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The relation between service and digital transition: implications for designers

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Abstract

Service and digital transitions create a range of solutions by combining their features and introducing both human and automated agents as intermediaries. The paper classifies non/digital product/service and explores how these transitions change user involvement. A model is proposed to assess the user's role with human (service) and automated (digital) intermediaries. Utilizing user journey phases, the model is applied to four case studies, revealing commonalities in transition occurrences. Evidence suggest a potential adoption in design identifying the key phases per each transitions.

Keywords: user involvement, digital transition, service transition, user-centred design, human behaviour

1. Introduction

In the last few decades, many firms have started to develop services, as well as have integrated their business models and orientation from products to services (see Baines et al., 2009 for a review). This service transition has been occurring for many economic (e.g., market orientation; Ward and Graves, 2005) and business reasons (e.g., creating value through functionality and assistance to better cater to customer's needs; Jacob and Ulaga, 2008).

At the same time, products are becoming digitally smart, connectable, upgradeable, and reprogrammable by embedding digital technologies (Cantamessa et al., 2020). The way these attributes and other digital features are implemented within the product or service determines different levels of digitalisation, resulting in a not univocal definition of digital artefact (Kallinikos, 2013).

These evolutions towards service and digital have been affecting the nature of an artefact. They have led to product-service systems (PSS; Goedkoop et al., 1999), cyber-physical systems (CPS; Baheti and Gill, 2011), and all the gradient of combinations of product/service/PSS and non/digital/CPS. At a more general level, artefacts evolve toward reducing human involvement (Altshuller, 1999) by introducing automated or service agents. These elements significantly impact the user's interaction, strongly affected by the nature of the artefact (Norman, 1988).

In line with the above considerations, this paper aims to investigate how digital and service transitions are direct expressions of the reduction of human involvement, considering that both force design routines and processes to change. In doing so, the present contribution has a specific scope: it investigates the interactions between humans and artefacts, particularly the categories of non-digital products, non-digital services, digital products, and digital services, by considering how the digital and service intermediaries introduced by the two transitions reduce users' involvement in the usage process.

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Hence, starting from the classification of non/digital product/service, as well as considering the differences between physical and digital interaction, the paper aims to investigate the three following research questions:

- How do service and digital transitions reduce user involvement, separately and combined?
- In favour of which agents does the reduction of user involvement occur?
- Which usage process phases are most affected by the reduction of user involvement?

By using a visualisation tool as the user journey map, a model has been built to investigate the user's involvement as a proxy of the degree of operational coverage by the service and digital intermediaries. The importance of user experience has already been recognised in the design literature (e.g., Kim et al., 2016), and user experience visualisation tools have been used to support design activities (e.g., feature trees; Iuskevich et al., 2021). Therefore, the paper aims at supporting designers in understanding which phase of the journey should be the focus of design activities when service or digital transition occurs. The paper is divided into five sections. The Background section analyses the context and main literature contributions to digital and service transition and user journey. Then, Methodology and Data discusses the method adopted and the analyses conducted for the present work. Results and Discussions section shows the evidence derived from such investigations. Finally, Conclusions are provided to discuss the implications of results and possible future studies.

2. Background

2.1. Service and digital transition

The five technological domains of digitalisation (i.e., internet protocols, augmented and virtual reality, powered and cheaper IT equipment, data mining, and machine learning; Cantamessa et al., 2020) give rise to a vast potential for both products and services, which often results into CPS and PSS. Hence, in this context, it is no longer a matter of designing a product or a service, but rather a system (also defined as an artefact) that might include a digital component (i.e., a product, a service, or a combination of the two; Colombo et al. 2022), where the technology might be an essential mediator of either positive or negative emotions (Sandström et al., 2008). Although the boundaries between products and services have become blurred, some definitions could help in interpreting the differences:

- Product is a tangible artefact whose functionality satisfies or anticipates users' needs (Kotler et al., 2006); it can be stored and sold/marketed. It results from production processes that anticipate product consumption and are standard, providing homogeneity to the product in terms of performance and quality (Hill, 1997; Zeithaml, 1981).
- Service is an intangible artefact (according to service design or service innovation) or locus of exchange (according to the Service Dominant Logic, Vargo and Lush, 2004) that satisfies or anticipates users' needs (Zeithaml, 1981). More than product, service is information intensive: it creates customer value primarily via information interactions between customers and providers, and the application of specialised competencies in terms of knowledge and skills. Service involves interaction with the user (Prahalad and Ramaswamy, 2004), often resulting in value co-creation (according to Design Thinking and Transformative design). Production is simultaneous to consumption (Jackson et al., 1995) through customised and unique processes that give the service the characteristic of heterogeneity in performance and quality. It can be sold, delivered/released, but not stored (Hill, 1997; Lovelock and Gummesson, 2004).
- Product-Service-System refers to a "marketable set of products and services capable of jointly fulfilling a user's need", in which the presence of features referred to product or service can vary from case to case and evolve over time due to technological development, economic value, and changing need of customers (Goedkoop et al., 1999). PSS can be distinguished (e.g., result-oriented, use-oriented and product-oriented PSSs; Valencia et al., 2015) according to what is more valuable and where the user perceives more relevance.
- Cyber-Physical System is a new generation of systems capable of expanding the abilities of the physical world towards computation, communication, and control (Baheti and Gill, 2011) or, more simply, as a system connecting physical and digital environments (Lee, 2015).

