

# Evaluarea satisfacției persoanelor vârstnice în utilizarea de tehnologii inteligente asistive: vINCI studiu de caz

Lidia BĂJENARU<sup>1,2</sup>, Ion Alexandru MARINESCU<sup>1</sup>, Mihaela TOMESCU<sup>1</sup>, Rozeta DRĂGHICI<sup>3</sup>

<sup>1</sup> Institutul Național de Cercetare - Dezvoltare în Informatică - ICI București

(lidia.bajenaru, ion.marinescu, mihaela.tomescu)@ici.ro

<sup>2</sup> Universitatea Politehnica din București, România

<sup>3</sup> Institutul Național de Gerontologie și Geriatrie „Ana Aslan”, București, România

rozetadraghici@gmail.com

**Rezumat:** În prezent, la nivel global, populația trece printr-o serie de schimbări demografice importante, ce se manifestă în special prin îmbătrânirea accentuată a populației, proces care va genera pe termen mediu și lung incertitudini privind sustenabilitatea modelului social actual. Principalul efect al acestui declin demografic este reprezentat de majorarea semnificativă a cheltuielilor publice privind serviciile sociale și de sănătate adresate vârstnicilor, aceștia prezentând risc mult mai ridicat de a se confrunta cu probleme de sănătate asociate vârstei ce necesită îngrijire de lungă durată. În acest context au fost inițiate programe de cercetare precum „Active and Assisted Living” (AAL) în Uniunea Europeană ce au drept obiectiv să finanțeze idei inovatoare care să conducă către implementarea unor noi soluții inteligente pentru autonomie asistată bazate pe tehnologii emergente și practici validate clinic ce permit abordări proactive și preventive în menținerea unei vieți active și sănătoase a persoanelor vârstnice. O astfel de idee a fost concretizată prin realizarea platformei tehnologice vINCI al cărei scop principal este acela de a oferi un instrument ușor de utilizat, ce permite vârstnicilor să își optimizeze stilul de viață pentru a-și asigura o longevitate activă prin utilizarea unei tehnologii de asistență personalizată, digitală, discretă, interconectată, adaptabilă și inteligentă. Această lucrare oferă o imagine de ansamblu a impactului tehnologiilor dezvoltate în cadrul proiectului vINCI asupra unui eșantion de utilizatori, analizând feedback-ul primit de la aceștia cu privire la satisfacția rezultată în urma interacțiunii cu aceste tehnologii. Au fost testate aplicația mobilă vINCI și dispozitivele inteligente asociate, prin intermediul cărora se realizează monitorizarea în timp real a diversilor parametri bio-medicali. Rezultatele acestei analize realizate în cadrul pilotului din România vor ajuta dezvoltatorii să îmbunătățească componentele de bază ale platformei vINCI și să creeze la final un produs competitiv pe o piață extrem de dinamică cum este cea a soluțiilor de asistență personalizată destinată persoanelor vârstnice.

**Cuvinte cheie:** Tehnologii inteligente asistive, internetul lucrurilor, monitorizare la distanță, satisfacția utilizatorilor, calitatea vieții.

## Assessing elderly satisfaction in using smart assisted living technologies: vINCI case study

**Abstract:** Currently, the global population is undergoing a series of important demographic changes, which is manifested especially by the accentuated aging of the population, a process that will generate in the medium- and long-term uncertainties regarding the sustainability of the current social model. The main effect of this demographic decline is the significant increase in public spending on social and health services for the elderly, who are at a much higher risk of age-related health problems requiring long-term care. In this context, research programs such as "Active and Assisted Living" (AAL) have been launched in the European Union with the aim of funding innovative ideas leading to the implementation of new smart solutions for assisted living (AL) based on emerging technologies and clinically validated practices that allow proactive and preventive approaches in maintaining an active and healthy life of the elderly. Such an idea was obtained through the realisation of the vINCI technology platform, whose main purpose is to provide an easy-to-use tool that allows the elderly to optimise their lifestyle to ensure an active longevity by using a technology of personalised, digital, discreet, interconnected, adaptable and intelligent support. This paper provides an overview of the impact of the technologies developed in the vINCI project on a sample of users, analysing the feedback received from them on the satisfaction resulting from the interaction with these technologies. The vINCI mobile application and the associated smart devices were tested, through which the real-time monitoring of the various bio-medical parameters is performed. The results of this analysis conducted under the Romanian pilot will help developers to improve the basic components of the vINCI platform and ultimately create a competitive product in an extremely dynamic market, such as personalised care solutions for the elderly.

**Keywords:** Smart assisted living technologies, internet of things (IoT), remote monitoring, user satisfaction, quality of life (QoL).

## 1. Introduction

Currently the world population is undergoing a series of important demographic changes due in particular to the increase of life expectancy combined with a decline of the fertility rate, which will lead in the medium and long term to the emergence of important socio-economic consequences (Papetti, 2021). In the European Union alone, the proportion of older people is expected to increase from 27,8% today to over 50% by 2060 (European Commission, 2015). Old age is generally associated with deterioration of functional and cognitive health, increased chronic diseases, reduction of social networks and low physical activity. In this context, the demand for care services for elderly will face increasing pressure worldwide, which will require a substantial increase in spending of the public and health services (United Nations, 2019).

To cope with these changes, research programmes that fund innovative ideas that can contribute to improving the quality of life of older adults through the use of unobtrusive, interconnected, adaptable and intelligent digital technology (Baraković et al., 2020) have been operationalised at European level. One such programme is Active Assisted Living (AAL), which aims to actively contribute to creating real opportunities for older people to stay healthy, active and happy and to live their life as they wish (European Commission, 2021). To achieve this goal, efforts are directed towards the implementation of new assisted living (AL) technological solutions based on emerging technologies (sensing devices, intelligent systems, open science cloud etc.), and clinically-validated practices that allow proactive and preventive approaches, in order to maintain an active and healthy life (Vevera et al., 2020).

The shift towards this type of approach to elderly care is facilitated on one hand by recent advances in new technologies, such as Artificial Intelligence (AI) and the Internet of Things (IoT) and the popularisation of smart communication devices, and on the other hand by the growing demand from older people for solutions to monitor their daily activity levels, allowing them to live a more sustainable and independent life (Alexandru et al., 2018; Barbu, 2019).

