Analysis of Psychographic and Human Factors for Building Personalyzed Product Ecosystems

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Abstract— **The research paper aims to propose a framework through which digital companies could customize personalization for their customers and users. With a help of it, they should be better at assessing the product-market fit and comply with digital product usage needs. The framework is based on digital consumer-oriented product ecosystems, personalization, and human factor literature review. Snowballing technique with multiple selection criteria is used to discover new literature and answer research questions on what ecosystems are, what impact their personalization, and whether that can be achieved by focusing on cognitive and psychographic human factors.**

Keywords— cognitive human factors, human factors, personalization, product ecosystems,.

I. INTRODUCTION

Digital and physical product ecosystems have become an important discussion aspect as today a single product value has become dependent on other additional products and services. Ecosystems are not an entirely new concept. At first, it was used in biology to describe living organism dependence and interconnectedness between them [1]. Now same concepts are appearing frequently in marketing research papers and in business informatics news portals.

The role of ecosystems for businesses, consumers and users have become more important than they used to be as digital and physical product integration in ecosystem can increase or decrease total value of another product. Previously digital and physical product ecosystems were small, they consisted of a couple of entities, but today because of the available connections and integrations between digital and physical products, the ecosystems can be massive. For example, comparing an ecosystem of watching TV, to a modern streaming entertainment ecosystem.

Previously to get the value from watching TV, the user needed a TV, remote, and batteries to power the remote. Then today to receive maximum usage value from streaming services such as Netflix user needs to own multiple devices (TV, smartphone, gaming console, etc), the account in specific platform application store, the application itself and a Netflix account. All of that to enjoy TV level of entertainment on demand anywhere and on every possible device. Similarly, it is with Spotify, Microsoft Office 360, Google G-suit, and even digital-physical ecosystems such as Apple's ecosystem, Android ecosystems, and more.

The point is that with the ecosystem consumer gains additional purchase values and ecosystem factor that needs to be taken into consideration. Users from the ecosystem gain functionality that can be integrated with other products. While businesses gain positioning and marketing opportunities if the ecosystem is interpreted correctly and personalized for its targets.

Ecosystems in the domain of business informatics are emerging paradigms. It is important to understand product ecosystems as this domain depends and thrives on interdependent product connections to create value for the users and business. This is a complexity of different systems and systems of systems that needs understanding, representation, and knowledge management on how to approach them. When understanding will be made, it will be possible to theorize about tools such as artificial intelligence and how it can be implemented.

This research paper theorizes that by identifying human factors that contribute to personalization perception - it would be easier to create digital and physical products that suits user needs and are economically viable for the business. The objective of this paper is to understand what consumer-oriented digital and physical product ecosystems are, what defines them, what they consist of, and offer digital businesses a framework for personalization customization. The article is structured as follows: first, literature research questions and inclusion criteria are defined. Second, using gathered literature answers to research questions are found. Third, a summary of the literature review is presented through the product digital and physical ecosystem personalization canvas. Fourth, future research possibilities are outlined.

II. LITERATURE REVIEW PROCESS

Three key research questions are defined:

RQ1: What defines as product ecosystems and how do they impact product value perception by users?

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The answer to this question will provide an understanding of the product development paradigm – ecosystems. (Answer in: Product ecosystems)

RQ2: What contributes to the personalization when users use a product or product ecosystem?

The answer to this question will provide and understanding what impacts user's perception of personalization. (Answer in: Ecosystem personalization)

RQ3: Can knowledge of users cognitive and psychographic factors help businesses to make more personalized products and ecosystems.

The answer to this question will provide an understanding whether cognitive and psychographic human factors can help to personalize products and ecosystems? (Answer in: Ecosystem personalization)

To find answers to provided questions a set of literature is needed. For that purpose, a snowballing method is used [5] where starting set is created by the following criteria:

- The selected article must be in the computer, science, marketing, cognitive sciences, social psychology domain.
- The selected articles should be from different publication years, covering as much time span as possible.
- The selected article must include studies on ecosystems oriented for user, consumers, or customers.
- Each selected study must include at least a combination of two keywords.

Relevant keywords that will later be used in Google Scholar as well as IEEE Xplore database searches are defined. Those are - *product perception, product ecosystems, personalization, human factors, human factor, engineering, psychographics, cognitive factors, affective products.* Additionally, combined keyword queries are used to broaden search results. Those are: (search term 1: personalization AND product ecosystems, search term 2: personalization AND human factors, search term 3: product ecosystems AND product perception, search term 4: product perception AND personalization, search term 5: personalization AND cognitive factors, search term 6: personalization, AND psychographics).