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On the other hand, one can refer to a digital artefact as:

- a bundle of intangible (bitstring) and tangible components (means or bearer), which can be stored and allows the storage, transmission, and transfer of the information contained in the intangible component. Such 'double nature' provides digital artefact with the following characteristics: non-rivalry in consumption, non-excludability, durability over time, being copied without high cost or effort, multifunctionality, and recombinability (Quah, 2003; Rayna, 2008). It embodies an 'experience-good' able to interact with other objects, humans, or the surrounding environment (Vitali et al., 2017). Digital artefacts (e.g., smartphones, PCs, etc.) often enable the use of technology-based services, thus embodying the service interface (also named 'service access equipment'; Sandström et al., 2008).

According to the previous descriptions, nowadays we are witnessing two transitions (i.e., the digital transition, from non-digital to digital, and the service transition from product to service) that intertwine in system evolution, generating a continuum of solutions as a combination of the enabling features the two transitions provide. Not necessarily one of the two transitions dominates the other, even though researchers have acknowledged that, from a business perspective, adopting digital technologies enables the delivery of services and the improvement of a service-oriented strategy (Kowalkowski et al., 2013). Digital and service transitions are thus often twisted in integrating digital architectures, tangible products, and intangible services, which make them 'agents' (Gero and Kannengiesser, 2003) that act as intermediary figures in delivering functions to the user and eventually embody value. Those transitions might occur when humans deliver a service or when an automated system, often digitally enabled, acts on behalf of the user, interacting with people and the environment. As a matter of fact, Altshuller (1999) observed that technical systems evolve by embedding the different functional elements to reduce human involvement. Normally, this happens first by relieving the human operator from the most tiring tasks and then gradually from those in charge of system control (and cognitively intensive).
As an outcome of the brief literature review presented, Figure 1 proposes an original map to depict the above transitions and position artefacts in their different stages of the continuum. Figure 1.a represents this interconnection between service and digital transitions, depicting non/digital product/service combinations and classifying them in four quarters: the first quarter is for non-digital products (top left), the second quarter for non-digital services (top right), the third quarter for digital products (bottom left), and finally, the fourth quarter for digital services (bottom right). Figure 1.b places in space and colour the different type of artefacts, according to their features (i.e., yellow and blue nuances represent the digital and service transition, respectively).
It is worth noting that the two dimensions should not be read as Cartesian axes in strict terms. For instance, a Cyber-Physical Product is both physical and digital at the same time, and a PSS combines the features of both products and services. In other terms, PSSs do not necessarily represent artefacts with a reduced presence of tangible aspects, they can also be as tangible as a product, but with an additional non-tangible component referred to as service.

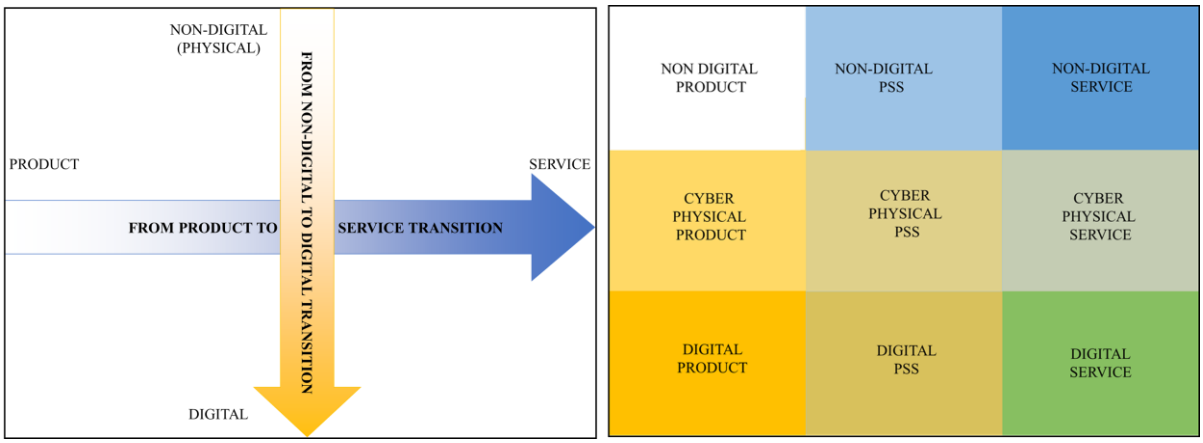

Figure 1. a) Service and digital transition; b) Artefacts classification

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2.2. Physical and digital interactions