Therefore, providing an integrated platform for promoting active ageing, person-centred and event-driven applications, reflecting the older adults' lifestyle, needs, Daily Level of Activity (DLA), usual habits and preferences, has become a pressing necessity to ensure their independence. Providing the elderly with such instruments is a step in the right direction for improving their QoL (Spinsante et al., 2021).

According to the Directorate-General for Economic and Financial Affairs (European Commission, 2015), the QoL parameters reflect individual physical health, psychological state, personal beliefs, social relationships, features of the surrounding environment and the person's relations with it. Assisted Living (AL) technologies can have positive impacts on different dimensions of a subject's health and QoL (Chen et al., 2015). Through the pervasive collection of data allowed by them, these technologies can become facilitators for operational optimisation of care services (Mendes et al., 2017).

This paper provides an overview of the impact of the technologies developed within the vINCI project on a sample of users, by analysing the feedback received from them on the satisfaction resulting from the interaction with these technologies. The results of this analysis will help developers to improve the basic components of participatory interface according to users' observations and understand how the whole system is perceived from an external point of view.

To this end, three independent studies have been initiated regarding user satisfaction obtained for real-life use cases in Romania, conducted by the Institute of Geriatrics and Gerontology "Ana Aslan" (NIGG), Connected Medical Devices (CMD) and ICI Bucharest (ICI). The first two studies were conducted under medical supervision in a controlled environment within the caregiving centres, while the study coordinated by the ICI was based exclusively on independent participants outside the care system for the elderly. This latest study has the role of controlling and validating the obtained results, as well as of verifying the impact of the technologies developed within the vINCI project, regardless of the place where they are used.

The paper is organised as follows: Section 2 provides a short description of vINCI technologies. Section 3 describes the process of measuring the user satisfaction regarding vINCI technology. Finally, Section 4 concludes the paper by summarising the overall aims of the project and the research steps that are being undertaken to fulfil them.

## 2. vINCI technologies

The Clinically-validated INtegrated Support for Assistive Care and Lifestyle Improvement: the Human Link (vINCI project) is one of the projects funded through the AAL programme and aims to improve the quality of life of older people through the early detection of symptoms related to some of the impairments associated with the ageing process and to trigger alerts in case of possible incidents. To achieve this objective, the vINCI project proposes the development of a technological platform capable of unobtrusively monitoring the older adult through a set of extensible and smart technologies, securely storing and analysing the information thus collected. Thus, vINCI provides institutions and individuals involved in the care of the elderly tools capable for objective instrumentation of the QoL intervention (Băjenaru et al., 2020; Spinsante et al., 2021).

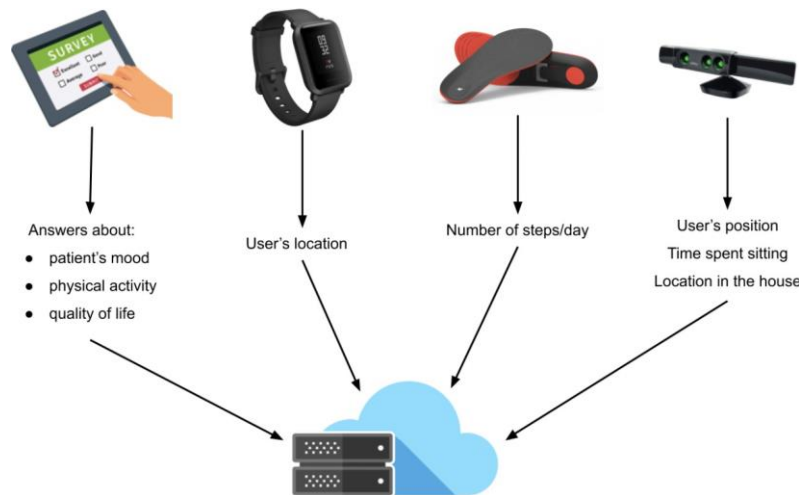
Several smart and environmental wearable devices are connected in a validated framework by the clinical pilot deployed at the National Institute of Gerontology and Geriatrics “Ana Aslan”, Bucharest, Romania (Drăghici et al., 2019). The provided aggregated solution allows the capture of various facets of events that lead to a decreased quality of life associated with old age (Spinsante et al., 2021).

The vINCI application connects multiple innovative user-oriented devices: smart watches that identify the location, smart insoles that count the steps, depth cameras that record one’s movements and smart devices (phone, tablet) on which the users can answer surveys and questions about their quality of life and mood. All the data will be aggregated and analysed inside a web platform which plans to create a much clearer picture of an elderly’s health, life and activity and also provide smart care, if necessary. The smart watches, smart insoles and the cameras, along with the survey application installed on the patient’s tablets or phones, are the main sources of data that will enter the platform. Every device has one or more dedicated microservices with which it communicates. This offers a very clear separation of the data that enters and flows through the application and also independence in development (figure 1). All data is aggregated and analysed in a mobile application (vINCI app) and a web platform (vINCI dashboard, used by the owners).

Behind the platform, the data are: a static patient profile; the results of a questionnaire on quality of life (QoL), as perceived by the monitored elderly person; data from monitoring devices that are integrated in the platform (smartwatches - CMD and Fitbit, smart insoles, depth camera); and, respectively, the data from the questionnaires regarding the level of activity and the psycho-social level of the monitored person. All these compose a model of the monitored data for a person subject to vINCI technology, a model that will be validated in clinical conditions using clinical data provided by the medical pilot from Romania.

## 3. User satisfaction process regarding vINCI technology

With the widespread use of information systems (IS) in many vital areas of society and the increasing reliance on them to support everyday activities, numerous studies over the years have attempted to provide a measure of the success of such a system in the context of this accelerating growth (Srinivasan, 1985; Brancheau et al., 1996).