The forward and backward snowballing methods are applied as citations and references point to further applicable research. To decide which research to include and exclude, further criteria are applied:

- The study describes product ecosystems in the computer science, social science, and marketing science domain.
- The study discusses human factor impact on product perception and personalization.

Through five iterations of literature research – 36 articles were found (Fig 1.).

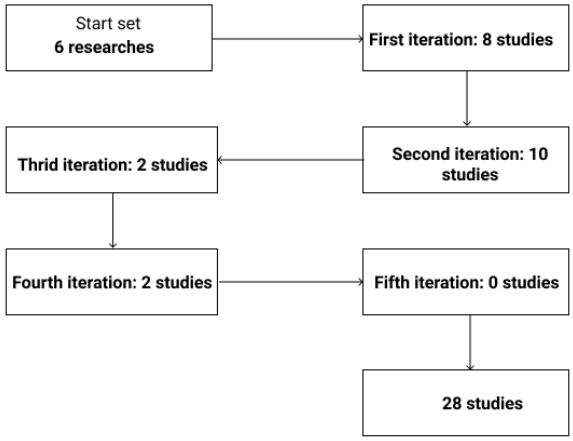

Fig. 1. Snowballing effect chart

III. PRODUCT ECOSYSTEMS

The ecosystem concept's original use is in biology describing the interconnectedness of entities in nature [1]. Since the 1930s, the term ecosystem appears in business and marketing, but without a clear definition. While lacking clarity on what exactly ecosystems are in business, authors agree that business success is not dependent on a standalone product anymore. Standalone products connected to a larger environment of other products or offers are considered beneficial to a user and business offering [2, 3, 4]. This brings to a narrower use of ecosystems in business, marketing, and computer science, which authors refer to as product ecosystems [5, 6, 7].

There are multiple levels of ecosystems, as one product may belong to many ecosystems. The product can be accounted as the core of the ecosystem or a complimentary product in another ecosystem. That means that there are at least primary and secondary ecosystems [8], for example, a battery is a secondary product in a television remote control ecosystem and the same battery becomes primary in the battery charger ecosystem where the whole idea concentrates on charging the batteries.

Moreover, ecosystems can be created with a specific purpose such as to extend the value of business-to-business solutions [5, 8]. As well as consumer-oriented with the purpose to mainly to serve customers' needs while executing business processes and shareholder interests [3]. This concludes that product ecosystems can have a purpose and direction where the orientation can be market (B2B, B2C), technology (IoT, server, software etc.), solution, etc.

While the general sentiment is that ecosystems should be open because of potential value that can be created from many interlinked products, there are closed ecosystems as well [9]. Unlike in open ecosystems where anyone can participate and benefit from ecosystem participants – closed ecosystems have a permission keeper who decides who can do what and who has access rights to ecosystems core products. For example, the Android ecosystem is considered open because anyone can use

available hardware and software possibilities to develop a are product that would work within the ecosystem. While creating a product for iOS ecosystem hardware or software developers need to comply with Apple policies of their hardware and API usage, and more [10].

Product ecosystems are dynamic, and they change over time. Changes may be induced by business decisions, customer requests, market tendencies [11], new product introduction which may sustain the ecosystem or disrupt it [12]. Due to dynamism and changes which may affect product ecosystem it is important to watch product ecosystems health as well. Robustness, diversity, productivity, and innovation are identified as ecosystems health factors [8].

There is no officially agreed definition of what is ecosystem, digital ecosystem, and product ecosystem in any of researched domains so each of the authors provides their own Table 1.

TABLE I. PRODUCT ECOSYSTEM DEFINITION

Source	***Definition***
Tim Williams Marinella Charmoro-Kc., 2013; Product Ecosystems: An emerging methodological approach to study the implementation of disruptive innovation: The case of CityCar	Complex network of interconnected things that surround the product.
Zhou, Fenf; 2012., Affective-cognitive design of product ecosystems for user experience	Dynamic unit that consists of all interdependent products and users, functioning together with its surrounding ambient factors, as well as their interactive relations and business processes.
Mayukh Dass, Shivina Kumar., 2013., Bringing product and consumer ecosystems to the strategic forefront	A brand is a part of a larger product ecosystem when the likelihood that it will be accepted by customers is linked, either positively or negatively, to the likelihood of acceptance of other products that constitute the ecosystem.
Kasulaitis, B. v., Babbitt, C. W., & Krock, A. K. (2019). Dematerialization and the Circular Economy: Comparing Strategies to Reduce Material Impacts of the Consumer Electronic Product Ecosystem.	An ecosystem approach enables a holistic understand-ing of the related impacts of individual product species andenvironmental forces, to evaluate the effects of technologicalinnovations as they relate to biotic and abiotic interactions. Second, the dynamic study incorporates temporal trends of con-sumption, through evolving community structure, and changesin technology.
Tobias, J. (2007). Accessibility and product ecosystems.	Using the concept of ecosystem found in ecological science, a set of relationships among products can be called the product ecosystem. In that context we understand that a specific collection of plants and animals may form a food chain; a plant may provide shelter for an animal; an animal may assist the pollination of a plant; a smaller animal may parasitize a larger one.

