Psychographic and Cognitive Human Factor Modeling in Decision Support Systems for Building Personalized Product Ecosystems

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Abstract: There are countless products build and launched every day. A growing number of possibilities for the consumer increases competition between similar products and product developers voluntarily or involuntarily are creating product ecosystems to stay competitive or relevant. As the products tend to form ecosystems, then for users it less decision of which product, instead of more of which ecosystem to buy into. This poses new challenges for product and ecosystem developers, how to comply with true user needs, and which are worth investing in. This position paper discusses the possibility that psychographic and cognitive human factor modeling could be the way to understand users and build personalized ecosystems using the decision support system. Following position, the paper is a proposal for future research in developing such decision support and conceptual model of user data and its relationship is proposed.

1 INTRODUCTION

Today's users and consumers are fortunate because there are many solution providers ready to fix their needs and problems. There are plenty of products that users can acquire and invest their time to get their desired tasks done. The issue today is not that there would not be a particular product or digital solution for users' problem, but the burden of making the right choice. Because right now users are not simply buying just one product, but the whole ecosystem that the product is in or will be in the future. We are living in a time where the line between digital products and physical products is blurring. Thanks to IoT and digitalization everyday items are connected to the internet and our smartphone apps (Mattern, Friedemann; Floerkemeier, Christian, 2010). Additionally, products from the same and different industries create product ecosystems (Dass, M., & Kumar, S., 2014). For example, Apple, Microsoft, and Google are known for creating their product ecosystems in which they are interested to keep users in and providing them with all the solutions to their needs. Companies like Ikea and Xiaomi strive for cross-industry partnerships to create a smart home environment for better living. Knowing that Xiaomi is a competitor to Apple, Microsoft, Google there is an unlikely chance that these IT companies would participate in IKEA and Xiaomi joined the ecosystem.

This paper is not about the company strategy and competition policy, but the user and the product ecosystem developer aspect. The objective of the position paper is to outline how currently user data is used to create new solutions and propose a preliminary conceptual model of how to extrapolate knowledge about users using their cognitive and psychographic data. It is important to evaluate what it means for users to be a part of any kind of ecosystem, what they gain, lose, and what kind of decisions they are having when enrolling in a product's ecosystem as well as what it means to be a product development company that creates products and ecosystems around them. How to make better decisions and which decision support systems or methodologies they should use. For digital-only and products connected to the internet, users place important to be aware of product quality as well as what kind of ecosystem integrations it has, with what kind of other services it works and with whom it doesn't (Dass, M., & Kumar, S., 2014). Most users don't want to be denied functionalities and features even if they are not planning to use them. That is loss aversion bias (Kahneman, D. & Tversky, A., 1992) that plays a powerful role in decision making. Another aspect is that users are paying attention to their personal data. Who and how are using them. Users are concerned

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about how companies collect, store, and use their personal data. But for companies data analysis often is how to improve their solutions to satisfy and retain their users (Crocco, M. S., Segall, A., Halvorsen, A. L., Stamm, A., & Jacobsen, R., 2020). For some ecosystems gathering, analyzing, and sharing data is the reason for their existence. Misusing and miscommunicating data usage creates a conflict between involved parties that may threaten the existence of the ecosystem itself. There is a need for fair exchange between users, their personal data, and companies that develop products and ecosystems. Where on one hand users would be happy to provide and share their personal data and companies would use them in a fair manner to provide the solutions for the user needs thus retaining them on their product and even building a product system around them.

To create better solutions companies often are using human factor modeling principles to gain a conceptual understanding of the user. The generated knowledge is used to better understand user needs and satisfy them in new product development, or product iterative update (Fischer, Gerhard, 2001). The objective of this paper is to propose an initial version of a conceptual model of human factor modeling using user psychographic and cognitive analysis to better understand their needs. The aim of this model is to be used as a start for the decision support systems to assist in personalized product or product ecosystem development, ensuring that user data is used for a good purpose to develop products that suit their true needs. The proposed system as well could assist designers in the decision making process as a design and creativity support system due to insights on human factors.

