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GLOBAL HEALTH 2021

Forward

The Tenth International Conference on Global Health Challenges (GLOBAL HEALTH 2021) continued a series of events taking a global perspective on population health, from national to cross-country approaches, multiplatform technologies, from drug design to medicine accessibility, everything under mobile, ubiquitous, and personalized characteristics of new age population.

Recent advances in technology and computational science influenced a large spectrum of branches in approaching population health. Despite significant progresses, many challenges exist, including health informatics, cross-country platforms interoperability, system and laws harmonization, protection of health data, practical solutions, accessibility to health services, and many others. Technological progress, personalized medicine, ambient assistance, and pervasive health complement patient needs. A combination of classical and information-driven approaches is developing now, where diagnosis systems, data protection mechanisms, remote assistance and hospital-processes are converging.

We take here the opportunity to warmly thank all the members of the GLOBAL HEALTH 2021 technical program committee, as well as all the reviewers. The creation of such a high-quality conference program would not have been possible without their involvement. We also kindly thank all the authors who dedicated much of their time and effort to contribute to GLOBAL HEALTH 2021. We truly believe that, thanks to all these efforts, the final conference program consisted of top-quality contributions. We also thank the members of the GLOBAL HEALTH 2021 organizing committee for their help in handling the logistics of this event.

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A Transition towards Digital Home Visits in Social Care and Home Health Care during the Corona Pandemic

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***Abstract*— During the pandemic, physical meetings were supposed to decrease as much as possible to avoid the virus to spread. Before the pandemic, the physical meeting favoured social care and home health care in Sweden. One solution was to digitize as many of these meetings as possible. Therefore, we investigated this transition in a web survey, including questions with predetermined and open-ended answers. The web-survey was sent to co-workers in home health care and social care in a middle-seized municipality in Sweden. The results showed that not all meetings could be transformed, like meetings with citizens with hearing or cognitive impairments. Challenges related to the transformation were instability in technical equipment, the professionals' and citizens' knowledge of handling technical equipment, and access to technical equipment support. Despite this did the co-workers digitize meetings whenever possible, adding operational and problem-solving attitude to the transformation. Due to this study's limitation, like respondents from one municipality and the pandemic's length, we intend to investigate further and understand the development of the transformation and how knowledge in the area increases.**

Keywords- digitization; social care; home health care; pandemic; physical meeting; digital meetings.

I. INTRODUCTION

In Sweden, the municipalities have the responsibility to provide social care and, to some extent, home health care. As a consequence of social distancing during the corona pandemic, ordinary home visits in social care and home health care needed to be reduced in Swedish municipalities. To compensate for this reduction in meetings In Real Life (IRL), digital technology for communication and meetings could be considered an alternative as a way of upholding continuity in an extraordinary situation [1][2]. However, before the corona pandemic, digital technology was only used to a limited extent by professionals in municipality-based social care and home health care in Sweden [3]. Some of the implementations and deployments of digital technology have also been criticized for being more of an end in itself than means for improved care [4]. It has also been found that turning a physical event into a digital one requires adaptation [5][6], to overcome challenges.

Some of the general challenges to use of digital technology that have been reported are problems with technical equipment, knowledge on how to handle technical equipment, access to support for technical equipment, and support from management [7]. Specific challenges in the domain of social care and home health care are privacy while communicating and caretakers' access to individually adjusted technical equipment [3]. Added to these challenges is the process of transition from physical meeting to digital meeting where not all meetings can be transformed and maintain high quality.

Thus, in the transition from traditional IRL home visits to ICT-based (Information and Communications Technology) home visits, there is a need to better understand challenges experienced by professionals in social care and home health, how they deal with these challenges and how they experience the possibility to digitize meetings. Therefore, the purpose of this study was to explore the transition toward increased use of digital home visits in social care and home health care in a Swedish municipality.

The paper is organized as follows: Section II presents a literature review on digital transformation and its challenges, Section III contains the method, and Section IV the results from the survey. Section V is a discussion, referring to the results and the literature review followed by the conclusion in Section VI.

II. LITERATURE REVIEW

Digital technologies have been found possessing a great transformative power, affecting the ways we communicate, consume, and create [8]. It has even been established those digital technologies no longer just can be viewed as mirroring the physical reality, but in some cases are what shapes the physical reality [9]. The digital transformation is therefore an established concept that [10] propose the following definition for:

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Digital transformation is a holistic effort to revise core processes and services of government beyond the traditional digitization efforts. It evolves along a continuum of transition from analog to digital to a full stack review of policies, current processes, and user needs and results in a complete revision of the existing and the creation of new digital services. The outcome of digital transformation efforts focuses among others on the satisfaction of user needs, new forms of service delivery, and the expansion of the user base. [10, p.12]

Even though digital technologies have a transformative power, the actual transformation will not start on its own. There are several different challenges that need to be addressed for the transformation to take place.