**Figure 1.** Different devices currently connected to vINCI App

However, quantifying the success of an IT system is a difficult task due to its often-abstract nature and the multitude of factors that can influence success and the complexity of the relationships between them (DeLone et al., 1992). In this respect, research efforts have been directed towards identifying as precisely as possible the factors that directly or indirectly influence the success of an IS and developing low-cost and easy-to-use success measurement tools. To support these initiatives, various models have been proposed over the years, incorporating the main success factors defined over time. The best-known model for measuring the success of an IS is the one proposed by DeLone et al. (1992). This model is composed of six major success factors: information quality, system quality, service quality, system use/ usage intentions, user satisfaction, net system benefits.

*User satisfaction* is one of the most important and widely used factors in measuring the success of an IT system. The widespread involvement of this factor in the success evaluation of an IT system is primarily due to its wide applicability in multiple domains, its ease of use in various tools and its high degree of results validity (Montesdioca et al., 2015). Consequently, it can be said that regardless of the domain a computer system serves, if its use leads to a positive experience, the user will be encouraged to use it again. (Chen et al., 2015).

The vINCI technology platform is a solution designed for ALL, strongly consumer-oriented, usually elderly people who face some of the challenges generated by aging or those who take care of the elderly, and for this reason, user satisfaction is seen as one of the key factors that will contribute to the adoption of this platform, as well as the future improvements of the vINCI technologies.

The process of measuring user satisfaction is performed in three stages. In the first stage, the users from the target group have access to the services and technologies developed within the vINCI project. The testing of these technologies and services is carried out across five multi-disciplinary controlled pilots (in Romania, Cyprus, Italy, Poland and Slovenia). Participants in these studies, independently or with medical support, are encouraged to use vINCI technologies (mainly mobile application together with intelligent devices for monitoring bio-medical parameters), the results being corroborated with other data sets regarding the quality of life or physical activity level, resulting in a consolidated report that indicates the evolution of the monitored parameters (in close correlation with the degree of user satisfaction).

For this paper, only the Romanian pilot will be described, and in the future this article will be extended with the consolidated results obtained at the level of all partners in the vINCI project. The Romanian pilot is based on three independent studies, regarding user satisfaction obtained for real-life use cases. The first two studies are coordinated by the Institute of Geriatrics and Gerontology "Ana Aslan" (NIGG) and Connected Medical Devices (CMD) and are carried out under medical supervision in controlled environments in Geriatrics and Gerontology Inpatient and Outpatient Departments for NIGG and in public and private care centres (Cajal Centre and Senior Residence

Ciofliceni) for CMD. The third study (CTR) is designed to control and validate the results obtained and to verify the impact of the technologies developed in the vINCI project, wherever they are used. This study was coordinated by ICI Bucharest and was based exclusively on independent participants from outside the care system.

During the second phase, users are invited to complete a user satisfaction survey that provides valuable insight into the real experience of individuals interacting with the vINCI services and technologies. In the final phase, the survey responses will be evaluated and the degree of acceptance of the technology will be studied. These results corroborated with data from another study within the project (Băjenaru et al., 2020; Balog et al., 2020) will allow developers to improve the interfaces and functions of the entire vINCI system, to finally deliver a product mapped to users' needs, market requirements and the results proposed in the project financing application.

The target user group includes older adults aged 65, without severe impairments, who live in a day care centre or alone for the control group and who understand the advantages of non-intrusive remote monitoring through technology of various physical, mental and social parameters. It is also important to mention that the older adults in the selected groups are still active persons (the non-movable residents or those with a form of dementia were not included in the pilot, because they would certainly not be able to make use of the vINCI product). All participants were evaluated against some exclusion criteria that have been described in other publications (Băjenaru et al., 2020).

For the NIGG and CMD pilots, one of the first important observations was that the majority of the elders in the caregiving centres are not regular users of smart technology, including here phones and tablets. Therefore, there are not used to and probably not open to the idea of interacting with friends or other individuals with the help of any app. Instead, the control group is made up of technologically independent people, who use smart devices on a daily basis to communicate, socialise and inform themselves.

Participation in the pilot studies was as follows: The NIGG study involved 39 persons, CMD 15 people, the control group (CTR) being made up of 21 participants. In order to receive feedback from the target user group, a lot of preparatory actions should be taken into account. First, the participants were trained in the use of the vINCI application and related technologies. After the completion of this stage, users were familiarised with the tool and methodology for evaluating satisfaction in the use of the technologies presented. In all these stages, NIGG and CMD study participants have benefited from the support of the medical staff, both from a technical and explanatory point of view. The control group benefited from an explanatory guide of the technologies used as well as of the way the study was carried out.

### **3.1. Method of data gathering**

Appropriate tools for measuring user satisfaction and for identifying weak points or failures are imperative for accurate assessment of vINCI technological platform. To meet this need, a number of tools were developed. In the context of assessing the degree of user satisfaction in using vINCI technologies, questionnaires are the chosen method of data gathering. This method uses specific questions to collect opinions of targeted group that can easily be analysed. The questionnaire is developed based on partners' experience, the study of various evaluation tools described in the literature, the objectives of the vINCI project and also, the results obtained so far.

The vINCI user satisfaction questionnaire (USQ) is divided into two parts. The first part of the questionnaire (part I) refers to some demographic data and the frequency of using vINCI mobile application. The second part of the questionnaire (part II) gives to developers a much more detailed picture of users' experience regarding the interaction with the vINCI environment. The information collected allow developers to improve the prototype of the vINCI system, so that the final version of the system can achieve the maximum degree of acceptance from users.

In order to simplify the data collection process, it was chosen to transpose the questionnaire into a digital format and present it using smart devices such as tablets or phones. The procedure for conducting the study was fully compliant with the rules of personal data protection (GDPR),

without storing personal data that could alter the condition of anonymous participation assumed by the initiators of the study and agreed by the participants. Table 1 shows the two sections of the questionnaire in English language. The questionnaire was presented in the native language of the participants, in this case Romanian.