Human-product interaction has been largely explored in design, where the nature, quality, and elements of this interaction are investigated (User-Centered Design; e.g., Norman, 1988) and extended considering messages provided by artefacts in resulting perception, judgement, and inducing activities (Interaction Design; Kim and Hong, 2012). Besides, focusing on human-computer interfaces and their importance in influencing human work and activity, captology explains how technologies can foster user's behavioural change (e.g., Fogg, 2003). Moreover, embedding digital technologies gives artefacts further features and properties such as reactivity, proactivity, preemptiveness, and interactivity (Ghajargar et al., 2017). These features make the artefacts agents of thoughtful and reflective interactions (as defined by Schön, 1983), capable of assisting users in building wisdom upon their knowledge (as intended by Ackoff, 1989). This reflective interaction (human-computer interaction, Dourish, 2004) occurs thanks to the augmented features of digital artefacts (i.e., deliberative, reflectional, experiential, and communicative features; Ghajargar et al., 2017) and their resulting ability to guide users to make conscious decisions, thus provoking peculiar thoughts and reflection. This augmentation, combined with increasing automation and agency, is gradually changing the role of digital technologies from tool to 'actor' in value creation (Pakkala and Spohrer, 2019).
In this sense, technologies offer various opportunities to stimulate, drive, or shape human behaviour, and mapping a user journey with all its touchpoints might help identify and design novel possible ways of interaction.

3. Methodology and data

The two transitions respectively introduce service and digital attributes to artefacts that make them 'agents' in delivering function and creating value for customers. Hence, depending on the transition, it is possible to observe the introduction of a human or automated agent that acts as an intermediary in executing the activities and creating value for the user, supporting or directly replacing them. Such agents indeed affect user involvement and, therefore, must be investigated to identify the direction toward which the reduction of human involvement (observed by Altshuller, 1999) is going.
For this purpose, in this paper, the user journey (Patton, 2012) that usually enables a general overview of users' experience (Halvorsrud et al. 2016) is employed to distinguish between the different phases. For each phase, the user's involvement is measured in relation to the other intermediary agents in terms of the relevance of their role in performing activities and creating value. In particular, the agents considered in the study, other than the user itself, are the artefact and the service agent (as a substitute of the user in performing a task/activity). In this way, designers can envision different scenarios and identify core areas of intervention to facilitate the user's navigation within the system (Evenson and Dubberly, 2010) and select the right design elements to convey value appropriately (Kim et al., 2016).
User experience is a small part of a more comprehensive concept of customer experience, but the decision-making process of purchasing is out of the scope of this paper. Therefore, the analysis focuses exclusively on the post-purchase phases of the customer journey (Figure 2.a), since it is part of the user journey, as depicted in Figure 2.b.

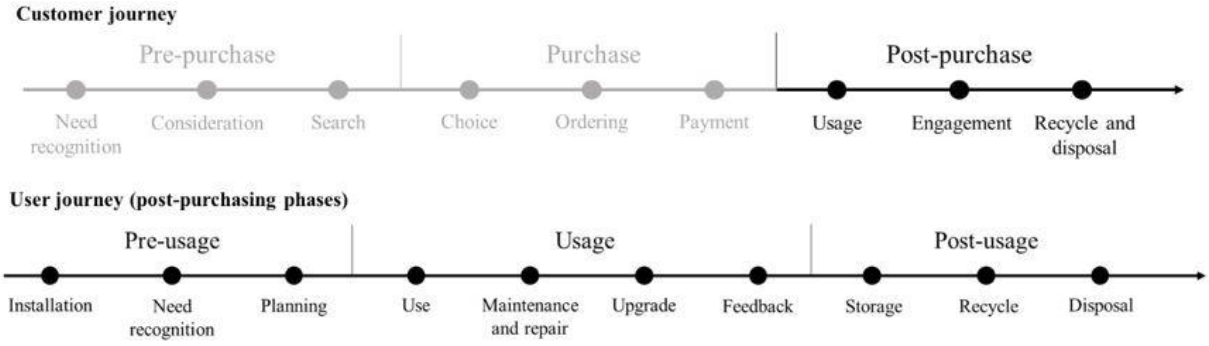

Figure 2. a) Customer journey; b) User journey

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To illustrate and confirm this analysis, some case studies have been selected and analysed through a focus group, considering the user involvement in the tasks/activities carried out along the journey. The focus group involved four experts, two seniors and two juniors, with competencies in Design, Engineering Design, Innovation Management, and Marketing. Given the different backgrounds and the collaborative situation, classical brainstorming has been adopted to assess the suitability of the case studies to the RQs, how they position in the map of Figure 1.a. and the intermediaries involved.

3.1. Case study identification

The identified case studies have been clustered in view of the accomplishment of a specific function to identify an artefact per category (for simplicity and with illustrative purpose only, exclusively the extreme cases of the two transitions have been considered). Figure 3 presents a partial result of the brainstorming, with some examples of identified case studies coloured according to their declared function (i.e., get the house clean, get around independently while driving, customise garments, have clean clothes, exercise with correct posture, time management) and the associated artefacts positioned in the map of Figure 1.a. Among these, four are highlighted with brighter colours as they represent the focus of this paper. These artefacts present i) technological maturity (i.e., technology has reached stable and hence easily comparable performance, Abernathy and Utterback, 1975), ii) good market penetration, with a limited number of companies supplying such technology in the industry. Consequently, the study does not aim to be exhaustive but rather conceptually representative.

