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Attitudes and preferences toward the adoption of voice-controlled intelligent personal assistants: evidence from Croatia

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Abstract

Introduction. The primary goal of this paper is to explore the current adoption level of voice-controlled intelligent personal assistants in a non-English speaking country. The focus was set on attitudes and perceptions of users and non-users related to benefits and barriers of intelligent personal assistants' adoption, privacy, and security issues.

Method. The research was conducted on a sample of 310 Croatian mobile users utilising an online survey and an adopted research framework.

Analysis. Statistical analysis used in the paper includes descriptive and inferential statistical methods, i.e., parametric and nonparametric tests (binary logistic regression, independent samples t-test, and Pearson's correlation).

Results. Based on the collected data, the adoption rate of intelligent personal assistants was generally low but present. Users tend to use such devices for fun and convenience, using their hands-free capabilities along with personalized task and information-seeking options. In contrast, non-users suggest that the main barriers to intelligent personal assistants' adoption were low perceived usefulness and functionality issues in addition to a lack of usage habits and related lack of experience.

Conclusion. The paper provides an examination of the differences between intelligent personal assistants' users and non-users and their perception related to privacy and security issues associated with trust in companies' appropriate use of their data.

Introduction

The Internet of things is emerging as the most promising technology in the fourth industrial revolution, surpassing artificial intelligence and robots (Forbes Insights, 2017; Nord et al., 2019). Unlike the Internet, which was built on data generated by humans, the Internet of things relies on data generated by things, enabling communication on three levels: human-to-human, human-to-things, and things-to-things (Madakam et al., 2015). The Internet of things could be described as a global network of physical objects with sensing and actuating devices that can be digitally connected and, therefore, can collect, analyse, and share data across other objects, software, and platforms (Koochang et al., 2022). It is estimated that there are approximately fifty billion Internet of things-connected devices in the world (Burhan et al., 2018). The smart industry is one of the most prominent areas of internet of things application. When Internet of things devices are connected to other devices in the Internet of things ecosystems, their capabilities may be increased even further (Wortmann and Flüchter, 2015).

A significant component of the Internet of things ecosystem is voice-controlled intelligent personal assistants, and their popularity has skyrocketed over recent years. An intelligent personal assistant can be generally described as any device with a software agent that provides professional, technical, or social support to a human (user)

by automating and simplifying numerous daily tasks (Saad et al., 2017). Technically speaking, intelligent personal assistants are driven by artificial intelligence functionalities such as speech recognition and natural language processing algorithms. Several microphones built into the device listen and record users' voices, then transfer the recorded data to a cloud-based natural language processing server through the Internet. Natural language processing servers can understand users' commands and deliver the best responses or select the most relevant services. Lastly, intelligent personal assistants use text-to-speech technology to respond to users (Yang and Lee, 2019). It should be noted that several different names and associated terminology have been utilised in available studies for this artificial intelligence-driven conversational software, such as voice-based digital assistants, smart speakers, smart voice assistants, personal intelligent agents, intelligent voice assistants, artificial intelligence personal assistants, speech-based intelligent personal assistants, voice assistants, digital personal assistants and others (Arnold et al., 2019; Budzinski et al., 2019; Ebbers et al., 2021; Liao et al., 2019; Mishra et al., 2021; Moussawi et al., 2021; Nallam et al., 2020; Pal et al., Sun et al., 2021; Vimalkumar, 2021; 2020; Zwakman et al., 2020). With some minor exceptions, these device names generally designate the same thing, so the term intelligent personal assistants will be used throughout the paper. It should be noted that using the suggested abbreviation without the voice component

could cause some confusion, but it is selected due to methodological foundation and related terminology utilised in this paper (Liao et al., 2019).

This paper refers to interactions with two kinds of intelligent personal assistants: phone intelligent personal assistants stand for software embedded with a smartphone (e.g., Google Assistant or Siri), and home intelligent personal assistant stands for a standalone smart home device (e.g., Amazon Echo or Google Home).

The popularity of intelligent personal assistants is usually connected with assisting users in managing various tasks such as providing helpful information, offering entertainment, and operating household equipment or appliances (Sun et al., 2021). The introduction of these devices simplified company operations, automated complicated tasks, and improved customer service. According to Statista (2020), more than half of Americans reported having used intelligent personal assistants on their smartphones at the beginning of 2020. Some of the most popular intelligent personal assistants on the market are Amazon's Alexa, Apple's Siri, Google's Assistant, Microsoft's Cortana, and Samsung's Bixby (Arnold et al., 2019).

In contrast to the rise in popularity, there are several significant barriers to the mass adoption of intelligent personal assistants. The most significant ones are related to the language issues for non-English speakers, and others include security and privacy issues. All aforementioned intelligent personal assistants are primarily focused on English-language speakers, while the available studies on the intelligent personal assistant experience of non-English speakers are scarce. Even though the number of supported languages on intelligent personal assistants is expanding, non-English performance still has ample room for improvement (Bogers et al., 2019; Hearn, 2019; Wu et al., 2020). This presents a barrier for users whose first language is not entirely supported, requiring them to communicate in a non-native language or face being excluded from using the technology (Pyae and Scifleet,

2018; Wu et al., 2020). It is essential to explore this topic because there are approximately 7.8 billion inhabitants globally, among which 1.35 billion speak English, and just 360 million of them are native English speakers, which might indicate there is an unsaturated market of intelligent personal assistants on a global scale (Lyons, 2021).

This study is based on a research framework by Liao et al. (2019), to compare the intelligent personal assistants market in the United States as an English-speaking country, and Croatia, which is a non-Anglo-Saxon country. The research design and research instrument were adopted from the original study utilising the proposed instrument structure and related composite variable constructs. It is an essential factor because Croatia is the 10th best-positioned country in English language proficiency among 112 countries, according to the Education First EPI report (EF, 2021). Many previous studies on this topic have been conducted without the socio-demographic context of non-English speaking countries, simultaneously ignoring the non-users of intelligent personal assistants and the main reasons behind the skepticism or adoption resistance to this technology. The main research gaps include the lack of available intelligent personal assistant adoption studies of non-English speaking countries and related benefits and barriers, as well as privacy and security issues.