2 BACKGROUND

Most newly created companies that are building products fail within two years of their product launch because of a poor problem-solution fit and negligence of the learning process during product development (Tripathi, N., Oivo, M., Liukkunen, K., & Markkula, J., 2019). This shows the risks of what can happen if important user needs are not met by the product developers. Newly found companies that have only one product as their main income source risks whole existence on its success. Established companies in case of product failure risks allocated budget and potential setback or loss in the given product market.

There are two key aspects when creating and releasing any product or ecosystem to the market, to maximize its success. First is the bigger picture - why the product is needed and what purpose it has - the focus on the fulfillment of psychological needs to create (Kim, J., Park, S., Hassenzahl, M., Eckoldt, K., 2011). Second - the product's embodiment design in detail concerning material, usability and interface. Thus, the two key aspects of product success are Macro UX and Micro UX as proposed in the research paper by Constantin von Saucken, Ioanna Michailidou, and Udo Lindemann - "How to Design Experiences: Macro UX versus Micro UX Approach".

Macro UX - the psychological needs the product fulfills is not something that users often consciously realize and are aware of. Thus, these are unconscious needs. If a user would be asked, as typically done in product development processes via focus groups, questionnaires etc, what he wants in a new future product, the answer will not directly show his real psychological need. The research on a user's implicit motives or psychological needs can lead to innovative ideas but requires a psychological background. Since most of the product decision-makers are not with knowledge in psychology they would benefit from knowledge on the user psychography. It is possible to build products that are more suited to users by knowing their true needs and motives, but it is only part of product success.

Another part is the Micro UX that focuses on the optimization of user experience (UX) in the later embodiment design stage by anticipating the user's perception and processing, (Von Saucken, C., Michailidou, I., & Lindemann, U., 2013) in psychology that is called cognition. A mental action or process of acquiring knowledge and understanding thoughts, experience, and the senses (Oxford dictionary, 2020). Having data on users' psychographic and cognitive thinking it is possible to build and modify the understanding of the user by creating a model to customize and adapt systems to the user's specific needs. Successfully created models can be used in decision support systems for new innovative solution development thus achieving user satisfaction.

The necessity for a decision support system is for decision-makers who often rely on their personal intuition when coming up with strategic decisions (Jossey-Bass, H. A. Simon, 1983). This position paper proposes an opportunity to help intuitive decision-makers to base their decisions not solely on their intuition, but on rational facts as well as make their decisions user-centered. Such a system could help make precise, personalized user-need centered decisions, as a result - maximize the chance for product success and drive effective resource usage.

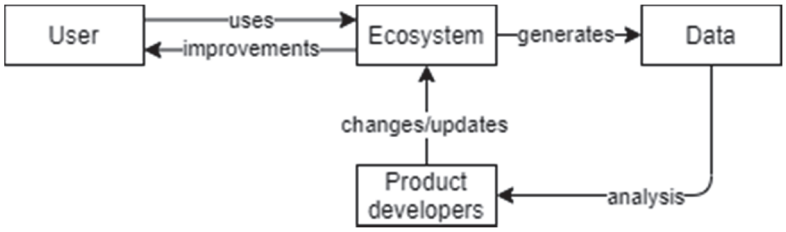

Figure 1: Current relationships in product development between the user, his data and product developers.

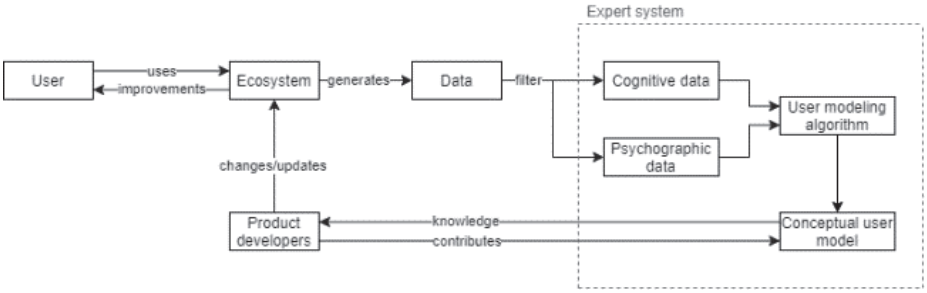

Figure 2: Conceptual model relationships between product ecosystem developers and the proposed decision support system.