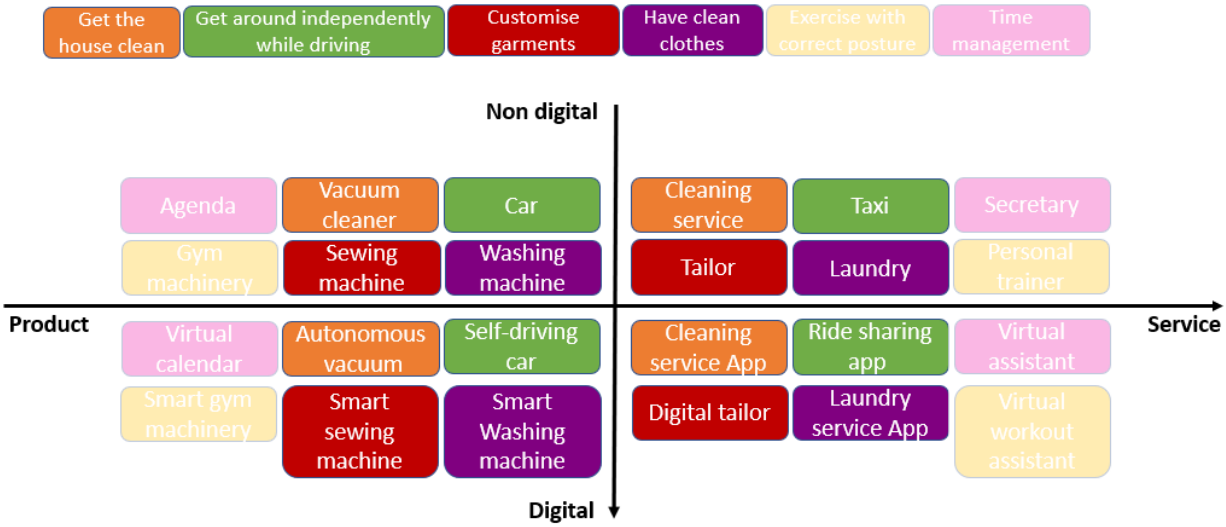

Figure 3. Case studies selected for the analysis

3.2. Evaluation by user journey

Starting from Oxford Dictionary definitions, all the phases related to the user journey were identified, with a focus on the most relevant in the design perspective (Table 1). These phases are characterised by different levels of user involvement (Lemon and Verhoef, 2016), often because an agent intermediates the user in action (Engholm, 2010). Therefore, the user journey is adopted to analyse the interaction between the user and the artefact, and thus to understand the specific phase in which this intermediation occurs and whether automated or service agents have a more relevant role in value creation.

Focusing on the four case studies in Figure 3, the user involvement, automated agent and service agent were explored in every category of artefacts (i.e., all the combinations of non/digital products/services). The evaluation occurred through a rating process carried out by the experts involved in the focus group, who were asked to answer the question: "*How important is the involvement of [X] in phase [Y]?*". Here, the user, automated agent and service agent defined X; the different phases defined Y.

The experts were provided with a rating file with distinct but equal sections dedicated to every case study, each including four matrixes for the evaluation of the single artefacts. Being the phases on the rows and the actors on the columns, the raters were asked to fill the cells with a score on an ordinal Likert scale from

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0 = "*not involved at all*", to 15 = "[X] *is the only one involved*", knowing the sum of the involvement of the three agents had to be equal to 15 per each phase (i.e., row sum). A final column was added to facilitate the process, showing the "remaining score" to be assigned and hence decreasing as the cells were filled. Cronbach's alpha was adopted to confirm raters' consistency ($\alpha = 0.712$). The raters' answers were averaged to define a general evaluation of the involvement of each agent in each phase for each artefact.

Table 1. Description of the user journey activities

Post-purchase	Pre-usage	*Installation*: place the artefact in position or connect for service or use
		Need recognition: perceive the need to reach a goal as existing or true
		Planning: arrange an interaction method or scheme beforehand
	Usage	*Use*: employ the artefact for a purpose
		Maintenance and repair: keep the artefact in an appropriate condition or operation
		Upgrade: improve or enhance the quality or value of the artefact
		Feedback: give/collect evaluative information derived from a reaction or response to a particular process or activity with the artefact
	Post-usage	*Storage*: accumulate or put the artefact away for future use
		Recycle: alter or adapt the artefact for new use without changing the essential form or nature
		Disposal: get rid of the artefact

4. Results and discussion

The main meaningful finding of the present work is an analogous involvement of the user in all case studies in relation to the role of the artefact and service, as intermediaries along the journey. In particular, user involvement always decreases in favour of the increasing relevance of intermediaries in accomplishing the function. Because of the similar patterns identified, results are here discussed per artefact category.

Non-digital products see exclusively the involvement of the user and the artefact. All activities are indeed covered by the user who interacts with the non-digital artefact, especially in the pre-usage and feedback phases. During use, maintenance, and upgrade, the artefact becomes crucial for the execution of activities and performance. Consequently, the relevance of its role is considered to be the maximum.