One challenge is for the users to adjust to the new digital setting [6]. The authors of [11] discuss the importance of assigning time for negotiation of boundaries and form adaptation strategies, such as how many participants can take part in a digital activity. Another important part is to practice and become familiar and comfortable with the approach, like putting on and using the camera. The users can partly get familiar with the technology through preparation- and familiarization activities [11] or practice sessions [12]. The users can also become familiar by adjusting, redesigning, or creating whole new versions of the activity to align with the digital technology used [1] [12]. The users need to become what [13][14] label technology ready. However, the authors of [7] argue that technology readiness is no longer a fundamental challenge. The argument for this is, according to [7] that those digital technologies have become a natural part in both the workplace and the private sphere. People have simply become more experienced in using this type of technology. However, there are also studies that indicates that technology readiness still is a big challenge [11][12][15] [16][17].

A second challenge is to make everyone socially present [18]. In a physical meeting, the social presence comes naturally as you occupy a physical space with your body. In digital meetings presence does not come as easily. There is a great chance that participants become blind and invisible to one another [19]. The lack of presence can emerge from having problems in participating in discussions [5] or feeling removed from the discussions all together [2]. But also, according to [15], due to lack of cues, difficulties in determining who was speaking, and difficulties in capturing others´ attention. Everyone needs to be involved [2][15].

Several research works, such as [7][20] emphasize the instability in the technology itself as the most evident challenge. Instability in technology creates disturbances and one way of avoiding unnecessary disturbances is to follow the advice of [21] and keep technology simple, but also clarify the technological requirements [13]. Even though technology is kept simple, disturbances might still occur like problems with the audio [2][12][13][15] different forms of lag [5], computer freezes [2], slow Internet connection [13], slow up-date [2], fragmentation or delays in screen sharing [15], loss of access to online spaces [11], etc. Disturbances might be due to the technology as such, but might also be due to a lack of knowledge of how to manage the technology [6][16]. Thus, it is necessary to plan for support [2][20][21]. Because even if the case is that all involved might be skilled users of technology, issues might arise that the users cannot solve on their own. The support might also concern, besides traditional troubleshooting of the technology used [11], setting up the new environment and its content [12][15].

A fourth challenge is directly related to the last part of the section above because management has an important role not only in the shaping of fundamental premises for distance collaboration [7][19], but making all users visible. In fact, [19] argue that good management is one of the most critical factors in distance collaboration.

III. METHOD

To address the purpose of the study, a web-based survey was conducted during April 2020. The study was conducted in a mid-sized Swedish municipality with approximately 64000 citizens. The municipality is sparsely populated, beside one city, two smaller communities and a vast rural area. In addition to the responsibility for social care including home care and special housing, the municipality´s health and social care administration also had the responsibility for home health care for citizens with a high level of care needs, e.g., for citizens with extensive home care or special housing. The professionals involved in the provision of social care and home health care were district nurses/nurses, physiotherapists, occupational therapists and social workers working and care staff.

A. Procedure and Data Collection

The respondents included in this study were district nurses/nurses, physiotherapists, occupational therapists and social workers working within the health and social care administration. A web-based survey was distributed by email through managers in the organization to all physiotherapists, district nurses/nurses, occupational therapists and social workers (i.e., the professional conducting needs assessment before social care is granted). The survey included questions related to access to and knowledge about ICT and views on possibilities and challenges toward using ICT. The survey included questions with fixed answers, as well as open-ended questions. The survey questions are included in Appendix 1.

In all, 82 professionals responded to the survey: district nurse/nurse (n=21), physiotherapist (n=16), occupational therapist (n=26), social worker (n=19). The majority worked within home care (n=46), in special housing (n=14), with clients with developmental disabilities (n=19), with daily living support for clients with neuropsychiatric diagnosis (n=2).

B. Analysis

The questions with predetermined alternatives for answers were analyzed and presented with descriptive

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statistics [22]. These questions were focused on which modes of communication the respondent had access to, e.g., telephone by landline, smartphone, laptop, stationary computer, and how he/she had used the different modes of communication. The three open-ended questions discuss possible meetings to digitize, meetings viewed as not possible to digitize, and challenges while digitizing meetings. The three open-ended questions were initially approached on an overall level to get familiar to the answers [23]. After our initial analysis, we further explored the material and categorized answers. The categorization was based on the answers, reflecting an inductive analysis [24]. This detailed analysis gave us a deeper understanding of the material and, e.g., for the question about meeting possible to digitize, gave us thirty-four categories, ranging from the interprofessional meetings without citizens to recruitment interviews.

IV. RESULTS

The descriptive statistics include the answers to questions about access to equipment, experience in using different modes of communication, and potential in using ICT. The answers to the open-ended questions include views on possible and meetings not possible to transform, as well as hindrances in transforming meetings.

A. Access to ICT and potential to use ICT

Overall, access to different types of equipment for communication was good; all respondents reported access to at least one piece of technical equipment that allowed digital communication. Eighty-one (99%) respondents had access to a smartphone, 63 respondents (64%) had access to a laptop, 34 respondents (41%) had access to a stationary computer, 33 respondents (40%) had access to a telephone by landline.