**Table 1.** vINCI user satisfaction survey – questionnaire items

	<b>Questionnaire Item</b>
Q1	How often do you use the vINCI application?
Q2	It is easy to learn how to work with the vINCI application.
Q3	The vINCI application is easy to use.
Q4	Using the vINCI app, I am better informed about my health.
Q5	My security level has improved using the vINCI application.
Q6	The vINCI application helps me obtain relevant quality of life data.
Q7	The vINCI application gives me the opportunity to communicate data about my physical condition/ quality of life more easily.
Q8	The system interface is pleasant and intuitive.
Q9	The results provided by the application are easy to access and understand.
Q10	I think I could improve my health using the vINCI app.
Q11	The information provided by the vINCI application is complete and useful.
Q12	The daily monitoring performed through the vINCI application does not interfere with my personal data.
Q13	The vINCI application has improved the quality of medical services received.
Q14	The interaction with the vINCI application is clear and easy to understand.
Q15	The organisation of the information on the screen of the devices running the vINCI application is clear and intuitive.
Q16	The vINCI application is very useful for me in my daily life.
Q17	Using the vINCI application is very exciting.
Q18	I like to interact with the vINCI application interface.
Q19	I use the vINCI application with confidence.
Q20	Overall, I am satisfied with how to use the vINCI application.

### **3.2. USQ Part I: demographic data and vINCI app frequency of use**

This study provides researchers with demographic data that help them better understand the impact of vINCI technology taking into account the distribution of participants by age, gender and level of education. Figure 2a, 2b and 2c provide demographic information about 75 older adults (39 from NIGG, 15 from CMD and 21 for Control group). As shown in figure 2a, most of the study participants in the two pilots, NIGG and CMD, are women, 59% (average values reported to the total of participants), are mostly between the ages of 65 and 75 years (57%), figure 2b, and with a good level of education (37,95% higher education, 52,87% secondary education), figure 2c. The control group confirms the homogeneity of this sample, offering similar characteristics: 80,95% women, 76,19% aged between 65 and 75 years and a high level of education (19% higher education, 66,67% secondary education).

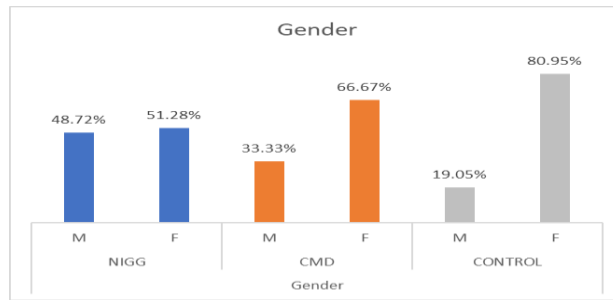


Figure 2a. Gender distribution

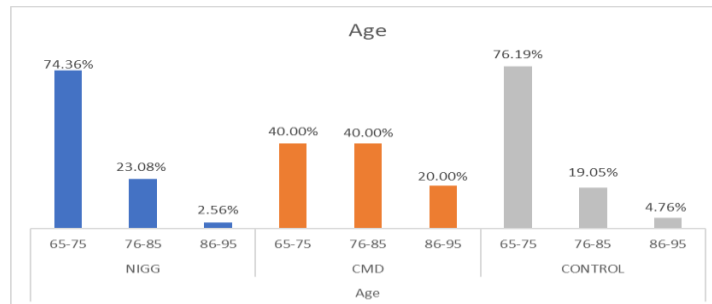


Figure 2b. Age distribution

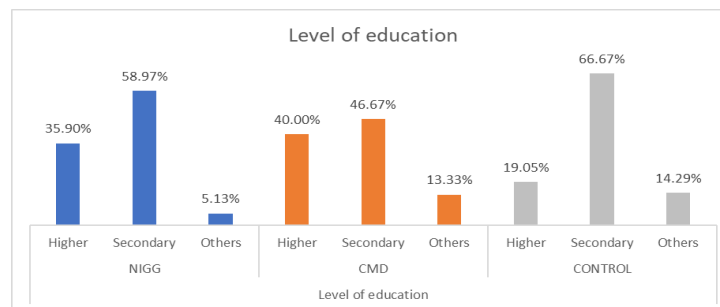


Figure 2c. Level of education distribution

Next, the users' answers regarding the frequency of use of the vINCI mobile application will be analysed. In figure 3 the predisposition of users to a daily use of the vINCI application at the level of NIGG and CMD, being almost 72% at the level of the two pilots, can be observed. On the control group there is a slightly different distribution of responses, much more uniform, which 38% of participants recorded a less frequent use of the application (this means once or several times a month). This difference can be explained by the technical and informational support provided for the first group by the medical staff in using application and smart devices associated with it. Hence the need for a better communication of the advantages of using the vINCI application, of improving the marketing strategy in order to create a successful product adopted on a large scale.

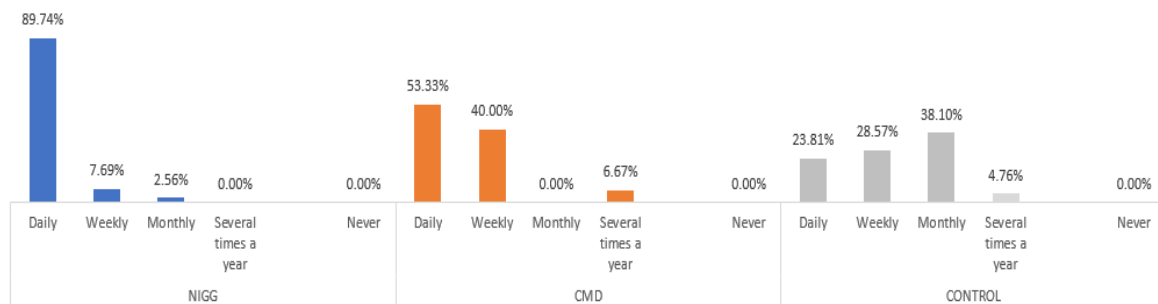


Figure 3. Frequency of use of the vINCI application (Q1)

### 3.3. USQ Part II: Interaction with all vINCI devices

In the second part of the questionnaire, there were formulated 19 statements (Q2 – Q20) covering all areas of intervention of the vINCI application, users being invited to express their agreement or disagreement with them. The participants had the possibility to indicate on a scale from 1 to 5 if they agree or disagree with a number of statements regarding the interaction with the vINCI application. The proposed scale measure has the following significance:

- *fully disagree*: users categorically reject the statement without the possibility of changing the adopted position;
- *disagree*: users reject the statement, but do not exclude a future reconsideration of the options if something is changing according to the users' expectations;
- *neutral*: the impact is minimal on users;
- *agree*: users agree with this statement, but expect some aspects of the interaction with the vINCI application to be improved;
- *fully agree*: Users fully agree with the statement without any comments.

