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Perception of the Internet of Things Technology and Devices by Young Consumers

Summary

The article deals with the perception of the Internet of Things (IoT) by young consumers from south-eastern Poland, on the base of CAWI study results (n=407).

IoT differs from previous ICT technologies regarding their perception and acceptance by users. IoT „transparency" for young users is one of the essential findings.

The analysis includes the perception of IoT devices for the consumer in the areas of benefits and concerns, measured by proprietary measurement scales. The identified benefits include areas of convenience, savings, health, and safety. For concerns, the areas regarding privacy, security and health, and also additional costs exist.

Key words: Internet of Things, IoT, consumers, perception, benefits, concerns.

JEL codes: D12, M39, O33

Introduction

The Internet of Things (IoT), the concept proposed by Kevin Ashton in 1999 (Ashton 2009), is the umbrella name for an ecosystem where objects (things) equipped with electronic sensors, communicate with each other and computers or mobile devices, often without the need for human interaction, through a variety of networking solutions. Although thousands of scientific papers on this topic were published (particularly in the last 2-3 years), studies focused on social perspective and demand side are still somewhat rare (Hsu, Lin 2016; Mącik 2017).

The Internet of Things concept is still little known by persons from outside of the IT industry, and most consumers use more or less advanced IoT systems in everyday life, often not knowing much about underlying technology and its applications.

The primary goal of this paper is to explore the perception of the Internet of Things by young consumers – the cohort born in the late '80s and '90s of the 20th century. This is the first generation growing up with easy access to most IT tools and applications, including the Internet and mobile devices, so they are often nicknamed as "digital natives" (Palfrey, Gasser 2008). They developed more technical skills and virtualised many aspects of their behaviour (Gołąb-Andrzejak 2016; Ratajczyk 2017). Although the scope of the digital skills may differ, and individual differences within this group are huge (Bennett, Maton, Kervin,

2008), most mentioned cohort members do not require substantial time to be accustomed to innovative digital technologies.

The first investigation of IoT perception by young Poles made by the author (Mącik 2016) led to the conclusion that the IoT usage is common but shallow, an often unconscious. Little if any participants mention the disadvantages of IoT, and the magnitude of perceived advantages is much higher. Taking this into account, leading research question arises:

RQ: What is the current perception of IoT by young consumers, and how this perception is changing, when the popularity of IoT applications increases in general?

The scope of the Internet of Things implementation

Practical implementations of Ashton vision spread in almost a decade later, about 2008-2009. Moreover, the real birth of the Internet of Things was announced when the number of devices connected to the Internet exceeded the number of inhabitants of the world (Evans 2011, s. 2). This coincides with rapid growth of popularity of RFiD, the increasing saturation of mobile devices using wireless networks (Wi-Fi), and the mobile broadband Internet access.

The contemporary IERC (IoT European Research Cluster) definition specifies IoT as "*A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network.*" (Vermesan, Friess 2015, p. 25).

By way of explanation, in IoT networks, any (smart) "thing" can gather data from its sensors, and automatically connects to the Internet, acting as a network node, to communicate with any other objects within the network. So IoT networks operation is a kind of deviation from the traditional concept of the Internet, understood as a combination of servers, routers, and access terminals for end-users. Instead, dynamically configured networks consisting of "smart objects" do exchange data with each other, and only if necessary, or upon request, make interaction with human users (Ożadowicz 2014). In effect, IoT is used to describe a broad group of technologies, devices, and their applications, including (Vermesan, Friess 2015, s. 29-53):
- wearables (integrating nanoelectronics and sensors to expand the functionality of body-mounted devices or clothes),
- smart health/wellness (devices monitoring the life functions or physiological parameters),
- smart homes and buildings (including home networks of smart consumer electronics/appliances, and buildings automation solutions),
- smart energy (managing energy use, generation and storage on household or building level in smart grids),
- smart mobility and transport (autonomous vehicles, and sensor-based traffic control infrastructure),

- smart cities (monitoring and integrating city's transport modes, communication, water, electricity supply to optimise usage of resources).

The paper omits two other applications of IoT: smart manufacturing and smart farming (with food security), as being beyond of the scope of interest of consumers, and focuses on first three areas mentioned earlier.

Sample and measures

In the study participated 458 respondents, of whom 407 filled an online questionnaire (CAWI) entirely (total response rate is 75.4%, and effective one (for complete responses only) – about 67%). Respondents were selected voluntarily, using purposive sampling with control of some demographic variables, and were invited to participate in the study via e-mail (607 invitations sent), in exchange of small reward in grade points for activity during author's classes. The sampling frame included the students of the economics department from a public university in Eastern Poland, declaring the use of the Internet and possessing at least one mobile device (population size about 4000 persons). Questions and scales used were a part of an extended instrument called: "*Consumer, his/her purchases and information technologies – 2017 edition*", worded in the Polish language.