Considering the provided research motivation, this paper examines the four main research questions and explores the research gaps (in line with the research concept by Liao et al., 2019):

- What are the main benefits and barriers to the adoption of intelligent personal assistants?
- What are specific profile differences between intelligent personal assistant users and non-users?
- What is the perception of privacy and security issues associated with intelligent personal assistants?

- What is the perception of trust in companies' appropriate use of intelligent personal assistant-generated data?

The following literature review provides more insight in the previous research findings and research gaps of the formulated research questions while the methodology section describes the relationships between the research instrument structure and concepts related to the research questions in more detail. Sections of the research findings deal with research questions and provide the related data analysis, followed by the discussion based on study findings as well as theoretical and practical implications. Limitations of the conducted research as well as guidelines for future research are provided in the next section, followed by the conclusion and supporting sections.

Literature review

The relatively novel technology of intelligent personal assistants has exhibited immense growth over the recent years, both on smartphones and as standalone devices, with yet insufficiently explored usage patterns and implications associated with the Internet of things concept. Since the launch of Siri in 2011, intelligent personal assistants have advanced technologically and have become extremely popular because they facilitate human-computer interactions in a more natural and intuitive way. These human-computer interactions are comparable to interpersonal connections, including answering questions, following dialogue, and assisting users with daily tasks (Bonneau & Probst, 2018).

Practically speaking, intelligent personal assistants are considered most beneficial when people don't have full use of their hands, such as driving, playing with kids, cooking, working on something else, or having dirty hands. In such scenarios, it is useful to ask the intelligent personal assistant for directions, set a reminder, or dictate a message (Cowan et al., 2017; Luger and Sellen, 2016). Communicating with an intelligent personal assistant does not require any specific knowledge or skills; the

only prerequisite is the capacity to have a conversation. Consequently, it allows children, seniors, and people with disabilities to access various services a lot easier and faster than before (Budzinski et al., 2019; Yaghoubzadeh et al., 2013). Since intelligent personal assistant functions are based on personal data, their algorithms attempt to predict users' preferences. The accuracy of preference approximation depends on the richness and quality of accessible user data, and accuracy will increase with more consumer behaviour data (Budzinski et al., 2019; Pasquale, 2015). Also, users can benefit from the intelligent personal assistant's algorithm because they can avoid consumer biases (Gal and Elkin-Koren, 2017). Lopatovska et al. (2019) were exploring user interactions with Amazon Alexa, which is a home intelligent personal assistant software and results showed that, out of the total number of interactions, participants reported 82% of instances of completed and satisfactory interactions. The same research indicated that most participants keep their home intelligent personal assistant in the living room, using it for various reasons such as checking the weather, finding facts, listening to the news, setting a reminder, calendar, timer, or alarm, playing music, telling a joke, playing a game, checking the time, or controlling other devices in the home. Home intelligent personal assistants serve as speech-based interfaces for household appliances, lighting systems, thermostats, media devices, and other Internet of things devices (Pridmore and Mols, 2020). Phone intelligent personal assistants are somewhat different from home intelligent personal assistants because they are always near the user and available on their smartphone. The most common reasons for using phone intelligent personal assistants were: (1) asking factual questions, (2) getting directions or the location of a place, (3) asking silly/funny questions, (4) dictating a text message, and (5) setting a timer (Liao et al., 2019).

A study from Insider suggested that 37% of intelligent personal assistant users love their devices so much that they wish it was a real human being (Shead, 2017). An emotional connection between artificial intelligence and

humans is obviously possible. In addition, people consider their intelligent personal assistant to be delightful to interact with, as fun, friendly and pleasant (Ki et al., 2020). Therefore, intelligent personal assistants can create social benefits for users; they can provide lonely people with a social presence and act as a companion. However, users' perceived control is crucial to a satisfactory intelligent personal assistant experience, and for instance, if users feel threatened because the intelligent personal assistant is always listening and recording them, it inhibits users from adopting that technology (Poushneh, 2021). Most of the research in behavioural sciences focused on technology adoption and used two types of motivations – utilitarian motivation (usefulness) and hedonic motivation (enjoyment) (Lee et al., 2020). Hedonic and utilitarian attitudes show a positive impact on intelligent personal assistant usage. However, anthropomorphism positively influences users' utilitarian attitudes, which has a more substantial effect on intelligent personal assistant usage (Mishra et al., 2021). Nevertheless, perceived anthropomorphism increases the enjoyment of intelligent personal assistant usage but not initial trust toward it (Moussawi et al., 2021). Users may be more motivated and ready (consciously or unconsciously) to conform with or adapt to the recommendations and requests when conversational agents can satisfy such demands with more human-like attributes. A study by Yang and Lee (2019) showed that automation is the most representative feature of intelligent personal assistants, and users' intention to adopt intelligent personal assistants may be directly influenced by their curiosity about automation. The visual attractiveness of home intelligent personal assistant has a significant impact on perceived enjoyment because it can affect consumers' aesthetic pleasure as a tool for house interiors (Yang and Lee, 2019).

Privacy, trust, and personal data issues

AI-driven technologies increasingly raise many questions from the public, and what is particularly important to explore is the issue of

privacy, security, and trust, along with the benefits or barriers to the adoption of intelligent personal assistants. As many of these systems rely on personal data, there is always a threat and concern to the users' privacy (Maedche et al., 2019). An approach known as privacy calculus states that consumers disclose their personal information in exchange for some benefits (Li, 2012; Urbonavicius et al., 2021, considering that personal data and privacy can be valued as a *final good*, as a good in itself (Acquisti et al. 2016). While many users claim to care about their privacy and have a positive attitude toward privacy-protection behaviour, this rarely translates into actual protective conduct, and this discrepancy between the claimed concern and actual behaviour is a phenomenon known as the privacy paradox (Brown, 2001; Barth and De Jong, 2017). Generally, meeting consumer privacy expectations increases the likelihood to adopt devices such as intelligent personal assistant (Cases et al., 2010; Eastlick et al., 2006; Ebbers et al., 2021; Liao et al., 2019) but also increases the level of trust related to the company or manufacturer (McCole et al., 2010). Furthermore, a violation of privacy expectations will undoubtedly result in adverse reactions from consumers including non-adoption, usage withdrawal or rejection, and associated negative perception (Liao et al., 2019; Miyazaki, 2009). People tend to avoid utilising voice commands in public situations due to concerns about privacy and socially appropriate behaviour (Easwara and Vu, 2015). According to Liao et al. (2019), the most important barriers to using intelligent personal assistants include concerns about utility, design, and privacy, namely; (1) I don't see any benefits from this feature, (2) I don't like talking aloud to my phone, (3) the user interface is frustrating, (4) it's awkward to use, (5) it often doesn't understand my voice, and (5) I have security/privacy concerns. However, an additional study showed that consumers probably would not quit using intelligent personal assistant if there is a service failure, but they are more likely to stop the use of specific functionality (Sun et al., 2021).