The responses distribution is shown in Table 2.

**Table 2.** Results distribution regarding the interaction with vINCI devices

	fully agree			agree			neutral			disagree			fully disagree		
	NIGG	CMD	CTR	NIGG	CMD	CTR	NIGG	CMD	CTR	NIGG	CMD	CTR	NIGG	CMD	CTR
Q2	13	2	1	2	7	11	3	5	3	1	1	1	0	0	0
Q3	13	2	3	21	6	14	3	5	3	2	2	1	0	0	0
Q4	8	1	4	22	2	12	8	10	5	0	0	0	1	0	0
Q5	1	2	0	21	3	14	12	10	7	5	0	0	0	0	0
Q6	3	2	7	22	7	14	10	5	0	1	1	0	3	0	0
Q7	3	2	5	27	6	15	7	6	1	0	1	0	2	0	0
Q8	8	1	2	25	8	16	4	4	3	0	2	0	2	0	0
Q9	4	1	0	29	6	10	5	6	10	1	2	1	0	0	0
Q10	4	5	3	25	5	13	7	4	5	1	1	0	2	0	0
Q11	1	1	0	29	3	13	8	8	8	1	3	0	0	0	0
Q12	17	1	0	20	3	19	2	9	1	0	2	1	0	0	0
Q13	8	1	1	22	6	15	5	6	5	2	2	0	2	0	0
Q14	12	3	1	24	7	15	2	5	5	1	0	0	0	0	0
Q15	5	1	2	28	9	14	6	4	5	0	1	0	0	0	0
Q16	7	1	1	18	6	13	10	8	6	2	0	1	2	0	0
Q17	6	1	0	25	6	9	5	5	11	3	3	1	0	0	0
Q18	3	1	2	28	6	14	5	7	4	3	1	1	0	0	0
Q19	4	1	3	28	8	14	4	5	4	3	1	0	0	0	0
Q20	5	1	2	29	9	15	3	4	4	2	1	0	0	0	0

Learnability is one of the five quality components of usability (the others being efficiency, memorability, errors, and satisfaction). Testing learnability is especially valuable for complex applications and systems that users access frequently, though knowing how quickly users can acclimate to their interfaces. In this study, users of both pilots found it easy to learn how to work with the vINCI application (56% of NIGG respondents and 47% for CMD agree with statement Q2). The control group confirmed this trend with a higher percentage (76%) resulting from more advanced skills in understanding and manipulating new technologies. However, there was a cumulative percentage of 19% of users who were neutral and disagreed with Q2 statement. In this case, additional studies are needed to identify the causes and improve the interfaces or how to interact with them.

The majority of respondents considered that vINCI app is easy to use. 78% of the cumulative answers of the NIGG and CMD pilots agreed and totally agreed with the statement Q3. Only 7% of users found certain aspects of the application difficult to use, which overall confirms the efforts of developers to make a useful and easy to use application.

The statement Q4 is based on one of the major objectives of the entire vINCI project, which aims to provide real-time information about the user's health through innovative technologies



(smart devices, mobile application etc.). According to the study, this goal has been partially achieved. The answers indicate that NIGG and CMD respondents agree with this statement in proportion of 57% - NIGG; 13% - CMD, while 21% - NIGG; 7% - CMD, fully agree. Also, there was a high percentage of neutral opinions (21% - NIGG; 67% CMD). Instead, the results on the control group are encouraging (19% fully agree; 57% agree; 24% neutral). However the result for NIGG and CMD pilots remains modest, requiring further development efforts to simplify vINCI technologies in order to be accepted by a large number of users.

The degree of security is another important objective needed to be reached in the vINCI project in terms of developed technologies. The application handles medical data that must be protected against any unauthorised access attempts. In this study, Q5 statement was designed precisely to measure the extent to which this goal was achieved. The results indicate that the vINCI app and its associated technologies give confidence to at least half of users in protecting their personal data. However, an important proportion (31% - NIGG; 67% - CMD; 24% CTR) provides a neutral opinion, which is why further efforts are needed to improve users' trust in this product.

Measuring the quality of life is an important parameter for estimating the outcomes of health care programs and interventions. Obtaining relevant data in this field is an important functionality of the vINCI application. The results obtained for the Q6 statement show us the following situation: 54% of study participants (56% - NIGG; 47% - CMD) agree with this statement, while 9% (8% - NIGG; 13% - CMD) fully agree. For about 28% (26% - NIGG; 33% - CMD) of the respondents, the opinion is neutral, while 4% respectively 6% reject partially or totally this statement. The results obtained on the control group confirm this tendency (67% agree; 33% fully agree; 7% disagree).

The collection and communication of data regarding the user physical condition/ quality of life represents an important functionality offered within the vINCI technological platform via the vINCI app. The Q7 statement evaluates the potential of the vINCI application to communicate data in a non-invasive, intuitive and simplified way about physical condition or quality of life. This statement was positively appreciated by over 70% of NIGG and CMD respondents (69% agree / 8% fully agree - NIGG; 40% agree / 13% fully agree - CMD) and by 95% of those of the control group (71% agree / 24% fully agree).

According to the results of the Q8 statement, the majority of respondents consider the interface of the vINCI app pleasant and intuitive. These results emphasize the development effort invested in creating vINCI interfaces that meet the users' needs, regardless of their digital literacy or skills in using smart devices. Below are some relevant results for Q8 statement: agree 64% - NIGG; 53% - CMD and 76% - CTR, while 21% - NIGG; 7% - CMD and 10% CTR fully agree. The rejection rate is relatively low, namely 13% for CMD and 5% for NIGG.