The resulting structure of the sample by respondents' gender (63,9% of women and 36,1% of men) does not differ significantly from the target population of students. The average age of respondents is 21.6 years with a standard deviation of 2.7 years, and range 17-34 years old. Most respondents identified their financial situation as good (54.3%) or average (34.9%). Less than 5% of participants declared a weak financial position and 5.9% - an excellent one. Average income per capita (IPC) was 1176 PLN with standard deviation 831 PLN. Median of IPC equals 1000 PLN. The 2/3rd of respondents reported using the Internet in any of the ways available to them, all day long – they are heavy Internet users.

Results

Knowledge of IoT term and IoT capable devices usage

More than 3/4 of respondents declared lack of knowledge of the term "Internet of Things". Of the approximately 23% of participants declaring its awareness, the vast majority heard about IoT during the last year, and only a few in the earlier period (Table 1).

There are no significant gender differences in the knowledge of IoT term (in chi-square independence test). Comparing to preliminary research from previous year those numbers are not increasing, and only the percentage of those accustomed with the term about 2-3 years ago slightly increased, while numbers of recently accustomed have fallen (Mącik 2017, p. 376), that confirms the lack of growth in the knowledge of the IoT term.

Table 1

Awareness of the Internet of Things (IoT) in the whole sample, and regarding gender and ownership of IoT capable devices, n=407 (in %)

Answers to the question: Have you ever heard the term Internet of Things (IoT)?	Whole sample	Gender		Ownership of any IoT capable device	
		Female (n=260)	Male (n=147)	No (n=93)	Yes (n=314)
No, I have not met with such a concept	76.9	80.0	71.4	23.0	77.0
Yes, the first time during last year	15.5	13.8	18.4	20.6	79.4
Yes, the first time 2-3 years ago	6.6	5.0	9.5	25.9	74.1
Yes, the first time earlier than 3 years ago	1.0	1.2	0.7	25.0	75.0
Total	100.0	100.0	100.0	22.9	77.1

Source: own research.

Table 2

Ownership and purchase intentions or selected IoT categories and devices, n=407 (in %)

IoT devices categories	Categories (total) and selected devices	Owns IoT capable devices (n=314)	Declares purchase intention (n=272)
wearables	total	13.4	32.4
	including: smartwatch (1) (2)	9.6	27.2
connected consumer electronics	total	91.1	36.0
	including: printer/MFP (1) (2)	78.0	13.6
	audio system or wireless speakers (2)	34.4	10.7
smart appliances	total	29.0	27.9
	including: loundry machine (1)	24.5	2.2
	automatic coffee machine (2)	7.0	14.7
smart home devices	total	22.6	30.5
	including: remote control of the entry gate (1) (2)	11.5	10.3
	remote control of indoor lighting (2)	9.2	7.4
other devices	total	18.2	16.2
	including: wireless car diagnostics (1) (2)	9.6	5.9

Note 1: percentages do not sum up to 100% in columns due to multiple choice response format. The question did not refer to the concept of the Internet of Things and was worded as follows: "Which of the following devices connected to the Internet or other devices via Wi-Fi, Bluetooth or Ethernet are used in your household? Please tick all that apply."
Note 2: numbers in parentheses denote: (1) most often owned device in the category, (2) highest declared purchase intention in the category.
Source: as in Table 1.

An interesting finding from the preliminary study, confirmed in presented research is the independence of ownership of IoT capable devices from knowledge the "Internet of things" term – about of ¾ of study participants use IoT networks – regardless they know IoT term or not (chi-square test is insignificant). It suggests an essential difference of IoT adoption comparing previous internet technologies – their adoption was conscious, in IoT example, it is a somewhat seamless experience – the consumer does not need to have knowledge or awareness of IoT existence to use it.

The IoT devices and networks ownership ratio is high (77% of respondents possesses at least one such device). Typically participants home IoT networks connect only a few devices – computer/laptop, smartphone/tablet and home Wi-Fi router with one (mode) to three other devices (median) - see Table 2 for the values on the category level, including most often owned devices, and most likely wanted to buy.

Verbal associations with the IoT concept

Since the concept of the "Internet of Things" is poorly known, the participants were asked about verbal associations with this term (an open-ended question). The 20 most common associations were visualised using a cloud of expressions, separately for persons not knowing the IoT term, and those familiar with the concept (Figure 1).

Figure 1

Most common verbal associations with "Internet of Things" term, n=407

a) respondents not knowing the IoT term (n=313)   **b) persons knowing the IoT term (n=94)**

Source: own research.