Concerns over security and privacy have clearly weakened motivation for using home

intelligent personal assistant (McLean and Osei-Frimpong, 2019) and have been examined in several studies. According to Mihale-Wilson (2018), one of the most significant concerns is the misuse of personal information, where 79% of participants in the study suggested that they are afraid of it. Another example of a lack of trust in intelligent personal assistants is the fact that most participants would allow intelligent personal assistant to perform transactions only if they maintain control over each activity, and 37% would allow automatic transactions without previous supervision only if the limit were €10. Such personal data can be misused by companies (manufacturers) or criminals, and as a result, users are concerned since they know little about how their data is utilised or which risks are involved (Ebbers et al., 2020). Criminals or attackers may breach the security of the devices, which can then be utilised to attack other linked smart devices, i.e., using home intelligent personal assistants to control a connected door lock (Edu et al., 2021; Lei et al., 2017).

A specific issue is related to how companies use personal data generated by intelligent personal assistants. Data confidence implies trust in companies, i.e., 'the use of intelligent personal assistants is safe, private, and secure' (Liao et al., 2019). Even though some findings from related studies stated that consumers' initial trust in a system impacts their intention to use it (Qiu and Benbasat, 2005; Kim and Prabhakar, 2004), the relationship between initial trust and intention to adopt intelligent personal assistant was not found to be valid (Moussawi et al., 2021). Still, findings by Lau et al. (2018) shows that intelligent personal assistant users trust companies like Amazon or Google because they have already built a positive relationship with these companies through their other services, and non-users of intelligent personal assistants distrust these same companies for the opposite reason – they have a negative experience with them. Notably, non-users of intelligent personal assistants show more concerns about home intelligent personal assistant being hacked than intelligent personal assistant users. On the other hand, some studies show that users' privacy concerns are not that great due to a sense of resignation toward

surveillance technologies and focusing on its benefits, but there is some wariness toward listening to private conversations and data collection of intelligent personal assistants (Liao et al., 2019; Lutz and Newlands, 2021; Mhaidli et al., 2020; Pridmore et al. 2019). Findings from Ebbers et al. (2020) showed that more than half of respondents would pay for an intelligent personal assistant which explains its decision, provides information about the potential consequences of data sharing, and provides visualised data. People who would pay for such a device more than 20 euros per month are primarily young, concerned about privacy, and risk-seeking. Interestingly, findings by Pridmore et al. (2019), where participants from the United States and participants from the Netherlands (European Union) were compared, showed that Americans generally accepted that their data is already online, and is being used for marketing purposes by large companies, so they have nothing to hide from their phone intelligent personal assistants or home intelligent personal assistants. On the other hand, Europeans were far more cautious regarding the same issue. Still, findings from Liao et al. (2019) show that nearly half of home intelligent personal assistant users said they were given the device as a gift which means that some intelligent personal assistant users may not have thought about privacy and trust issues before allowing an intelligent personal assistant in their home. Attitudes toward intelligent personal assistants in research on consumers from Germany show significant differences between different groups of intelligent personal assistant users and non-users, but trustworthiness is perceived as the biggest concern of non-users. However, intelligent personal assistant users tend to have more positive attitudes than non-users since their attitudes are naturally formed by their experience, and that is true for attitudes relating to needs centricity, independence, innovativeness, trustworthiness, usefulness, timesaving, and user-friendliness (Arnold et al., 2019). Findings from Mols et al. (2021) suggest that phone intelligent personal assistant users are less concerned about home intelligent personal assistant security, platform, and surveillance issues than phone intelligent personal assistant non-users, and a potential

explanation could be that experience of using a phone intelligent personal assistant lowers their concerns about home intelligent personal assistant listening and recording their private conversations. This leads to the conclusion that experience of using intelligent personal assistant and continued growth in the use of intelligent personal assistants might result in lower concerns of the public. However, home intelligent personal assistant adoption is particularly sensitive, and it's being followed with significant privacy concerns (Koops et al., 2017). These concerns are additionally fueled by such examples, which include Amazon's Echo/Alexa recording a private conversation and sending it to some random contact or Google Mini inadvertently spying on Artem Russakovskii and sending his personal data to the Google database (Russakovskii, 2017; Wolfson, 2018).

Language related issues

Intelligent personal assistants such as Alexa, Siri, or Google Assistant are developed initially in the English language setting and work best when using English as a primary language. However, intelligent personal assistants have also expanded their service to other languages as well. Siri is supported in 21 languages, Google Assistant in 12 languages, and Alexa in 8 languages. Alexa, Siri, and Google Assistant are supported in many European languages besides English. French, Italian, German, and Spanish are supported in all three of mentioned intelligent personal assistants; Danish, Dutch, Norwegian, and Swedish, by Siri and Google; Portuguese by Alexa and Siri; and Finnish, Turkish and Russian only by Siri (Summa Linguae, 2021). Among the Slavic languages, Russian is the only one supported by a single intelligent personal assistant, Siri, on Apple's devices (Lopatovska, 2019). Where intelligent personal assistant use is enabled in their native language, a higher percentage of individuals is expected to use it. According to Eurostat (2020), intelligent personal assistants are most frequently used in the UK (38%), then Iceland (24%), Netherlands (20%), Denmark (19%), Norway (19%), Sweden (18%), Germany (17%), Spain (17%), Finland (17%), Slovenia (14%), Italy (12%) and Croatia (8%). Research by Bogers et

al. (2019), conducted in Denmark, shows that most intelligent personal assistant users interact with intelligent personal assistants in their native language. The study shows that Siri is the most popular intelligent personal assistant in Denmark, most likely because it has been available in the Danish language since 2015 (Frizell, 2015). However, a usability test of the Danish version of Siri with seven different tasks revealed that speech recognition and understanding mistakes had a negative influence on user satisfaction, effectiveness, and performance. The same thing was repeated in mixed-language interactions, Danish requests for English terms, and the results were even more problematic. Consequently, it takes more time and effort to correct Siri (Bogers et al., 2019).