In the context of a highly dynamic market regarding products and services for health care (Health Europe, 2022), the Q9 statement can be seen as one of the key factors that can influence the market success of the vINCI technological platform, especially since it addresses mainly a niche of users made up of elderly people. The statement evaluates the vINCI app in terms such as ease of access and understanding. 65% of the NIGG and CMD participants (74% - NIGG; 40% - CMD) agree with this statement, while 9% (10% - NIGG; 7% - CMD) fully agree. The degree of acceptance of this statement is lower for the control group, only 48%, a similar percentage being for neutral opinions. The degree of cumulative statement rejection for all three pilots is 5%.

Another important objective of the vINCI is to provide a health impact quantification of the proposed technologies, showing the benefits to potential users. In this direction, the Q10 statement evaluates the subjective perception of the study participants regarding the potential expected benefits. The answers provided show that at the level of both pilots, NIGG and CMD, for 72% of participants (agree 64% - NIGG / 33% - CMD; fully agree 10% - NIGG; 33% - CMD) there is a belief that their health could be improved by using the vINCI application and associated technologies. This expectation is confirmed by more than 61% of participants in the control group (62% agree; 14% disagree).

At the level of integrity and correctness of the information provided through the vINCI

application, we have a percentage of 59% of the NIGG and CMD participants (74% - NIGG; 20% - CMD) who agree with statement Q11. However, 30% of participants (21% - NIGG; 53% - CMD) preferred to express a neutral opinion. For the control group, the percentages are as follows: 62% agree and 38% have a neutral opinion on this statement. These results require further analysis to identify the motivation of users who have meaningfully expressed their neutral opinion and even disagreement (3% - NIGG; 20% - CMD) with the Q11 statement.

The protection of personal data and respect for privacy are fundamental European rights that are stipulated in the European directives that are fully integrated into the national legislation of each Member State of the European Union. Within the vINCI project, the aim was to create products addressed to the global market that comply with these provisions. The Q12 statement collects and compares the answers obtained on this topic. The participants (51% / 44% - NIGG; 20% / 7% - CMD; 90% / 0% - CTR) overwhelmingly confirmed in proportion of 80% (agree / fully agree) the compiling of vINCI app with personal data protection regulations.

The way in which the vINCI application influences the quality of medical services is a defining element that has been taken into account since the design phase. A subjective assessment regarding the fulfillment of this objective was provided through the answers received to the Q13 statement. Thus, almost 69% of the NIGG and CMD participants (56% / 21% - NIGG; 40% / 7% = CMD) positively appreciate this impact (agree / fully agree), 20% having a neutral opinion (13% - NIGG; 40% - CMD) while 11% disagree and fully disagree. Under these conditions, it is necessary to improve the services provided within the vINCI application in order to maximize the impact on the quality of medical services received by users.

According to the ISO 9241-11:2018 standard (ISO, 2018), the clarity and simplicity of interactions within an application helps make the messages clearer and meaningful to users. The distribution of responses for Q14 statement shows that the interaction with the vINCI application is clear and easy to understand for 85% of participants (cumulative response for NIGG and CMD – agree and fully agree). 13% have a neutral opinion, while 2% disagree.

From the point of view of organising the information within the vINCI application, over 80% of study participants (cumulative response for NIGG and CMD – agree and fully agree Q15 statement) appreciated the way this information is organised and presented through the application interfaces. For the control group, the answers had the following distribution: 67% agree; 10% fully agree; 24% neutral.

An important percentage of over 59% of the study participants (cumulative response for NIGG and CMD – agree and fully agree Q16 statement) consider the vINCI application very useful in their daily life. For 33% (26% - NIGG; 53% - CMD) of participants the opinion is neutral, while 7% disagree or fully disagree. These values confirm the usefulness of the application and especially the fact that the vINCI project, through the proposed technologies, added value to the comfort and users safety.

For almost 70% of the study participants (cumulative response for NIGG and CMD – agree and fully agree Q17 statement), the vINCI application is considered interesting, which corroborated with the results of previous statement (Q16), provides an overview of the great potential for popularisation among users. More modest values are found in the control group: 43% agree; 52% have a neutral opinion; 5% disagree.

The vINCI application also marks a success in terms of interface design, over 70% of respondents being happy to interact with the application's interfaces (cumulative response for NIGG and CMD – agree and fully agree with Q18 statement).

Building trust is one of the central goals of user experience design. This means user trust is the key to success, and this aspect involves creating a credible application that allows users to perform the proposed tasks in a safe and effective environment. Over 76% of study participants (NIGG and CMD) agree and fully agree with the statement Q19, which represents a high degree of confidence in the vINCI application and related technologies. For the control group we have the following distribution of responses: 67% agree; 14% fully agree; 19% neutral.

Statement Q20 represents the conclusion of this study, through which the participants give a global note to the vINCI application. According to the received answers, over 81% of the participants (NIGG and CMD) positively appreciate the vINCI application as a whole, which confirms the fact that the vINCI project represents a successful project through the technologies developed and delivered, bringing a real benefit to the users. However, 13% (8% - NIGG; 27% - CMD) of respondents have a neutral opinion, while 6% (5% - NIGG; 7% - CMD) disagree. For the control group we have the following distribution of responses: 71% agree; 10% fully agree; 19% neutral.

## 4. Conclusions

In this paper, the degree of user satisfaction in using the technologies developed within the vINCI project was evaluated. The vINCI mobile application and the associated intelligent devices were tested, through which the real-time monitoring of the various bio-medical parameters is performed. The conclusions made on the basis of the analysis results on the satisfaction survey are as follows. First, as a result of the analysis of the responses to the perception of ease of access and understanding by the users, 74% agree and strongly agree. Second, an analysis of the subjective perception of study participants about the potential benefits expected from vINCI technology shows that over 72% of participants are convinced that their health could be improved by using vINCI and associated technologies. Third, following the analysis of user satisfaction using vINCI technologies, the survey showed that the way in which vINCI application influences the quality of medical services is a defining element that was taken into account from the design phase. Thus, over 69% of the participants positively appreciate this impact. The final statement of the survey is the conclusion of this study, in which the participants give an overall rating to the vINCI application. According to the answers received, over 81% of the participants positively appreciate the vINCI application as a whole, which confirms that the vINCI project is a successful project through the technologies developed and delivered, bringing a real benefit for users. This study could be of real benefit to companies and researchers developing smart healthcare products for specific IT systems.