Common attributes of the given definitions are that digital-physical product ecosystems are unidentifiable by size, they consist of multiple physical or digital products, that are interconnected which benefits business and the user, and one product (physical or digital) may be part of multiple ecosystems at the same time while being primary product in one and secondary in other. From this we conclude that the definition of product ecosystem is – *at least two interconnected products – physical or digital, whose value, to the business and user, is increased because of combined functionality or offer they provide.* From here further this is considered as ecosystem definition that applies to physical- digital products as they have become inseparable in modern offering.

Businesses who create physical-digital products have a better chance of success recognizing ecosystems, purposefully creating them, or integrating their products into existing ones as customers and users find more value in interconnected solutions [13].

IV. ECOSYSTEM PERSONALIZATION

Through multiple studies, personalized solutions have shown an advantage over ones that are created as one solution fits all [14, 15, 16]. Users tend to enjoy personalized products more than regular ones, as well as recommend them to others [17]. Personalization for its targeted audience can become one of the main advantages as well as a positive return on investment for the business [18]. That is the reason why personalization should be acknowledged when building products and product ecosystems.

Personalization is a process that changes the functionality, interface, information content, or distinctiveness of a system, to increase its personal relevance to an individual or a group of individuals [11]. In personalization, adaption is more sophisticated personalization involving mental, cognitive modelling of the user to enable system abilities to distinguish an individual user from a group of users [14]. Personalization can be described through dimensions where the focus is on what is personalized, to whom and to what level it is automated [11][19] and used technology that drives the personalization result [14].

In computer science, personalization definition is looked through the lens of frameworks, technology, algorithms, data mining, and output of the result [20, 21, 22]. Often personalization in computer science is left to deep learning algorithms where it becomes hard to understand why exactly a particular solution is personalized for a specific user. Such personalization approaches of e-commerce, social media content, etc does not work for a new personalized product or ecosystem development, because processes involve many experts, discussions and negotiation and cannot be automated. For digital and physical product development and ecosystem personalization an expert system would be better suited as experts could use it to better understand their users within ecosystems and act on their personalization needs.

Cognitive sciences view personalization through human centred viewpoint. Opposing to computer sciences technological viewpoint, cognitive science definitions of

personalization is on observation-based user model that represents user knowledge, goals, interests, values, tasks, interests, preferences, relationships to distinguish him amongst different users [23, 24, 25, 26].

For building personalized ecosystems and digital-physical products a cognitive science personalization approach should be considered as a priority and then for expert systems technical execution level – computer sciences with its algorithms, frameworks, databases, technologies.

A. Psychographic and cognitive human factors in personalization

To understand users' knowledge, goals, interests, values, tasks, interests, preferences, relationships a combination of cognitive and psychographic human factors could be used as both are interested in understanding human preferences and how they think [27, 28]. In the context of personalization cognitive human factors would answer questions about user mental models, sense-making, activities, motor expectations, goals, actions [23]. While psychographics would explain users' values, attitudes, interests, affections, and affective expectations [27]. Both, cognitive and psychographic human factors allow to gain meaningful information about the user and his preferences, which combined with product builder intentions can be used to customize personalization of a product or ecosystem.

B. Digital-physical Ecosystem success factors

Building an ecosystem or attuning a product to it is a complex and resource intense undertaking. That is affected by certain success factors. The success factors reported in literature are given in Table II.

TABLE II. PRODUCT ECOSYSTEM SUCCESS FACTORS

Success factors	[12]	[14]	[15]	[16]	[39]
Productive and able to increase return on investment for business and residents of ecosystem	X	X	X	X	
Direction and purpose of ecosystem	X	X		X	
Value of the ecosystem network for its users	X			X	X
Positive affective and cognitive impact for users		X		X	X
Multiple interlinked products	X	X	X	X	X
Evolving over the time	X	X		X	

V. PRODUCT ECOSYSTEM PERSONALIZATION CANVAS

To begin personalization customization of a digital-physical product for an ecosystem, developers need to know participants in the ecosystem, what are available and unavailable integration possibilities with the existing products, and user factors within the ecosystem. For that reason, a digital-physical product ecosystem personalization canvas is proposed because of this research paper. Product ecosystem personalization canvas template (see Fig 2.) features an ecosystem users cognitive and psychographic value description where matching information can be entered by an expert.