Users whose first language is not supported by the intelligent personal assistant are forced to speak with their device in a language other than their first language; it is most often in English (Wu et al., 2020). Findings from Pyae and Scifleet (2018) showed that native English speakers considered it simpler to use, friendlier, and possibly more beneficial than non-English speakers. Still, another study indicated that intelligent personal assistants, such as Alexa, can recognize accented speech from English learners of various first languages. Although the accentedness rating from respondents was 2.8/5, which is slightly higher than the neutral 2.5, the intelligent personal assistant's ability to interpret the participants' accented speech did not appear to be affected. (Moussalli and Cardoso, 2019). Interestingly, results from a slightly older study by Jonsson and Dahlbäck (2011) revealed that a female voice performs better for a non-native English speaker in general, but for native English speakers, the gender of voice does not appear to be a factor. What is also interesting is that non-native English intelligent personal assistant users prefer phone intelligent personal assistants over home intelligent personal assistants, and native English speakers prefer home intelligent personal assistant. Non-native English speakers considered the visual feedback on the smartphone to be significant in supporting interaction and instilling confidence in the

intelligent personal assistant's capacity to understand their commands (Wu et al., 2020). Strikingly, the fact is that many of these intelligent personal assistants, especially the most popular intelligent personal assistants on the market today (Alexa, Cortana and Siri), appear to be distinctly gendered female and users feel more comfortable giving orders to a female voice than a male one (Loideain and Adams, 2020).

It can be generally concluded that specific intelligent personal assistant features and user-related interactions are affected by its voice-operated functionality and that available language selection plays an essential part in many aspects of intelligent personal assistant device adoption. Language-related obstacles should be explored as an adoption barrier, along with privacy and personal data issues and other previously described intelligent personal assistant adoption factors.

Methodology

The aim of this paper is to explore the attitude and perception towards voice-activated intelligent personal assistants of both users and non-users in a European, non-English speaking country. The methodological approach was based on a research framework by Liao et al. (2019). Using the proposed instrument structure and associated composite variable constructs, the research design and research instrument were adapted from the original study. Several minor adjustments have been made to address the particular context of the environment in which the research was

conducted. These adjustments focused on several languages related issues during the translation process of the research instrument and specific device capabilities with apparent differences between the observed markets (the original study was conducted in the USA and the current one in Croatia). All adjustments were a result of a pilot study prior to data collection process and did not affect the comparability between the studies.

The online questionnaire was created in Alchemer software and consisted of 30 questions and 61 related items. Following the adopted structure by Liao et al. (2019), survey questions focused on mobile technology adoption, associated frequency of use and confidence levels, intelligent personal assistant devices use, and related attitudes. More specifically, there are three adopted constructs from the original study: Digital Literacy Related to Smartphone Use (10-item task/scale evaluating how confident a user feels performing specific tasks on a smartphone), intelligent personal assistant Data Concerns (7-item scale to evaluate privacy and security concerns related to intelligent personal assistant usage) and intelligent personal assistant Data Confidence (4-item scale to evaluate trust in companies' appropriate use of intelligent personal assistant generated data). Obtained mean values, standard deviations, and scale reliability measures (Cronbach's alpha) were generally similar to the original study, with some exceptions regarding intelligent personal assistant Data Confidence (details are presented in Table 1).

Construct	Original study measures	Current study measures
Digital literacy related to smartphone use	M=4.16; SD=0.83; α =.89	M=4.10; SD=0.89; α =.93
Intelligent personal assistant data concerns	M=3.12; SD=1.14; α =.91	M=3.58; SD=0.96; α =.90
Intelligent personal assistant data confidence	M=1.94; SD=0.86; α =.84	M=2.89; SD=0.81; α =.76

Table 1: Construct measures comparison

Questions were dominantly closed-ended and based on a 5-point Likert type scale where the marginal positions were described as 1 – Completely disagree (or Not at All Concerned/Confident), and 5 – Completely agree (or Extremely Concerned/Confident). The methods of statistical analysis used in the paper include descriptive and inferential statistical methods i.e., parametric and nonparametric tests (binary logistic regression, independent samples t-test and Pearson's correlation). For the statistical analysis of the collected primary data, several software packages were utilized including SPSS Statistics 23, Microsoft Office Excel and JASP 0.16.2.

In the process of respondent recruitment, available digital communication channels were utilised, primarily social networks, virtual communities, and specialised thematic groups. There were two prerequisites established for participation in the survey: participants needed to be mobile phone users, and participants' country of residence was required to be Croatia. Due to the relatively high drop-out rate, the data-collection process consisted of several waves of respondent recruitment communication, starting in August 2020 and

finishing in September 2021. In this period, 472 responses were obtained, but only 310 were selected for data analysis. The remaining 162 responses were excluded from the analysis due to survey abandonment, a significant rate of missing data, or otherwise unusable or invalid data. A final, convenience-based sample consisted of N=310 respondents. A detailed overview of the sample is provided in the next section.

Research findings

Based on the total sample, 59.4% of respondents were females, and the remaining 40.6% were males. The most frequent age category is the one between 25 and 34 years (43.5%), while the average age across the total sample is 28.78 (SD=7.91). Regarding the education level, 41.9% of respondents have obtained a master's degree, and based on current employment status, half of the respondents are employed, with an additional 41.6% being students. Most of the respondents live in households with four members and generate monthly income between 8.001 and 12.000 HRK (Croatian kunas). The detailed distribution of sample characteristics is presented in Table 2.