## Acknowledgment

The research presented in this paper is supported by the project “vINCI: Clinically-validated INtegrated Support for Assistive Care and Lifestyle Improvement: the Human Link” (funded by EU AAL 2017 Programme and Executive Unit for Financing Higher Education, Research, Development and Innovation - UEFISCDI Romania) and partially by the project “Non-invasive monitoring and health assessment of the elderly in a smart environment (RO-Smart Ageing)” (funded by the Romanian Core Program of the Ministry of Research and Innovation).

## REFERENCES

1. Alexandru, A., Coardoş, D. (2018). *Utilizarea tehnologiilor Big Data și IoT în Domeniul Sănătății*. Revista Română de Informatică și Automatică (Romanian Journal of Information Technology and Automatic Control), 28 (1), 61-84.
2. Barbu, D. C. (2019). *Soluții de prelucrare specifice Big Data*. Revista Română de Informatică și Automatică (Romanian Journal of Information Technology and Automatic Control, vol. 29(2), 35-48.
3. Băjenaru, L., Marinescu, I. A., Dobre, C., Prada, G. I., Constantinou, Costas S. (2020). *Towards the development of a personalized healthcare solution for elderly: from user needs to system specifications*. Proceedings of the 12th International Conference on Electronics, Computers and Artificial Intelligence – ECAI 2020, Bucharest, Romania, online, 25-27 June 2020.

4. Băjenaru, L., Marinescu, I. A., Dobre, C., Drăghici, R., Herghelegiu, A. M., Rusu, A. (2020). *Identifying the Needs of Older People for Personalized Assistive Solutions in Romanian Healthcare System*, Studies in Informatics and Control, 29(3), 363-372.
5. Balog, A., Băjenaru, L., Cristescu, I., Herghelegiu, A. M. (2020). *Needs and preferences of elderly patients regarding AAL systems: a latent profile analysis*. Proceedings of the 8-th edition IEEE International Conference on e-Health and Bioengineering - EHB 2020, Iași, Romania, 29-30 October 2020.
6. Baraković, S., Baraković Husić, J., van Hoof, J., Krejcar, O., Maresova, P., Akhtar, Z., Melero, F. J. (2020). *Quality of Life Framework for Personalised Ageing: A Systematic Review of ICT Solutions*. Int. J. Environ. Res. Public Health 2020, 17, 2940. <https://doi.org/10.3390/ijerph17082940>.
7. Brancheau, J. C., Janz, B. D., Wetherbe J. C. (1996). *Key Issues in Information Systems Management: 1994-95 SIM Delphi results*”, MIS Quarterly, 20(2), 225-242.
8. Chen, Y. H., Chengalur-Smith, I. (2015). *Factors influencing students' use of a library Web portal: Applying course integrated information literacy instruction as an intervention*. The Internet and Higher Education 26: 42–55. DOI:10.1016/j.iheduc.2015.04.005.
9. DeLone, W. H., McLean, E. R. (1992) *Information Systems Success: The Quest for the Dependent Variable*, Information Systems Research, 3(1), 60-95.
10. Dobre, C., Băjenaru, L., Marinescu, I. A., Tomescu, M., Prada, G. I., Spinsante, S. (2021). *New opportunities for older adults care transition from traditional to personalised assistive care: vINCI platform*. Proc. The 23rd International Conference on Control Systems and Computer Science (CSCS23) – 2021.
11. Drăghici, R., Rusu, A., Prada, G. I., Herghelegiu, A. M., Băjenaru, L., Dobre, C., Mavromostakis, C. X., Spinsante, S., Batallak, J. M., Gonzales-Velez, H. (2019). *Acceptability of Digital Quality of Life Questionnaire Corroborated with Data from Tracking Devices*. Proceedings of the 24th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD), pp.1-6, doi: 10.1109/CAMAD.2019.8858470.
12. European Commission (2021). *AAL Programme - Ageing Well in the Digital World*. <http://www.aal-europe.eu/our-achievements/>, accessed 2022.
13. European Commission, Directorate-General for Economic and Financial Affairs. (2015). *The 2015 ageing report economic and budgetary projections for the 28 EU member states (2013-2060)*. Report European Union, 2015.
14. Health Europe (2022). *Analysing the growth of eHealth and digital solutions during the pandemic*. <https://www.healtheuropa.eu/analysing-ehealth-and-digital-solutions-during-the-pandemic/112945/>, accessed 2022.
15. ISO 9241-11:2018(en). *Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts*. <https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-2:v1:en>, accessed 2022.
16. Mendes, S., Queiroz, J., Leitao, P. (2017). *Data driven multi-agent m-health system to characterize the daily activities of elderly people*. In: CISTI '17, Lisbon, pp. 1–6.
17. Montesdioca, G. P. Z., Maçada, A. C. G. (2015). *Measuring user satisfaction with information security practices*. Computers & Security, 48, 267-280.
18. Papetti, A. (2021). *Population aging and the persistence of three key global trends*. SUERF Policy Brief, No. 225, November 2021.
19. Spinsante, S., Poli, A., Mongay Batalla, J., Krawiec, P., Dobre, C., Băjenaru, L., Mavromoustakis, C. X., Constantinou, C., Molan, G., Drăghici, R., Herghelegiu, A. M., Prada, G. I., Gonzalez-Velez, H. (2021). *Clinically-validated Technologies for Assisted Living The vINCI Project*. Journal of Ambient Intelligence and Humanized Computing,
20. Srinivasan, A. (1985). *Alternative Measures of System Effectiveness: Associations and Implications*, MIS Quarterly, 9(3), 243-253.

21. United Nations (2019). *World Population Ageing 2019: Highlights - the United Nations*. <https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf>, accessed 2022.
22. Vevera, A. V., Barbu, D. C., Neagu, G., Ciupercă, E. (2020). *Proiectul NI4OS-Europe – suport pentru Inițiativa națională Open Science Cloud*. *Revista Română de Informatică și Automatică (Romanian Journal of Information Technology and Automatic Control)*, 30(2), 81-94.