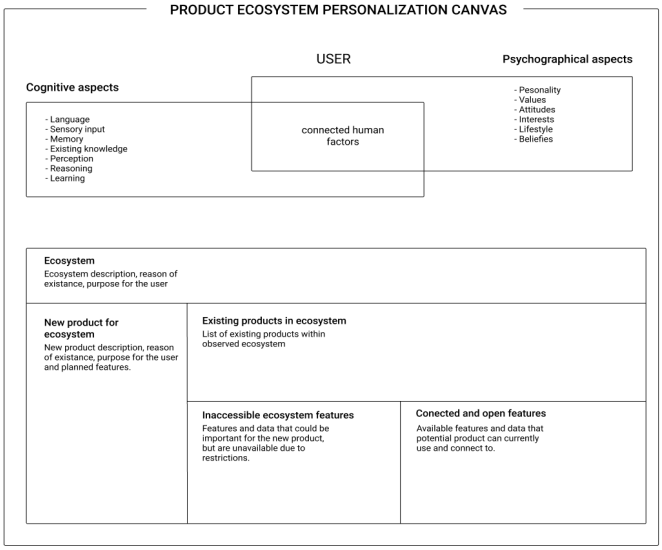

Fig. 2. Product ecosystem personalization canvas template

Knowing user's psychographics and cognitive aspects are not enough, there is a broader need to know additional aspects of the ecosystem to create a new personalized product. It is necessary to know what other products participate in the ecosystems as well as what are integration possibilities with these products. It is important to know what integrations are open for everyone within the ecosystem and which are not. For example, purpose, an attempt to fill a digital-physical product ecosystem personalization canvas was made. The case is the creation of one unified health and exercise service and equipment tracking app for iOS and Android platforms. Five user interviews were made to conclude existing health and exercise tracking ecosystems data and validate into the personalization canvas for experts to start analysing data and building a personalization decision on it (see Fig 3.).

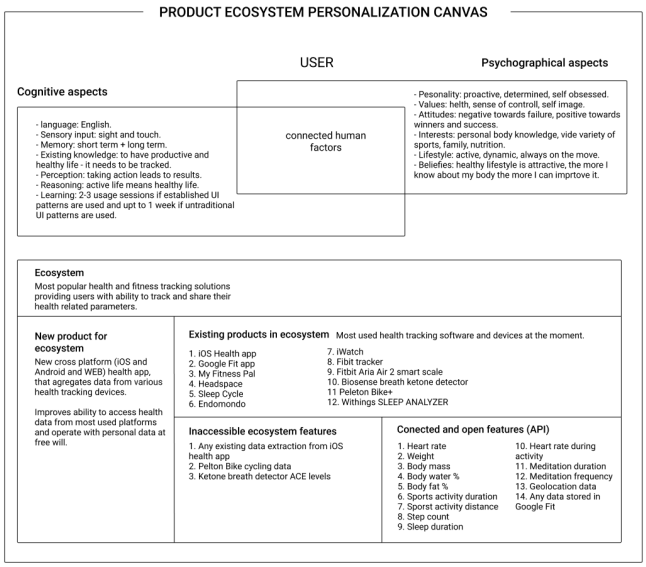

Fig. 3. Product ecosystem personalization canvas for cross-platform app

VI. Conclusion

This research paper is an attempt to discover a new emerging paradigm – digital-physical product ecosystems as well as how they can be made better by the business for users through personalization. While there is not much research done on the specific topic, through snowballing method and combination of multiple papers in ecosystems, personalization, cognitive and psychographic factors allow formulating an understanding of what ecosystems are and what factors can be used for personalization.

Through literature review, definition of digital-physical product ecosystems is provided. It is concluded that digital-physical product ecosystems are large and complex systems often within systems, without clearly definable beginning and end. Product ecosystem personalization canvas, which is the result of a literature review on product ecosystem personalization is proposed to identify, represent, and manage knowledge in this topic.

The proposed canvas is the beginning of further research on how to deal with complexity at different levels. An example canvas was completed with a real-life case of unified health and fitness tracking application for iOS and Android platforms, further testing is requiring as for now in the current stage these canvases are based on the literature review. In future research, an attempt to use artificial intelligence to extrapolate information is needed to complete the digital-physical product ecosystem canvas.

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