		Frequency	Percent (%)
Gender	Male	126	40.6
	Female	184	59.4
Age	24 and below	110	35.5
	25 - 34	135	43.5
	35 - 44	49	15.8
	45 - 54	13	4.2
	55 - 64	3	1.0
Education	Elementary school	2	0.6
	High school	72	23.2
	College / Bachelor	70	22.6
	Master's	130	41.0
	Ph.D. or Postgraduate	36	11.6
Employment status	Pupil	2	0.6
	Student	129	41.6
	Employed	155	50.0
	Unemployed	23	7.4
	Retired	1	0.3
Household income	4.000 HRK and less	9	2.9
	4.001 - 8.000 HRK	56	18.1
	8.001 - 12.000 HRK	87	28.1
	12.001 - 16.000 HRK	74	23.9
	16.001 - 20.000 HRK	40	12.9
	20.000 HRK and more	44	14.2
Household members	1	31	10.0
	2	64	20.6
	3	48	15.5
	4	97	31.3
	5	47	15.2
	6 and more	23	7.4

Table 2: Sample characteristics

Most respondents (73.2%) are users of Android-based mobile phones (which include Samsung, Huawei, Xiaomi, LG, Sony, HTC, Honor, and others), with the remaining 26.8% users of iOS-based devices (any version of Apple iPhone). Respondents reported spending an average of 4.65 hours (SD=2.7, range: 1-20) daily on their mobile phones, regardless of the reason that the device is used. In addition, participants were asked to state how they would feel if they needed to spend a day out of home, knowing that they had forgotten to bring their mobile phones with them. Responses were recorded on a 5-point scale (ranging from 1-Not at all anxious to 5-Extremely anxious). Over a third of respondents (35.5%) suggested they would feel slightly anxious, with an additional 26.1% suggesting moderate anxiety. Only 15.2% reported they would not feel anxious at all, while 5.2% would be highly anxious. An average mean value of 2.62 (SD=1.1) suggests a lower

moderate level of perceived anxiousness among respondents in the described scenario.

Benefits and barriers to adoption of intelligent personal assistants

Benefits of intelligent personal assistant adoption

Across the total sample, 65 respondents (21%) reported that they had previous experience with an intelligent personal assistant on their mobile phones (including those who currently use it or have been using it in the past). They were asked to identify the reasons why they used intelligent personal assistant through a list of 11 possible causes with the possibility of multiple responses (and the additional option of not using anything included in the list). The most popular reasons for using intelligent personal assistant were: (1) asking silly or funny questions just for laughs (38.4%), (2) playing music (34.8%), (3) asking factual questions

(33.5%), and (4) getting directions/location of a place (27.4%). Other reasons on the provided list recorded under 20% of respondent votes. Interestingly, 43.9% of respondents reported none of the above option.

The same respondent group was asked to select the single most useful reason to use intelligent personal assistant on their mobile phone from the same list of possible causes. The most frequently chosen options were: (1) getting directions/location of a place (18.5%), (2) setting a reminder or to do item (16.3%), followed by three items with the same recorded value (14.1%), specifically (3a) asking factual questions, (3b) dictating a text message or email and (3c) playing music. Following the most important reasons for using intelligent personal assistant on their mobile phone, respondents were asked to rate intelligent personal assistant success rate on a 5-point scale (with the marginal positions described as 1 - Not at all successful and 5 - Completely successful). Three quarters (75%) of phone intelligent personal assistant users described the success rate as Mostly successful (scale position 4), with an additional 20% describing it as Completely successful. Precisely 40% of intelligent personal assistant users reported using it several times per week, while other frequency categories were relatively evenly distributed; 17.5% multiple times a day, 12.5% about once a day, 17.5% about once a week, and 12.5% less often.

In addition to using intelligent personal assistant on their mobile phones (phone intelligent personal assistant), the respondents were asked to state if they owned a standalone intelligent personal assistant device (home intelligent personal assistant), including Google Home/Google Home Mini, Amazon Echo/Echo Dot (any version), and Apple HomePod. Across the total sample, 74 respondents (23.9%) reported owning at least one of the suggested intelligent personal assistant devices, among which Google Home/Google Home Mini was the most popular option (19%).

Barriers to intelligent personal assistant adoption

Across the entire sample, there were 270 respondents (87.1%) who stated that they did not currently use intelligent personal assistant on their mobile phones (including those who had never used it and those who had deactivated the feature). Using a 5-point scale (1=Not at All Important and 5=Very Important), the respondents rated seven predefined factors which may have affected their decision not to use intelligent personal assistant on their mobile phones or stop using it. The factor list included (starting with the highest average mean value): (1a) it doesn't understand my voice most of the time (M=3.45, SD=1.34); (1b) I don't like talking aloud to my phone (M=3.45, SD=1.38); (2) I don't see any benefits from this feature (M=3.43, SD=1.32); (3) it's awkward to use (M=3.20, SD=1.28); (4a) the user-interface is frustrating/doesn't work as I want it to (M=3.0, SD=1.32); (4b) I have privacy/security concerns about these features (M=3.0, SD=1.37). In addition, the same group of respondents was asked an open-ended question to suggest the main reason for not using phone intelligent personal assistant or for stopping using it, with 260 respondents providing an answer. Their responses were broadly classified into six categories (some respondents suggested more than one reason, and those were organized in more than one category accordingly), with the most frequently used included: unnecessary or useless (56.54%), non-functional or not working properly (17.31%), no habit of using it (10.77%), privacy issues (5.38%), do not have it or know how to use it (3.85%) and other (15.38%). Furthermore, taking into account that the language used for controlling the intelligent personal assistant device is one of the barriers related to perceived usefulness and usability issues, respondents were asked to estimate would they use intelligent personal assistant (or use it more often) if it understood or spoke their native language (Croatian language in this situation). Precisely half of the respondents (across the total sample) responded positively,

suggesting that the language barrier might be an element to additionally explore in the future.

