12] Greenpeace, 2012. 18th Guide to greener electronics. Retrieved on 16 September 2022 from <http://www.greenpeace.org/international/en/Guide-to-Greener-Electronics/18th-Edition/>
- [13] Natarajan, N., 2013. The future of mobile phone design. Retrieved on 16 September 2022 from https://www.foe.co.uk/news/phone_design_solutions_mib_39150
- [14] Edbring, Emma & Lehner, Matthias & Mont, Oksana. (2015). Exploring consumer attitudes to alternative models of consumption: Motivations and barriers. *Journal of Cleaner Production*. 123. <https://doi.org/10.1016/j.jclepro.2015.10.107>.
- [14] Louviere, J.J., Hensher, D.A., 1982. On the design and analysis of simulated choice or allocation experiments in travel choice modeling. *Transp. Res. Rec.* 890, 11–17.
- [15] Brissaud, D.; Sakao, T.; Riel, A.; Erkoyuncu, J.A. Designing value-driven solutions: The evolution of industrial product-service systems. *CIRP Annals* 2022, 71, 553–575.
- [16] Moreno, M., Turner, C., Tiwari, A., Hutabarat, W., Chamley, F., Widjaja, D., Mondini, L., 2017. Re-distributed manufacturing to achieve a circular economy: a case study utilizing IDEF0 modeling. *Procedia CIRP* 686 – 691.
- [17] Rexfelt, O., & Hiort af Ornäs, V. (2009). Consumer acceptance of product-service systems. *Journal of Manufacturing Technology Management*, 20(5), 674–699.
- [18] Amaya-Amaya, M., Gerard, K., Ryan, M., 2008. Discrete choice experiments in a nutshell. In: M. Ryan, K. Gerard, Amaya-Amaya M. (eds.), *Using discrete choice experiments to value health and health care*, 13 – 46. Springer.
- [19] Hidalgo-Crespo, J., Moreira, C. M., Jervis, F. X., Soto, M., & Amaya, J. L. (2021). Development of sociodemographic indicators for modeling the household solid waste generation in Guayaquil (Ecuador): Quantification, characterization and energy valorization. Paper presented at the European Biomass Conference and Exhibition Proceedings, 252–259
- [20] Hidalgo, J., Amaya, J., Jervis, F., & Moreira, C. (2019). Influence of socio-economic factors on household solid waste (HSW) generation of the city of Guayaquil, Ecuador. Paper presented at the Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology, 2019-July. <https://doi.org/10.18687/LACCEI2019.1.1.24>
- [21] Johnston, R.J., Boyle, K.J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T.A., Hanemann, W.M., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., 2017. Contemporary guidance for stated preference studies. *J. Assoc. Envir. Resour. Econ.* 4(2), 319–405.
- [22] Hidalgo-Crespo, J., Alvarez-Mendoza, C. I., Soto, M., & Amaya-Rivas, J. L. (2022). Towards a circular economy development for household used cooking oil in Guayaquil: Quantification, characterization, modeling, and geographical mapping. *Sustainability (Switzerland)*, 14(15) <https://doi.org/10.3390/su14159565>.
- [23] Rombouts, S. (2019). Towards a better understanding of consumer acceptance and valuation of product-service systems (PSS) - A discrete choice experiment on laundry solutions. Simon Rombouts.
- [24] Hidalgo-Crespo, J., Álvarez-Mendoza, C. I., Soto, M., & Amaya-Rivas, J. L. (2022). Quantification and mapping of domestic plastic waste using GIS/GPS approach at the city of Guayaquil. Paper presented at the *Procedia CIRP*, 105 86–91. <https://doi.org/10.1016/j.procir.2022.02.015>.
- [25] Orme, B. (2016). *CBC/HB V5, Software for Hierarchical Bayes Estimation for CBC data*, Sawtooth Software, Orem (Utah).