Non-digital services present an essential role for the service agent in creating value. In pre-usage, service agents act as intermediaries to the user on the information side (indeed, services are information-intensive). Thanks to service agents' cognitive or physical abilities to suggest the appropriate time/way to intervene, they make their role relevant both in need recognition and planning phases. However, these suggestions might turn out to be a limitation of freedom for the user, who results not completely independent in their choices (Prahalad and Ramaswamy, 2004). During usage, user involvement is at its lowest level as disengagement and delegation from activities are often precisely the reason why the user opts for the service in the first place (Lovelock and Gummesson, 2004). In these phases, the role of the service agent is as important as the role of the artefact, which is still used to execute the activity. Similarly, maintenance and repair are almost completely delegated as they are unpleasant and not value-added activities (Han et al., 2012). On the contrary, feedback remains in users' hands, requiring their direct and active participation. Post-usage phases present dynamics of involvement similar to pre-usage. More specifically, service storage is not possible by definition, but all the systems involved in delivering a service require it. Analogous considerations are valid for the recycle and disposal phases but with a greater service intermediation because of the extended producer responsibility (EPR; Wallas, 2006).

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Digital products again see the exclusive involvement of the user and the artefact, but with a more important role of the latter. The product is automated and acts as an intermediary in more tasks/activities. In pre-usage, during installation, the user is required to configure the artefact. Such activity has greater relevance than in the previous two non-digital cases, since the user is shifting the system's control from usage to pre-usage phases. In usage, automated systems are often deputed to control and autonomously implement related actions (Cascini, 2012), where data are crucial (Cantamessa et al., 2020).
A major role of the artefact is considered in need recognition and planning, as well. The artefact, in fact, intermediates these activities by sending reminders and recommending several options to the user. During use, user involvement is at a minimum since the artefact is able to act autonomously and almost substitute the user, thanks to automation. Upgrade considerably involves the artefacts since it is often imposed as necessary to continue the use or to guarantee a better experience (Saarikko et al. 2020). Post-usage considerations about the role of the user and the automated agent are the same as for non-digital products. Digital services are considered the greatest change with respect to non-digital products as both service and digital transitions have occurred, and therefore the above-described effects are overlapped. From the rating, the artefact and service agent are equally relevant intermediaries in creating value along the journey and accomplishing the target function.
Figure 4 provides a visual representation of the results associated with the objective of getting the house clean, as an explanatory example. The four categories are shown in the same order as in Figure 2: the top left represents the non-digital product (the vacuum cleaner); the top right depicts the non-digital service (cleaning service or operator); the bottom left is the digital product (autonomous vacuum cleaner); the bottom right is the digital service (cleaning service app). Moving to the right means service attributes are added to the artefact (i.e., service transition), leading to the intervention of the service intermediary (blue area). On the other hand, moving to the bottom, digital technologies are embedded in the artefact (i.e., digital transition), and the relevance of the role of the automated agent increases (yellow area) to reach the user's goal.