To achieve that, the position paper's aim is to propose a model for a decision support system based on human factor modeling principles where it would help to make better decisions for Macro UX and Micro UX aspects. Psychographic and cognitive human factor modeling is proposed as a key aspect of generating new, untapped knowledge that will be used in the product and ecosystem development decision-making process.

3 CURRENT APPROACH

To better evaluate and seek improvements, it is necessary to understand how currently most of the products are created and what are the relationships between the user, product developer, and data.

Because of rapid digitalization and IoT common and previously unimagined solutions more and more are connected to the internet. As users are interacting with products and solutions, data is generated and brought back to users in the form of knowledge. For example, Philips Sonicare toothbrush and its application. Toothbrush - when used is generating data about tooth cleaning frequency, duration, applied pressure and time spent in cleaning teeth. This information is sent to the backend for parsing data into knowledge and sent back to the user via a mobile app telling him to visit a dentist, change brush hardness, etc. In order to build the next product iteration, ecosystem or entirely new product, product developers analyze user-generated interaction data, analyze it and seek insights for improvements that could better serve users. All that is done with an aim to make next-generation or new products worthy and appealing for the purchase.

3.1 Conceptual Model

The objective is to propose a conceptual model that represents what is the relationship between users, product, ecosystem, and the expert system within the product creation and improvement phases. As well as to show what type of data would be used in psychographic and cognitive human factor modeling to create a decision support system for personalized product ecosystems.

At first, user-generated data would be filtered into two key user-product relationships describing data - cognitive and psychographic. Data identification and structuring is an important stage because each data type would be modeled separately through human factor and user modeling algorithms. As a result of modeling a conceptual model would emerge that would describe users existing and potential relationships with the product or ecosystem. The gained knowledge of user preferences and taken actions would describe their knowledge of the usage patterns as well as their perception of the product ecosystems. Knowledge of user psychographic preferences and behavioral patterns are what can help product developers to create more personalized products and their ecosystems. Using a decision support system product developers would be able to

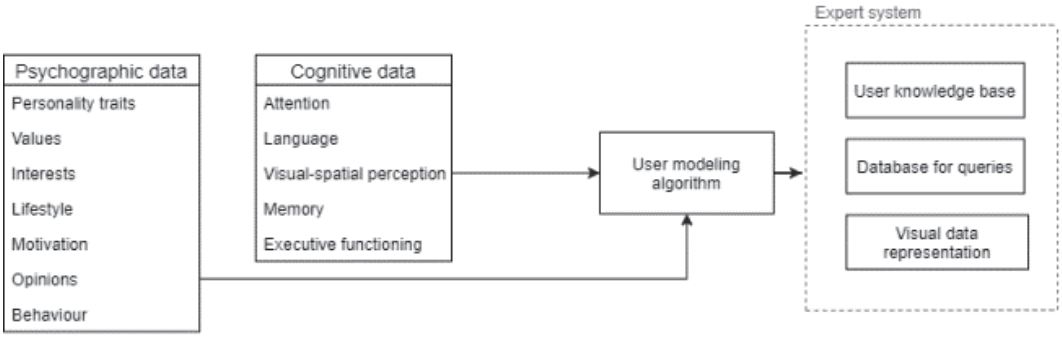

Figure 3: Psychographic cognitive data and decision support system outcome.

access knowledge on their users and gain answers on product ecosystem existential questions. Questions as - what type of user would use it, for what purpose they would serve, what kind of psychological needs are covered, and which are not. And answer interaction-based questions - how what will be used, will they understand functionality, would product functionality within the ecosystem solve users' need for it.