**Lidia BĂJENARU** este Cercetător Științific gradul II la Infrastructura de cercetare – PRECIS și membră a Laboratorului de Inteligență Artificială și Sisteme Multi-Agent din cadrul Universității Politehnica București (UPB). Este absolventă a Universității Tehnice „Gheorghe Asachi” din Iași, Facultatea de Electrotehnică, Automatizare și Informatică. A primit titlul de doctor (Magna Cum Laude) în “Informatică Economică” la Academia de Studii Economice București. De asemenea, își desfășoară activitatea ca Cercetător Științific gradul II în Departamentul „Comunicații, aplicații și servicii digitale” la ICI București. Principalele sale interese de cercetare sunt în domeniul educației, e-Learning, e-Health, mobile computing, inteligență artificială, ontologii, e-servicii, e-guvernare, social cloud computing. A coordonat și a fost membră în echipe de cercetare în peste 40 de proiecte naționale și internaționale, dintre care mentionăm “vINCI - Clinically-validated INtegrated Support for Assistive Care and Lifestyle Improvement: the Human Link”.

**Lidia BĂJENARU** is a Senior Researcher at the Research infrastructure – PRECIS and member of the Artificial Intelligence and Multi-Agent Systems Laboratory at the Politehnica University of Bucharest (UPB). She has graduated the "Gheorghe Asachi" Technical University of Iași, Faculty of Electrotechnics, Automation and Computer Science. She received a Ph.D. (Magna Cum Laude) in Economics Informatics at the Bucharest University of Economical Studies. She also works as Senior Researcher at the “Communication, Digital Applications and Systems” Department of ICI Bucharest. Her main research interests are in the field of education, e-Learning, e-Health, mobile computing, artificial intelligence, computer ontologies, e-services, e-government, social cloud computing. She coordinated and has been a member in research teams in more than 40 national and international projects, one being “vINCI - Clinically-validated INtegrated Support for Assistive Care and Lifestyle Improvement: the Human Link”.



**Ion Alexandru MARINESCU** este cercetător științific gradul III (din 2015) în Departamentul „Sisteme și Aplicații pentru Societate” din cadrul Institutului Național de Cercetare-Dezvoltare în Informatică – ICI București. A absolvit Facultatea de Inginerie Mecanică și Mecatronică cu specializarea „Robotică și Automatizare” la Universitatea Politehnica din București (2007), precum și cursurile de Master în Inginerie Mecanică din cadrul aceleiași universități la Facultatea de Inginerie Mecanică și Mecatronică (2009). Principalele domenii de interes pentru activitatea de cercetare includ: proiectare baze de date relaționale, business intelligence, dezvoltarea de sisteme informatice în domeniul patrimoniului cultural, educației, administrației publice și mediului înconjurător.

**Ion Alexandru MARINESCU** is a Scientific Researcher III (since 2015) within the „Systems and Applications for Society“ Department of ICI Bucharest. He graduated from the Faculty of Mechanical Engineering and Mechatronics with specialisation in „Robotics and Automation“, Politehnica University of Bucharest (2007), and he has a Master's Degree in Mechanical Engineering – Politehnica University of Bucharest – Faculty of Mechanical Engineering and Mechatronics (2009). The main areas of interest for the research activity include: design of relational databases, business intelligence, design and implementation of web applications for e-culture, e-health and e-government.



**Mihaela TOMESCU** a absolvit Institutul Politehnic din București, Facultatea de Electrotehnică, Secția „Utilizări”. În prezent, deține funcția de cercetător științific în Departamentul „Comunicații, aplicații și servicii digitale”, din cadrul Institutului Național de Cercetare-Dezvoltare în Informatică – ICI București, având o vechime de peste 25 de ani. Are experiență în domenii precum: proiecte naționale, europene și de cooperare bilaterale în domeniul TIC și competențe în efectuarea de cercetări axate pe eficientizarea proceselor informaționale specifice unor domenii diverse, precum și în testarea și evaluarea de software și sisteme informatice. A participat la elaborarea a peste 30 de articole în reviste științifice.

**Mihaela TOMESCU** graduated the Polytechnic Institute of Bucharest, Faculty of Electrotechnics, Section „Usages”. Currently, she holds the position of scientific researcher in the „Communication, Digital Applications and Systems” Research Department of the National Institute for Research & Development in Informatics – ICI Bucharest, having a seniority of over 25 years. She has experience in national projects, European and bilateral ICT projects and skills in performing research focused on streamlining information processes specific to various areas as well as in testing and evaluating software and information systems. She has participated in the elaboration of over 30 articles in scientific journals.



**Rozeta DRĂGHICI** este Cercetător Științific II - Psiholog Principal la Institutul Național de Gerontologie și Geriatrie “Ana Aslan” București din 1995, Lector Universitar Asociat la Universitatea din București. Are peste 150 de comunicări la congrese naționale și internaționale, a publicat 42 de articole și 5 capitole de carte în domeniul Gerontopsihologiei și Psihologiei clinice. A făcut parte din echipa de cercetare a 20 proiecte naționale și internaționale ca AAL - Virtual and memory adaptable spaces creating stimuli for the senses in ageing people with dementia SENSE-GARDEN, vINCI - Clinically-validated INtegrated Support for Assistive Care and Lifestyle Improvement: the Human Link, SI4SI - Smart Solution for Senior Isolation.

**Rozeta DRĂGHICI** is a Scientific Researcher II - Senior Psychologist at “Ana Aslan” National Institute of Gerontology and Geriatrics Bucharest since 1995, Associate Professor at the University of Bucharest. She has participated with more than 150 communications at international and national scientific events, she has published 25 articles and 5 chapters within the field of GerontoPsychology and Clinical Psychology. She was an active member of the research team in 20 national and international research projects such as AAL - Virtual and memory adaptable spaces creating stimuli for the senses in ageing people with dementia SENSE-GARDEN, vINCI - Clinically-validated INtegrated Support for Assistive Care and Lifestyle Improvement: the Human Link, SI4SI - Smart Solution for Senior Isolation.