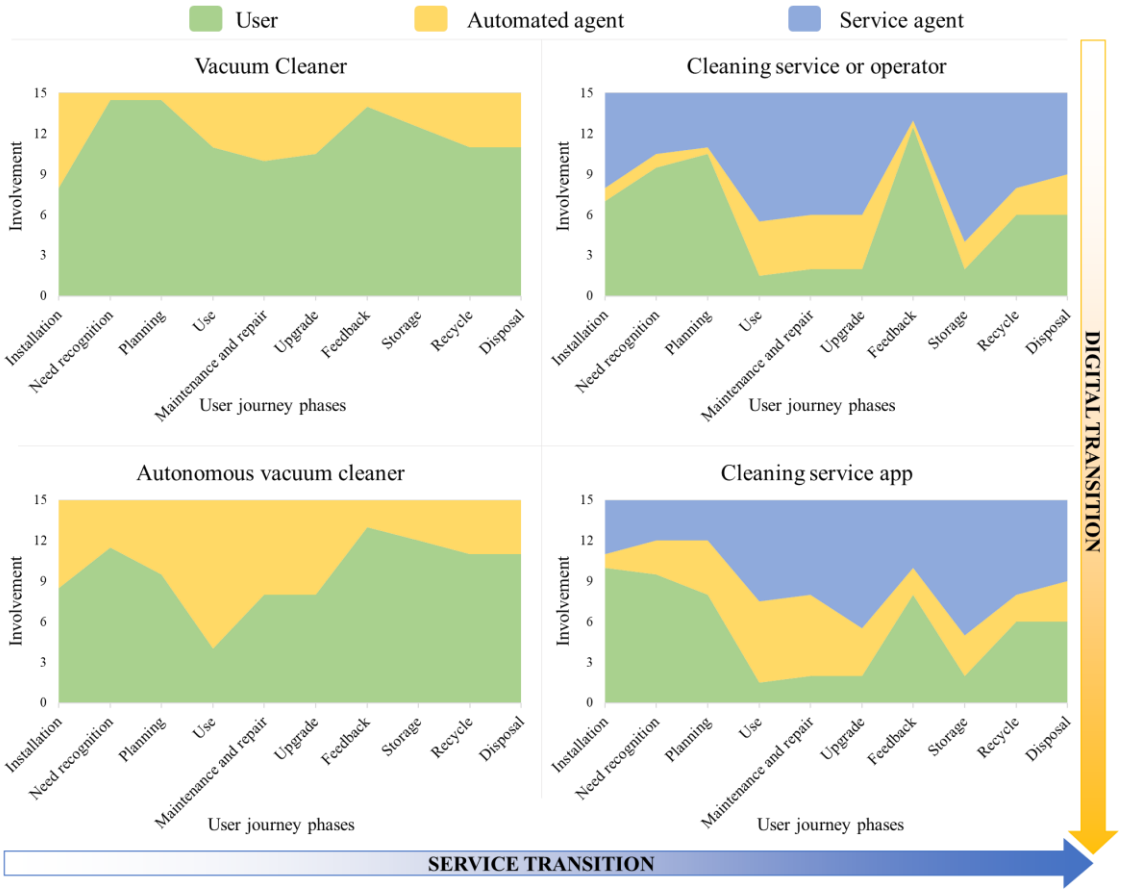

Figure 4. Preliminary results in the user's goal of "getting the house clean"

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The horizontal axis presents the phases of the user journey, while the vertical axis shows the values of the Likert scale used in the evaluation process, consistently setting the maximum involvement of an actor in a phase at 15. The total area of each graph thus indicates the full participation required to achieve the objective of the case study and it is indeed divided among the different actors according to their contribution. This representation enables us to easily envision the relationship between the user and the two agents (automated agent and service agent) and how this changes among the transitions.

In the analysed artefacts, the green area decreases in all four cases, meaning both service and digital transitions reduce user involvement while introducing service and automated agents (human and/or digital). In general, what results from the digital transition is a decrease in user involvement in favour of a greater relevance of the automated agent, which, becoming more automated, provides more support in pre and post-usage phases while almost substituting the user in usage activities. On the other hand, within the service transition, the intermediary offers assistance in all phases, especially in usage and post-usage. Finally, when they occur together, both the automated artefact and the service agent act as intermediaries, thus releasing the user from several constraints in terms of time and place of the activities to be done (Lovelock and Gummesson, 2004) and consequently leading to the lowest relevance of the user role. In both transitions, pre-usage phases and feedback are the last activities to be delegated, while the presence of intermediaries, albeit limited, also in these phases can be interpreted in light of the users' trust in technology and service quality in delegating the recognition of their needs (Almarashdeh, 2018). This result is consistent with Altshuller (1999) about technical systems evolution, but besides distinguishing between service and digital transition, it adds a more detailed vision of the phases in which it occurs and of the agent by whose hand intermediation occurs.

The resulting framework might describe the state of the art in the combination of digital and service transitions and guide the development of future products/services, especially developing guidelines for integrating services and digital technologies.

In particular, user journey maps offer a high-level overview of the comprehensive experience in which the user engages so that designers can understand their needs and their way of interacting to convey value by selecting the appropriate design elements (Kim et al., 2016). Moreover, a visual storyline helps designers envision different possible scenarios and identify the core areas of intervention to facilitate the user's navigation within the system (Evenson and Dubberly, 2010). This will lead to more structured problems in conceptual design: understanding how a new digital product could reduce the user's involvement in a specific phase could help designers to identify the critical features and dimensions of the artefact deserving attention to providing value (the one that can be perceived since interaction) to user. Moreover, once one recognises the pattern in the user's involvement along the two transitions and considers digital services as the last step in terms of the timing of development (Kowalkowski et al., 2013), this model may help design future solutions.

5. Conclusions

Starting from a classification of artefacts resulting from the service and digital transitions, the paper presents a model to evaluate the user's involvement in the phases of the usage process, when interacting with non/digital products/service artefacts. Early evidence from the four selected case studies emphasised the reduction of user's involvement foreseen by Altshuller's (1999), showing an increasing role of intermediary agents. In both transitions, their relevance is greater in the usage, maintenance and repair due to the user's willingness to disengage from the execution of these activities.

The resulting framework could imply an extension of the traditional disciplinary domain of design with the necessary expertise to manage the particular technological and service attributes of such artefacts.

The study has some limitations. The first is related to the focus group analysis. The results constitute preliminary evidence for more robust insights, but they should be further validated with a wider sample of respondents based on the one proposed method. Moreover, selecting the case studies by identifying the main function narrows the focus to the main scope of the artefacts, neglecting the many other possible use cases of considered products/services.

Finally, the actual categories are limited to the main four. It would be reasonable to extend such analyses to hybrid situations, especially understanding if intelligent artefacts (including AI systems) could lead to further categories among digital ones. Suggestions for future studies also include to investigate all

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these categories, extending the number of case studies and search for correlations among the digital and service transitions in different industries. This could help to identify patterns typical of a specific sector in increasing the relevance of intermediaries' roles in reaching a specific goal.