For cognitive user modeling used data would be attention, language, visual-spatial perception, memory, and executive functioning. For psychographic user modeling it would be personality traits, values, interests, lifestyle, motivation opinions, behaviour data. It would be used separately for the user modeling algorithm since cognitive data can be more easily collected through service usage data and is quantitative data. The expected outcome of cognitive and psychographic data modeling is a decision support system.

3.2 Outputs of Decision Support System

Market researchers have been attempting to develop predictive models for understanding consumer preference of newly developed products and ecosystems they are in. Preference mapping techniques are the most popular methods among these prediction models to understand what product attributes are driving preference (R. Krishnamurthy, A.K. Srivastava, J.E. Paton, 2007). It is important to link describing product and ecosystem attributes, such as appearance, packaging, ease of use and others with customer preference from perspective of how it fits in their daily lives (psychography) to how they are going to use it (cognitive actions). An important aspect of human-centered system design is cognitive compatibility, which means that the structure of the human-machine interface of the computer should match the cognitive styles of the users (Fuchs-Frothnhofen, P., Hartmann, E., Brandt, D., & Weydandt, D., 1996. Psychology has been applied to HCI research in recent years to inform design choices and understand differences in how in- dividuals use technology. It enables researchers to arrive at conclusions regarding design effectiveness, since successful technology development requires input from a representative set of potential users and, more precisely, the range of differences among individuals may influence technology. Some factors may include age, gender, job duties, language, culture and fundamental idiosyncratic attributes, such as personality and motivation (Alves, T., Natálio, J., Henriques-Calado, J., & Gama, S., 2020.

Business must satisfy customers and their needs, to stay competitive - decision support system purpose is to use input data from the users to identify what attributes they value the most. Knowing that users - when using any product or ecosystem generate data, the decision support system can use the given data and parse that into the knowledge about user preferences about particular products as well as to better understand ecosystem usage patterns. The purpose and given output of the decision support system is knowledge about unstructured user behaviour data that represents which product and their ecosystem attributes they value the most and how they interact with its features. Based on proven aspects that users likability of a product impacts on how it fits in his daily life through his personality and usage patterns - such a decision support system task is to model user data and provide with clear value and behaviour description what particular users want in a product ecosystem. Using this decision support system product developers will be able to see data on their users at one unified place and query database on specific user actions and their opinions. For the valuable knowledge output on users,' the developers would be able to query whether user's behavior matches their values – which would be considered as a strong positive signal that can be used as

confirmation on matching with user's preferences. And the same if users' behaviors do not match with their values – that would be an indicator that what the user says and does are two different things and further investigation is needed. Which most of the case is potential for additional insights and product opportunities.

4 APPLICATION CASES

Several application cases are introduced to showcase the potential use of the decision support system in B2C markets. Each application case consists of key elements used in any product development cycle - potential or existing users, product development team and data that is known or can be mined.

4.1 New Product Introduction

Whenever a new digital-only, internet-connected product or whole ecosystem is about to be created and introduced to the users, there is a degree of uncertainty whether it is going to succeed or not. To minimize the risk of failure, the product and ecosystem need to be maximally attuned to user needs. Else it has the potential to become yet another thing that is not needed and it would cease to exist in its early lifecycle. Often new solution development should start with its purpose and reason for existence. This is something that is frequently overlooked by the stakeholders and is the reason why even well-crafted products can fail. Product and business development as well often are driven by stakeholder's inspiration and emotions. Thereof there are not enough data and evidence and research on what to base the upcoming product or ecosystem. User preferences, lifestyle attributes, and expectations often are not well-read. Thus, increasing unknown factors of overall products or its ecosystem's ability to be personalized for a specific target audience. Product developers would benefit from the proposed decision support system mostly from the psychographic aspect because it would help them to tap into the user personality traits, values, interests to attune desire, and a true necessity for the product.