Profile differences between intelligent personal assistant users and non-users

To examine the differences between the users and non-users of intelligent personal assistant, binary logistic regression models were utilised to predict phone intelligent personal assistant adoption as well as home intelligent personal assistant adoption, following the research framework suggested by Liao et al. (2019). Predictors included respondent demographic variables (such as gender, age, monthly income,

type of smartphone used, and smartphone digital literacy), intelligent personal assistant privacy and security issues (intelligent personal assistant Data Concerns and Data Confidence), and ownership. Results from logistic regression models (Table 3) indicated that Model 1 (phone intelligent personal assistant Adoption) is significant (at $\chi^2(8)=67.16$, $p<.001$) while Model 2 (home intelligent personal assistant adoption) is, in fact, not significant (at $\chi^2(8)=12.98$, $p=.12$) as indicated in the following table (statistics for Model 2 were included in the table for purely illustrative purposes but won't be discussed further on due to the fact it is not statistically significant and therefore not valid).

	Model 1 (Phone intelligent personal assistant adoption)	Model 2 (Home intelligent personal assistant adoption)
Parameter Estimates: Beta (Odds Ratio)		
Demographic variables		
Gender (male)	-.14 (.87)	-.2 (.82)
Age	-.03 (.97)	-.02 (.98)
Income	.11 (1.11)	.05 (1.05)
Smartphone digital literacy	1.86 (6.40)***	-.09 (.91)
Smartphone type (iPhone)	1.93 (6.87)***	-.43 (.65)
Privacy and Security		
Intelligent personal assistant Data concerns	.01 (1.01)	-.12 (.89)
Intelligent personal assistant Data confidence	.37 (1.44)	.34 (1.40)
Intelligent personal assistant ownership		
Home intelligent personal assistant use (Yes)	.99 (2.69)*	-
Phone intelligent personal assistant use (Yes)	-	.81 (2.25)*
Model fit	$\chi^2=67.16$, $df=8$ ***	$\chi^2=12.98$, $df=8$
Nagelkerke Pseudo R2	.36	.06

* $p<.05$, ** $p<.01$, *** $p<.001$.

Table 3: Models predicting phone and home intelligent personal assistant adoption

Results from Model 1 indicated that three predictors were significant in terms of predicting phone intelligent personal assistant adoption: smartphone digital literacy, smartphone type used, and ownership of home intelligent personal assistant. Specifically, respondents who used phone intelligent personal assistants were more likely to have a

higher level of smartphone digital literacy, to own an iOS-based mobile phone (iPhone users), and to use a home intelligent personal assistant. Contrary to the initial expectation, intelligent personal assistant Data Concerns and Data Confidence were not significant predictors in this model.

Perception of privacy and security issues associated with intelligent personal assistants

Privacy and security concerns related to intelligent personal assistant usage were evaluated using an adopted construct intelligent personal assistant Data Concerns (Liao et al., 2019), which is a 7-item composite variable based on a 5-point scale (detailed construct elaboration is provided in the Appendix A). The average mean score of $M=3.58$ ($SD=0.96$) suggests a higher moderate level of perceived concerns related to privacy and security associated with intelligent personal assistant. In addition, it might be beneficial to examine the differences in intelligent personal assistant Data concern levels among the subgroups across the total sample. The observed differences or correlations were tested using the independent samples t-test and Pearson's correlation coefficients. Female respondents revealed a higher level of perceived concerns ($M=3.73$, $SD=0.88$; $t=-3.5$, $df=308$, $p=0.001$), as well as non-users of phone intelligent personal assistant ($M=3.62$, $SD=0.94$; $t=2.16$, $df=308$, $p=0.032$). Furthermore, respondents with lower digital literacy related to smartphone use exhibited higher privacy and security concerns (negative Pearson's correlation coefficient with weak intensity, $r=-0.21$, $p<0.001$). Similarly, respondents with a lower level of trust in companies' appropriate use of intelligent personal assistant-generated data exhibited higher privacy and security concerns (negative Pearson's correlation coefficient with weak intensity, $r=-0.25$, $p<0.001$).

Perception of trust in companies' appropriate use of intelligent personal assistant-generated data

Trust in companies' appropriate use of personal data generated in intelligent personal assistant use was evaluated using an adopted construct intelligent personal assistant Data Confidence (Liao et al., 2019), which is a 4-item composite variable, based on a 5-point scale (detailed construct elaboration is provided in the Appendix A). The average mean score of $M=2.89$ ($SD=0.81$) suggests a lower moderate

level of perceived trust-related issues in the use of intelligent personal assistant -generated data. Once again, it might be beneficial to examine the differences in intelligent personal assistant Data confidence levels among the subgroups across the total sample. The observed differences or correlations were tested using the independent samples t-test and Pearson's correlation coefficients. Non-users of phone intelligent personal assistant exhibited a lower level of trust in the appropriate use of intelligent personal assistant-generated data ($M=2.85$, $SD=0.81$; $t=-2.22$, $df=308$, $p=0.027$), as well as non-users of home intelligent personal assistants ($M=2.83$, $SD=0.81$; $t=-2.4$, $df=308$, $p=0.017$). As already stated in RQ3, respondents with a higher level of privacy and security concerns exhibited a lower level of trust in companies' appropriate use of intelligent personal assistant-generated data ($r=-0.25$, $p<0.001$).

Comparative analysis of the conducted studies

There are several distinct differences between the original study and conducted research within this manuscript, along with many observed similarities. First and foremost, the initial distinction lies in the market as well as user differences between the USA and Croatia. The sample size is considerably smaller in the current study ($N=310$) in comparison to the original one ($N=1160$). The original study consisted of 61.5% iPhone users compared to 26.8% in this study. Apparent differences are observed in the intelligent personal assistant adoption rates between the studies: in the initial study, there were 45% of phone intelligent personal assistant users with an additional 11% who used it in the past compared to 12.9% of current users and 8.1% of previous users of phone intelligent personal assistant. In addition, there are differences in motivating factors for phone intelligent personal assistant adoption. A relatively similar situation can be observed with home intelligent personal assistant adoption: 33% of the original study respondents were home intelligent personal assistant owners in comparison with 23.9% in the current study. The subset of home

intelligent personal assistant users is again larger in the original study but with a considerably smaller difference.