People not knowing the concept of IoT, associated it most often with purchases (online), products (things or objects), a large choice (diversity), which is not very accurate. Some of the respondents were unable to indicate any specific associations. Relevant associations were relatively rare. In the group accustomed with the IoT concept, the associations were more relevant and most often referred to data, their exchange and collection, information, modernity, smartphones, other smart devices, and technology in general. Positive and neutral associations dominated answers, and only a few statements had a negative connotations, for instance: "*something unnecessary*" (respondent does not know IoT concepts), "*lack of privacy, cyberattacks*", "*evil, idiots, surveillance, no choice*" (respondents knowing the notion of IoT term).

Perception of the usefulness of IoT capable devices

As some IoT critics say, some IoT devices can be perceived as offering little or no real usefulness for the user (e.g. smartwatches displaying notifications about alerts displayed on user's smartphone), and as surveillance devices gathering vast amounts of data about users and places where they are installed. To check how existing and future IoT devices are perceived by study participants, after presenting them non-technical definition, they were asked in an open-ended question about most useful IoT device. Provided answers include mostly the devices performing the controller or user interface roles in IoT networks – e.g. smartphones. Persons not knowing the IoT concept most often perceived as useful such devices like smartwatches, smart fridge, smart toothbrush (filming the inside of the mouth), and connected home appliances. The pattern was similar for participants accustomed to IoT concept: most often they choose smart fridge, smart TV and smartwatch.

Interesting is the perception of the smart fridge as the model example of home IoT device. Such device checking expiry dates of stored food, making purchases of lacking products, and proposing the cooking recipes was often mentioned. This is the reception of media reports of product concepts, while available models offer typically only remote control of basic functions via a smartphone app.

Less typical propositions were: "*app to turn off the iron from the smartphone*", "[equipped with sensors] *training shoes, gathering training stats*", or "*watch* [device] *remotely turning on the green light on pedestrian crossings*". Some of the propositions were rather futuristic, e.g.: mentioned few times device that *"...monitors health, and carries out the necessary medical tests and plans a treatment program*", "*a bed monitoring sleep and waking up in its proper* [sleep] *phase*", "*animal speech synthesizer*", "*chip for a dog opening the door to the flat when he wants to come in, and I will be out of the house*", as well as "*contact lenses equipped with VR function*". Some mentioned ideas may become interesting IoT products in the future.

Benefits and concerns related to the use of IoT

Benefits and concerns associated with the use of IoT technologies were measured on a Likert-type five-point scale (described: 1 – completely disagree and 5 – completely agree),

where respondents assessed the intensity of specified benefits and fears. Based on exploratory factor analysis, these elements were grouped into three areas separately for the perceived benefits and concerns. Benefits include dimensions of the convenience of use, savings, and improving safety or health, and the fears were dimensionalised as threats to privacy, fears about costs, and risks to safety or health. The results for mentioned dimensions rescaled to original scale 1 to 5 are shown in Figure 2 (for benefits and concerns separately). The allowed length of text does not allow to present the results at the level of scale statements – some of the data are presented in other author's publications (Mącik 2016; 2018).

The primary area of perceived benefits from IoT usage is convenience – making easier everyday life, helping to plan life, controlling devices used and giving better ways to communicate with others. Less obvious are savings-type benefits: time savings, being better informed about new products/offers and buy it, better planning of purchases.

Figure 2

Level of perceived benefits and concerns associated with IoT usage, n=407
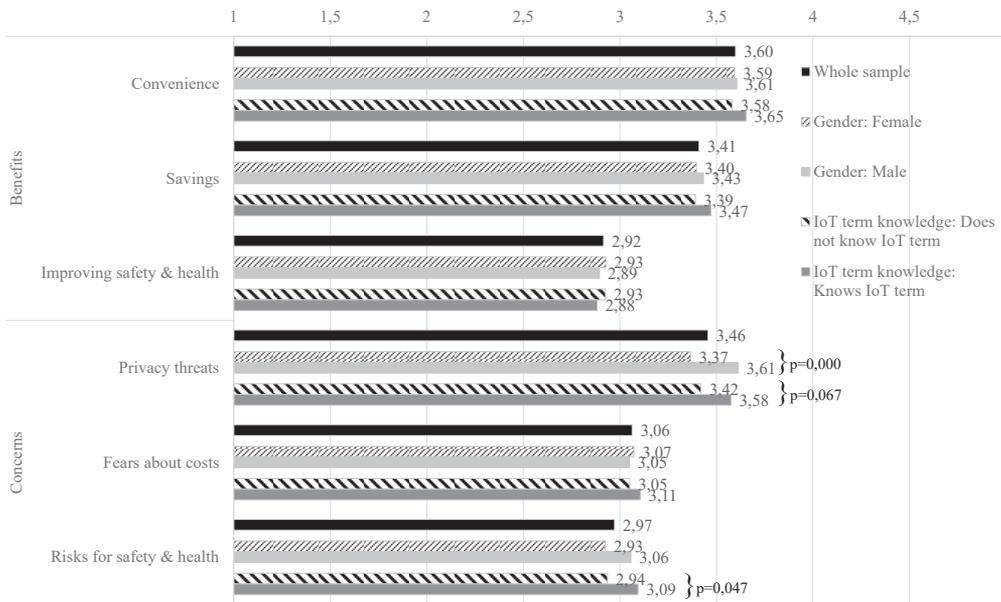
Source: as in Figure 1.