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References

Abernathy, W. J. and Utterback, J. M. (1975), "A dynamic model of process and product innovation", *Omega*, Vol. 3, No. 6, pp. 639-656, https://doi.org/10.1016/0305-0483(75)90068-7

Ackoff, R.L. (1989), "From data to wisdom", *Journal of applied systems analysis*, Vol. 16, n. 1, pp. 3-9.

Almarashdeh, I. (2018), "The important of service quality and the trust in technology on users perspective to continues use of mobile service", *Journal of theoretical and applied information technology*, Vol. 96, No. 10, pp. 2954-2972

Altshuller, G. S. (1999), *The innovation algorithm: TRIZ, systematic innovation and technical creativity*, Worcester, MA: Technical innovation center.

Baheti, R., and Gill, H. (2011). Cyber-physical systems, The impact of control technology, *IEEE Control System Society*, vol. 12 n. 1, pp.161-166.

Baines, T.S., Lightfoot, H.W., Benedettini, O. and Kay, J.M. (2009). "The servitization of manufacturing: a review of literature and reflection on future challenges", *Journal of Manufacturing Technology Management*, Vol. 20, No.5, pp. 547-567, https://doi.org/10.1108/17410380910960984

Cantamessa, M., Montagna, F., Altavilla, S., and Casagrande-Seretti, A. (2020), "Data-driven design: the new challenges of digitalisation on product design and development", *Design Science*, Vol. 6, No. 27, https://doi.org/10.1017/dsj.2020.25

Cascini, G. (2012). TRIZ-based anticipatory design of future products and processes. Journal of Integrated Design and Process Science, 16(3), 29-63.

Colombo, S., Montagna, F., Cascini, G., and Palazzolo, V. F. (2022), "Digital artefacts and the role of digital affordance", *Proceedings of the 17th International Design Conference, Dubrovnik, Croatia, May 23-26, 2022*, Vol. 2, The Design Society, Glasgow, pp. 11-20, https://doi.org/10.1017/pds.2022.2

Dourish, P. (2004), "What we talk about when we talk about context", *Personal and ubiquitous computing*, Vol.8, No. 1, pp. 19-30, https://doi.org/10.1007/s00779-003-0253-8

Engholm, I. (2010), "The good enough revolution—the role of aesthetics in user experiences with digital artefacts", Digital Creativity, Vol. 21, No. 3, pp. 141–154. https://doi.org/10.1080/14626268.2010.488809

Evenson, S., and Dubberly, H. (2010), "Designing for service: Creating an experience advantage", In: Salvendy, G. and Karwowski, W. (Eds.), *Introduction to service engineering*, pp. 403-413, https://doi.org/10.1002/9780470569627.ch19

Fogg, B. J. (2003). *Persuasive Technology: Using Computers to Change What We Think and Do*. Morgan Kaufman Publisher Inc., San Francisco, CA, US.

Gero, J., Kannengiesser, U. (2003). Function-Behavior-Structure: A model for social situated agents. Workshop on Cognitive Modeling of Agents and Multi-Agent Interactions, International Joint Conference on Artificial Intelligence, 101, 107.

Ghajargar, M., De Marco, A., and Montagna, F. (2017). "Wise things: When smart objects stimulate reflection". *Proceedings of 11th International Conference on Interfaces and Human Computer Interaction*, *Lisbon, Portugal, 21-23 July*, 2017, Vol.1, pp. 233-238

Goedkoop, M. J., Van Halen, C. J., Te Riele, H. R., and Rommens, P. J. (1999), Product service systems, ecological and economic basics. *Report for Dutch Ministries of environment (VROM) and economic affairs (EZ)*, Vol. 36, No. 1, pp. 1-122,

Halvorsrud, R., Kvale, K., and Følstad, A. (2016), "Improving service quality through customer journey analysis". *Journal of service theory and practice*, Vol. 26 No. 6, 840-867, https://doi.org/10.1108/JSTP-05-2015-0111

Han, S., Lee, S. and Pena-Mora, F. (2012). "Identification and Quantification of Non-Value-Adding Effort from Errors and Changes in Design and Construction Projects", *Journal of Construction Engineering and Management*, Vol. 138 No. 1, pp. 98–109, https://doi.org/10.1061/(ASCE)CO.1943-7862.0000406.

Hill, T. P. (1977), "On goods and services". *Review of income and wealth*, Vol. 23 No. 4, pp. 315-338. https://doi.org/10.1111/j.1475-4991.1977.tb00021.x

Iuskevich, I., Hein, A.-M., Amokrane-Ferka, K., Doufene, A., and Jankovic, M. (2021), "A Data-Driven Approach to User-Experience-Focused Model-Based Roadmapping for New Product Planning", in *Proceedings of the*

https://doi.org/10.1017/pds.2024.34 Published online by Cambridge University Press