Following the difference in intelligent personal assistant adoption rate, it should be noted that 28% of respondents from the original study reported never using intelligent personal assistant on their phones, in comparison to 39% in the current study. The most cited barriers to intelligent personal assistant adoption are reasonably similar in both studies, primarily addressing utility, usability, and privacy. However, respondents in the current study suggested additional issues with voice recognition of the English language as their foreign language.

An interesting set of differences can be observed in models predicting intelligent personal assistant adoption. In the original study, both tested models were significant. Model 1 focusing on phone intelligent personal assistant adoption revealed that age and intelligent personal assistant Data Confidence were additional significant predictors (on top of smartphone digital literacy, smartphone type used, and ownership of home intelligent personal assistant). Perhaps the biggest surprise related to model comparison are the results from Model 2 in the current study, which indicated that the model is not significant, which is contrary to the original study. It is only possible to speculate on the possible reasons behind this unexpected situation. Most likely reasons may include relatively low usage rates among study participants (as home intelligent personal assistants are still novel devices even compared to phone intelligent personal assistants), related lack of experience in device usage, and additional language and cultural differences between the two studies.

Discussion

In several aspects, the current study builds upon past findings related to intelligent personal assistant adoption. Following the adopted research methodology by Liao et al. (2019), two research models were tested to gain deeper insight into intelligent personal

assistant adoption and associated attitudes and preferences on European, non-English speaking users (in terms of user's first language). This study provides a comparative analysis with the original study, with several distinct differences being described and elaborated. The initially proposed model allowed the exploration of intelligent personal assistant adoption as well as related benefits and barriers, which confirmed the value of the model and its implications. In addition, the current study indicates the need for additional testing and improvement of the proposed model, especially in a different setting compared to the initial research. Based on the provided literature review and primary research, the observed differences and discrepancies could be related to three main areas: a) cultural and market differences, b) language barriers (primarily related to non-English speaking users), and c) usability issues. In addition, previous studies indirectly imply that intelligent personal assistant users could be categorized into 3 segments associated with language use and their proficiency: 1) native-English speakers, 2) speakers of additional languages supported by intelligent personal assistant, and 3) non-native-English speakers (who most dominantly use English when interacting with intelligent personal assistant).

The research conducted on a sample of Croatian citizens can serve as an illustrative example of the situation in the European market for a non-English transition country and can be treated as indicative in terms of drawing and comparing conclusions. However, it should be noted that the employment of English as a first foreign language is noteworthy in Croatia, as indicated by the Education First EPI report (EF, 2021). Considering the collected data, it can be concluded that the use of intelligent personal assistants is relatively limited, i.e., that there are still apparent reservations about the application of this type of technology. According to the literature, such a level of current use was to be expected. However, it is quite interesting that home intelligent personal assistants are slightly more popular than phone intelligent personal assistants, which is not common, even in significantly more developed

markets. Nevertheless, both phone and home intelligent personal assistants are gaining traction around the world, and given current trends and projections explored in this study, it is reasonable to believe that intelligent personal assistant adoption will continue to grow. Given that the underlying technology is still relatively new and will continue to advance, it is reasonable to predict that it will become an integral part of digitally enabled communication standards for personal and business use.

Many studies suggest that privacy and security issues are among the most important barriers to intelligent personal assistant adoption, and similar findings were found in this study. However, while many users claim to care about their privacy and have a positive attitude toward privacy-protection behaviour, this perception does not always convert into actual protective behaviour, and this discrepancy is often described as the privacy paradox (Barth and De Jong, 2017; Brown, 2001). Moreover, even though privacy and security concerns were perceived as a major adoption barrier in this study, it is evidently not as important as several more prominent obstacles such as the language barrier and usability issues (mostly related to perceived usefulness, unfamiliarity, and social context).

Following this, it is not uncommon for users of digital technologies to suggest one course of action with their attitudes while behaving quite differently, as is the case with the main barriers to the use of intelligent personal assistants shown. However, this does not mean that privacy and security concerns are less important, especially when it comes to trust. Namely, users are very sensitive to personal data, and intelligent personal assistant devices process large amounts of personal data. That is why it is extremely important how users perceive business entities that collect and process their personal data, i.e., how much trust there is in such business entities. In addition, the expected rise in intelligent personal assistant adoption will most probably affect how users interact with data within the internet information space, especially related

to information-seeking procedures and patterns. Various business entities should take into consideration these implications when developing and refining their digital presence strategies, including such elements as content structure, information findability, and optimisation tactics.

Limitations and future research guidelines

This study suffers from several notable limitations. The available sampling techniques, in addition to the high drop-out rate of respondents, forced the unexpected extension of the data-collection process, lasting over a year. Even though there is no valid way to measure the main reasons for a high drop-out rate in the data-collection process, there is an indication that the research topic (as described in the welcome screen at the beginning of the survey) was unfamiliar to many possible respondents and therefore resulted in survey abandonment. The survey welcome screen was very clear in instructions on who could participate in the study, but, in hindsight, it seems that some additional motivational elements could have been employed. The sample distribution may contain several non-uniform demographic variables (primarily related to education level and employment status). Due to the non-probability sampling approach, the findings' generalisability is limited. In addition, the sample is county-specific which also may affect the generalisability of results. This study adopted a proposed research framework that has not been extensively tested yet as the research area is still insufficiently explored. Due to survey size and complexity, two constructs were intentionally left out in this stage of research but are planned for the next stage (these constructs are related to general privacy concerns).

Future research efforts should include all the proposed constructs and elements. Additional drivers of intelligent personal assistant adoption should be explored as well as a comprehensive understanding of privacy, security, and trust-related growing expectations. There are several further

directions of intelligent personal assistant usage that should be explored, such as application in online shopping or purchasing (and other areas related to e-commerce), utility and perceived quality in information seeking in the internet information space, and intelligent personal assistant device usability tests. The observed language barrier in intelligent personal assistant adoption should be taken into consideration for future examination of intelligent personal assistant usability, especially for users who don't speak English and for non-native English-speaking users. It would be beneficial to expand the research to more countries and markets to examine the potential differences among them, but also to additionally validate and potentially refine the research framework.