4.2 Iterative Product Update

When a service has already been launched, but it is time to update its capabilities it is important that the introduced new update still captures user needs. If the product starts to deviate from the initially designed purpose or becomes hard to use due to new feature introduction - users may search for an alternative. This is a risk for stakeholders and developers because in new iterative product updates there are aspects that could go wrong with the decision making. And since stakeholders and product developers mostly rely on their instincts when developing - the risk is even greater. For iterative product updates it is important to evaluate whether it is even needed. There are cases when companies release a new iterative update with minimal changes, mostly due to marketing reasons and users buy it but have little or no gain in improvement. This may leave users confused and unhappy especially if the update requires financial investment from them. It is important to evaluate how and if the existing user base is perceiving product or ecosystem personalization efforts from the previous generations before a new and updated generation is released. Stakeholders may discover that by comparing behavioral and product usage data from what they were when the product was launched and what they have become over time. For example, how long time is now spent on using product function comparing to what it was in the beginning. What user values were impacted when the product was released and how they are changes over the product's existence time. Existing or non-existing change in data provides some knowledge for product developers whether they have achieved personalization overtime or not. As well as this should help them to make a decision on next-generation based on knowledge. Benefit for iterative product and ecosystem updates in a matter of personalization comes from understanding user psychographic data change since the previous iteration, as well as improvements in usability through cognitive analysis.

4.3 Integration in the Product Ecosystem

Introducing the product to the existing ecosystem poses a couple of questions that need to be asked by product developers before investing in the resources. Product development for an ecosystem is associated with whether users need a product to be part of the ecosystem and vice versa. And from a cognitive aspect how users will understand the connection between the product ecosystem and vice versa. An interesting use case for the decision support system would be understanding the users who are already in the existing ecosystem before developing for it. For example, Apple HomeKit is an existing product ecosystem of smart home connectors, there is room for more, but the question is how to gain a competitive edge by being more user need-oriented.

To not enter the existing ecosystem with a less personalized product, compared to already existing competitors, stakeholders need to know existing user needs in the ecosystem. As well as which needs (psychographic and cognitive) are already fulfilled and which are not. For that purpose, it is important to analyze user cognitive and behavioral trends in a particular ecosystem. Trends change over time shows a rise and fall in the demand for a specific product's purpose and its usage. And ideally. compare the data with the existing player product offering. The challenge is to gather data that is already known to the competitors because they are already in the given ecosystem. This challenge will be addressed in future work as well.

5 FUTURE WORK AND CONCLUSION

To achieve successfully made ecosystems and products within them, then created ecosystems and products need to be personalized for the user in a way that corresponds to their actual needs. It is not enough to make offering attractive in it form factor, it needs to meet users' expectations in terms of functionality and be aligned with users' personality traits. Altogether many aspects need to be taken into the account to create a result that succeeds for customers and businesses at the same time. As discovered in this paper – most of the stakeholders are relying on their intuition when making decisions rather than making calculated, evidence-based decisions. There are much researches done on users' cognition and its impact on the likability of the end product and lesser where users psychography is taken into the account, especially to evaluate user values and personal beliefs. There is a lack of proposals where psychography and cognition both and combined could be used in human modeling for better understanding their motives, preferences, their values expectations as well as how product or ecosystem will be preferred to use.

Based on this proof of concept paper that describes the necessity for a rational decision support system for stakeholders who are building personalized product ecosystems – psychographic and cognitive human factor modeling could be used. There is potential on having a decision support system that answers questions – why to build and what features in what way should be added by combining psychography and cognition of a user. Thus answering macro UX and micro UX questions, and in ideal case giving decision support to stakeholders to achieve personalized products and ecosystems for user needs.

The conceptual model will be further researched, attuned and developed in the framework of the research and innovation project. Additional human factor modeling decision support system application cases will be identified, more usable cognitive and psychographic data will be defined and user modeling algorithms will be introduced. When the decision support system is built it will be tested for its efficiency improvement over the feedback loop and will be piloted in the actual product development cycle.

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