For improving safety and health, the perceived benefits are not considered high – except for better care of own health and physical condition. There were no significant differences in perception of benefits from IoT usage in groups defined by gender and knowledge of IoT term.

From concerns most serious are ones connected with privacy threats, including the possible uncontrolled leaking of personal and sensitive (e.g. health) data, sharing behavioural data (e.g. places visited, shopping made), and also exposing to obtrusive advertising. In this area significant difference exists between genders (Figure 2) – men are more likely to perceive privacy treats as more dangerous – is this an effect of better knowledge of this group about IT in general or more often having something to hide? Lower averages were counted for fears about costs incurred from IoT usage, mainly connected with behavioural discrimination in shopping (including price discrimination) and possible higher electricity costs. Risks for safety and health are not treated as serious ones – only fears about losing control of owned devices and own or family members security have means above middle point of the scale. For this dimension, a significant difference exists between study participants with prior knowledge of IoT versus those who do not know this term (Figure 2).

The general level of concerns connected with IoT usage is lower than benefits – benefits are more natural to imagine of experience than some of the concerns, which require more conscious usage and sometimes professional knowledge in IT area.

Answers of respondents in presented research are similar to those obtained in preliminary research (Mącik 2016). Slight differences are in the direction to lower values in a later study, particularly for privacy threats. This suggests rather slow changes (if any) in the perception of benefits and concerns coming from usage of the IoT devices in different applications.

Conclusions

Lack of comparable studies does not give the possibility to compare presented research results with other scholarly publications directly.

It is noteworthy that "Internet of Things" differs from previous ICT technologies regarding their perception and acceptance by users. IoT "transparency" for young users, despite their lack of knowledge of the IoT concept and the technology involved, is one of the essential findings of the research. Additionally, study participants more likely distinguish than connect different network technologies – for instance: Smart-TV or printer/MFP connected to home Wi-Fi router is distinguished from the speaker connected to a smartphone via Bluetooth, and both rarely are perceived as parts of broader IoT ecosystem.

Study results show that perception of IoT differs in some aspects between individuals with prior knowledge of IoT term – connecting it most often with data collection, and those who do not know it – associating IoT mostly with shopping or retail applications.

Perceived benefits of IoT usage (mainly convenience) are more pronounced comparing to concerns and fears (with privacy-related issues being most important). There is a need to study further mentioned topics, as presented research results apply only to the young generation of consumers.

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Postrzeganie technologii i urządzeń Internetu Rzeczy przez młodych konsumentów

Streszczenie

Artykuł dotyczy percepcji technologii i urządzeń Internetu Rzeczy (IoT) przez młodych konsumentów z południowo-wschodniej Polski, na podstawie badań własnych (CAWI, n=407). IoT różni się od innych technologii ICT pod względem postrzegania i akceptacji przez użytkowników. „Przejrzystość" technologii IoT dla młodych użytkowników jest jednym z najważniejszych wyników badania. Prezentowana analiza obejmuje postrzeganie urządzeń IoT przez konsumentów w obszarach korzyści i obaw mierzonych własnymi skalami pomiarowymi. W zakresie korzyści uwzględniono obszary wygody (najbardziej dostrzegany), oszczędności oraz zdrowia i bezpieczeństwa. Obawy dotyczące prywatności (najsilniejsze), bezpieczeństwa i zdrowia, a także kosztów są również analizowane w artykule.

Słowa kluczowe: Internet Rzeczy, IoT, konsument, percepcja, korzyści, obawy.

Kody JEL: D12, M39, O33

Восприятие технологии и устройств интернета вещей молодыми потребителями

Резюме

Статья касается восприятия технологии и устройств интернета вещей (англ. IoT) молодыми потребителями из юговосточной Польши на основе собственного обследования (CAWI, n=407). IoT отличается от других технологий ICT с точки зрения восприятия и одобрения пользователями. «Прозрачность» технологии IoT для молодых пользователей – один из основных результатов изучения. Представляемый анализ охватывает восприятие устройств IoT потребителями в сфере выгоды и опасений, измеряемых собственными измерительными шкалами. В отношении выгод учли сферу выгоды (наиболее заметную), экономии, а также здоровья и безопасности. Опасения, касающиеся неприкосновенности частной жизни (самые сильные), безопасности и здоровья, а также издержек, также анализируются в статье.

Ключевые слова: интернет вещей, IoT, потребитель, восприятие, выгоды, опасения.

Коды JEL: D12, M39, O33

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