International Conference on Engineering Design (ICED21), Gothenburg, Sweden, 16-20 August 2021. https://doi.org/10.1017/ pds.2021.7
Jackson, R. W., Neidell, L. A., and Lunsford, D. A. (1995), "An empirical investigation of the differences in goods and services as perceived by organizational buyers". *Industrial Marketing Management*, Vol. 24 No. 2, pp. 99-108. https://doi.org/10.1016/0019-8501(94)00037-W
Jacob, F., and Ulaga, W. (2008), "The transition from product to service in business markets: An agenda for academic inquiry". *Industrial marketing management*, Vol. 37 No. 3, pp. 247-253, https://doi.org/10.1016/j.indmarman. 2007.09.009
Kallinikos, J. A. (2013), "The Ambivalent Ontology of Digital Artefacts". *MIS Quarterly*, pp. 357-370.
Kim, E., Chung, J., Beckman, S. and Agogino, A.M. (2016), "Design Roadmapping: A Framework and Case Study on Planning Development of High-Tech Products in Silicon Valley", *Journal of Mechanical Design, American Society of Mechanical Engineers Digital Collection*, Vol. 138 No. 10 http://doi.org/10.1115/1.4034221
Kim, Y., and Hong, Y. (2012), Interaction model for products and services using affordance. *Proceedings of the ASME Computer and Information in Engineering Conference, Chicago, Illinois, 12-15 August, 2012*, Vol. 2, No. 32, pp. 645-652. https://doi.org/10.1115/DETC2012-71110
Kotler, P. Armstrong, G., Brown, L. and Adam, S. (2006), *Marketing*, Macquarie Graduate School of Management
Kowalkowski, C., Kindström, D., and Gebauer, H. (2013), "ICT as a catalyst for service business orientation". *Journal of Business & Industrial Marketing*. Vol. 28 No. 6., pp. 506-513. 10.1108/JBIM-04-2013-0096
Lee, E. A. (2015), "The past, present and future of cyber-physical systems: A focus on models". *Sensors*, Vol. 15 No. 3, pp. 4837-4869, https://doi.org/10.3390/s150304837
Lemon, K. N., and Verhoef, P. C. (2016), "Understanding Customer Experience Throughout the Customer Journey", *Journal of Marketing*, Vol. 80, No. 6, pp. 69-96. https://doi.org/10.1509/jm.15.0420
Lovelock, C., and Gummesson, E. (2004). "Whither services marketing? In search of a new paradigm and fresh perspectives", *Journal of service research*, Vol. 7 No. 1, pp. 20-41. https://doi.org/10.1177/109467 0504266131
Norman, D.A. (1988) The psychology of everyday things. Basic Book
Pakkala, D., & Spohrer, J. (2019). Digital service: technological agency in service systems. Proceedings of the 52nd Hawaii International Conference on System Sciences.
Patton, J. (2012). *User Story Mapping: Discover the Whole Story, Build the Right Product*. O'Reilly & Associates, Sebastopol, Ukraine
Prahalad, C.K. and Ramaswamy, V. (2004). *The Future of Competition: Co-creating Unique Value with Customers*. Harvard Business School Pres. Boston, MA.
Quah, D. (2003). Digital Goods and the New Economy. Available at SSRN: https://ssrn.com/abstract=410604
Rayna, T. (2008). "Understanding the Challenges of the Digital Economy: The Nature of Digital Goods". Communications & Strategies, No. 71, pp. 13-16, 3rd Quarter 2008, Available at SSRN: https://ssrn.com/ abstract=1353583
Saarikko, T., Westergren, U.H. and Blomquist, T. (2020). "Digital transformation: Five recommendations for the digitally conscious firm", *Business Horizon*, Vol. 63 No. 6, pp. 825-839, 10.1016/j.bushor.2020.07.005
Sandström, S., Edvardsson, B., Kristensson, P. and Magnusson, P. (2008), "Value in use through service experience", *Managing Service Quality: An International Journal*, Vol. 18 No. 2, pp. 112-126. https://doi.org/10.1108/09604520810859184
Schön, D. (1983). The reflective practitioner: how professionals think in action. Basic Books, NY.
Valencia, A., Mugge, R., Schoormans, J., & Schifferstein, H. (2015). The design of smart product-service systems (PSSs): An exploration of design characteristics. International Journal of Design, 9(1). https://www.ijdesign.org/index.php/IJDesign/article/view/1740
Vargo, S. L., and Lusch, R. F. (2004). "Evolving to a new dominant logic for marketing". *Journal of marketing*, Vol. 68 No. 1, pp. 1-17 10.1509/jmkg.68.1.1.24036
Vitali, I, Arquilla, V. and Tolino, U. (2017), "A Design perspective for IoT products. A case study of the Design of a Smart Product and a Smart Company following a crowdfunding campaign", *The Design Journal*, Vol. 20 No. sup1, pp. S2592-S2604, https://doi.org/10.1080/14606925.2017.1352770
Wallas, M. (2006). "Extended producer responsibility and product design: Economic theory and selected case studies", *RFF Discussion Paper (06-08)*, https://doi.org/10.2139/ssrn.901661
Ward, Y., & Graves, A. (2005). "Through-life management: the provision of integrated customer solutions by aerospace manufacturers", *Working Paper Series*, University of Bath School of Management, 14.
Zeithaml, V. A. (1981). "How consumer evaluation processes differ between goods and services", *Marketing of services*, Vol. 9 No. 1, pp. 25-32.

https://doi.org/10.1017/pds.2024.34 Published online by Cambridge University Press