Conclusion

Voice-controlled intelligent personal assistants (or virtual voice assistants) are establishing a prominent market position all around the globe and, given the current trends as well as estimated predictions of continuous technological improvement, it can be reasonably assumed that intelligent personal assistant adoption will continue to expand. Considering that the underlying technology is still relatively novel and that it will undoubtedly continue to evolve, it can be expected that in a few years, it will become an integral part of the lives of digitally literate people all over the world. Moreover, the ability to communicate with an intelligent personal assistant does not necessitate any specific knowledge or skills; the only requirement is the ability to speak. As a result, intelligent personal assistants allow for more natural and intuitive human-computer interactions. Because intelligent personal assistant functions rely on personal information, their algorithms try to forecast users' preferences. The depth and quality of available user data determine the accuracy of preference approximation, and accuracy will improve as more consumer behaviour data becomes available.

The primary goal of this paper was to explore the current level of voice-controlled intelligent personal assistant adoption in a non-English

speaking European country. The main research focus was set on attitudes and perceptions of both users and non-users related to adoption benefits and barriers, privacy and security issues, trust as well as mobile phone usage patterns, motivators, and associated digital literacy. Voice-controlled intelligent personal assistants are still a relatively novel technology that is gaining popularity among users globally, mainly utilised in two distinct forms: on mobile phones (phone intelligent personal assistant) as well as standalone devices (home intelligent personal assistant). This study examined how (non)users perceive intelligent personal assistants, how they use it or why they don't, and what is the expected adoption behaviour in the future. This paper provides an examination of the differences between intelligent personal assistant users and non-users as well as an overview of (non-)user perception related to privacy and security issues associated with intelligent personal assistant and trust in companies' appropriate use of intelligent personal assistant-generated data.

The respondent base consisted of mobile phone users from Croatia, mainly young adults with bachelor's or master's degrees, mostly employed. Based on the collected data, the adoption rate of intelligent personal assistant was still relatively low: 21% of respondents were phone intelligent personal assistant users, and 23.9% were home intelligent personal assistant users. Intelligent personal assistant users tend to use such devices for fun and convenience, utilising its hands-free capabilities and personalised tasks, and information-seeking options. Even though the user base is somewhat limited, they were generally satisfied with the success rate of used devices, which they reported using several times a week or more frequently. Phone intelligent personal assistant users tend to have a higher level of smartphone digital literacy in comparison to non-users, own an iOS-based mobile phone (iPhone), and are more likely to use a home intelligent personal assistant device. On the other hand, intelligent personal assistant non-users suggested that the main barriers to intelligent personal assistant adoption were low perceived usefulness and functionality issues. Interestingly, privacy

issues were reported as the most critical barrier for only 5% of non-users. However, a higher moderate level of perceived concerns related to privacy and security associated with intelligent personal assistant was detected across the total sample, together with a lower moderate level of perceived trust-related issues in the use of intelligent personal assistant-generated data. When it concerns interpreting and comparing findings, the study that was undertaken on a sample of Croatian individuals can be used as an indicator of the status in the European market for a non-English transition country.

This study's findings have broader implications for understanding the adoption and diffusion of emerging technologies. It provides insights into how attitudes and perceptions shape adoption behaviour, highlighting the need for user-centered design and addressing perceived barriers to adoption. The study's focus on user

perceptions of privacy and security issues associated with intelligent personal assistant-generated data highlights the need for ongoing research in this area. As intelligent personal assistants become more prevalent and collect more personal data, there is a growing need for effective privacy and security measures to protect user data and maintain trust. The study's findings also have practical implications for developers and marketers of intelligent personal assistants. By understanding user motivations and preferences, they can design more effective and personalized services that meet user needs and improve the overall user experience. The study's focus on digital literacy and mobile phone usage patterns also has broader implications for understanding how technology is shaping information behaviour and access. As technology continues to evolve, it is essential to understand how it is shaping information practices and how individuals can best navigate this changing landscape.

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Appendix A – Composite variable construct items and scales

Smartphone Digital Literacy

The question was additionally elaborated with a description (*How confident are you doing the following tasks on your smartphone? For example, if you're very confident, you should be able to complete a task quickly and without hesitation. If you have no confidence completing a task, you wouldn't know where to begin.*)

10-item composite variable including the following items (tasks):

- Adjusting which apps have permission to access my microphone.
- Sending photos taken on my phone to other people.
- Deleting an app from my phone.
- Creating a personal hotspot with my phone.
- Downloading music to my phone.
- Changing my location privacy settings.
- Connecting another device to my phone using Bluetooth.
- Updating my phone to the newest operating system.
- Changing the access code / password on my phone.
- Sharing my location with someone else through my phone.

Used 5-point scale:

1. Not at All Confident
2. A little Confident
3. Somewhat Confident
4. Moderately Confident
5. Confident

IPA Data Concerns

7-item composite variable including the following items (statements):

- I am concerned that my questions directed at the device are stored and used by the service provider (e.g., Google, Amazon) to predict my interests and future needs.
- I am concerned that other people might activate/access the device and disrupt my internet accounts or personal information.
- I am concerned that my questions directed at the device are stored and might be accessed by law enforcement.
- I am concerned that the device is always recording any sounds in the room.
- I am concerned that the device is always listening.
- I am concerned that other people might activate/access the device and trigger unauthorized purchases.
- I am concerned that my questions directed at the device are stored and sold to third parties (e.g., advertisers).

Used 5-point scale:

1. Not at All Concerned
2. Slightly Concerned

3. Somewhat Concerned
4. Moderately Concerned
5. Extremely Concerned

IPA Data Confidence

4-item composite variable including the following items (statements):

- I'm confident information communicated between the device and the service provider (e.g., Apple, Google) is always encrypted.
- I'm confident any personal information communicated to / from the device is protected by a privacy policy.
- I'm confident these devices are secure and cannot be hacked or accessed without authorization.
- I'm confident that microphones on these devices are not activated without a user's direct action (e.g., saying "OK Google").

Used 5-point scale:

1. Not at All Confident
2. A little Confident
3. Somewhat Confident
4. Moderately Confident
5. Confident