All professionals had access to some type of communication software; we found the type varied across participants. One was Microsoft Outlook for daily use of communication via email and calendar bookings and another was Skype for business. The latter had been available for more than 4 years and Microsoft Teams had begun being used during 2019. The professionals used the software Procapita for internal communication regarding care planning. A larger proportion of the respondents had experience in using Microsoft Teams than Skype: for verbal calls 23 vs. 2 (altogether 30%), for video calls 38 vs. 4 (altogether 51%), and for written communication 50 vs. 2 (altogether 61 %).

In relation to the question about sufficient knowledge, 28 respondents (34%) consider that they lacked sufficient knowledge about ICT, 22 (27%) that they had sufficient knowledge whereas 31 (38%) had good or very good knowledge. Twenty-nine respondents (35%) considered that they had no access to the equipment required whereas 53 (65) considered that they had sufficient, good or very good access to the equipment required. Thirty-two respondents (39%) considered that they had no access to sufficient support, 25 (30%) that the support was sufficient and 25 (30%) that access to support was good or very good.

B. Views on possibilities and challenges

The qualitative analysis illustrates a clear difference between possible meetings and non-possible meetings. The proposals for possible meetings from each respondent clearly exceed the meetings viewed as not possible to digitize. The suggestions for possible meetings are mainly internal meetings, where the suggestions include follow-ups, planning, and consultations. The limitations described are about the citizen not having access to the right technology, if the citizen is suffering from cognitive impairment or that the home visit includes some form of physical activity such as taking care of wounds.

1) Meetings viewed as possible to digitize

The answers to the questions which meetings could be digitized cover all of the described meeting categories, such as internal or external personal meetings, staff meetings concerning citizens, or meetings with citizens. Many of the respondents expressed answers related to three or four categories in their answers, implying that the respondents have a solution-oriented attitude towards digital meetings. Some of them even describe how they are conducting such meetings, where one example is assessments:

> *"...It doesn't go as fast or with the same fingertip feeling, but everyone gets help. Assessments are done via photo; I write what angles I need and body parts that need to be included in the picture. Since "my" staff at all the accommodations understands and appreciate that I do this, it has been very good."*

Among the number of meetings that are listed as digitizable, most are meetings where citizens are not participants in the meetings, such as interprofessional meetings without citizens or professional meetings (only a profession). After that, many of the respondents' state that meetings where citizens are discussed, so-called care planning, case meetings or follow-up, can be digitized. Even meetings that could be considered to need physical interaction, home visits, are listed as possible digitizable meetings. The conditions specified in the opportunity to digitize home visits and other visits with citizens are that everyone has access to and knowledge of digital aids and that the citizen does not have a hearing impairment or suffers from cognitive impairment. Some respondents also stressed that meetings with citizens with dementia also can be digitized, with help from relatives or home care staff.

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"Citizens who do not have a long-time dementia / cognitive impairment and can handle a phone. In some cases, this can be solved with the help of home care staff."

Several respondents state that there must not be too many participants included in internal meetings, regardless of whether they are focused on issues related to citizens or purely staff meetings, if these meetings should be possible to digitize.

2) Meetings viewed as impossible to digitize

When it comes to meetings that are viewed as impossible to digitize, these mainly relate to meetings with citizens where the physical meeting must take place. The respondents emphasize several such meetings, like palliative care, taking care of wounds, injections, sampling, or testing of technical aids at home. In all these meetings, the physical meeting was considered a prerequisite for the task to be performed and completed satisfactorily for the citizen.

The meetings that were considered to be somewhat possible to digitize were those that were about trying out or changing something in relation to technical aids needed in the home. The reasoning around these issues indicate that it was both a question about assessing practical situations related to the home care staff´ tasks, as well as the opportunity to try out the technical aid itself. Despite the challenges described, one respondent has resolved the need for physical meetings during the pandemic as follows:

"I have solved individual settings for technical aids "semi" - I meet the staff at the entrance with current aids, set up the wheelchair based on the staff's description and supervise how the leg rests are to be adjusted. I follow up from home, if something needs to be fixed, we decide the time at the entrance when staff comes with the aid in question […] The staff is so much better now and observant of good/bad sitting, for example than ten years ago."

Another respondent describes that there is a need for other routines during, for example, delivery of technical aids in order to be able to digitize home visits:

"Testing of aids can be more difficult. This includes the delivery of aids that today cannot be made to the citizen's home but are delivered to the prescriber. Sees a potential that some testing can take place in the home environment depending on; what type of aid it is, the support around the person and change in delivery options for aids."

Other meetings that are viewed as difficult to digitize are those where the citizen suffers from cognitive or hearing impairments. Several respondents are frank on the difficulties to digitize such meetings. Another perspective is that some respondents view internal staff meetings as not suitable to digitize and relate it to the importance of the physical contact during and after a meeting. Several respondents emphasize education as hard to digitize, both for newcomers and education for experienced colleagues. One respondent expresses it like this:

"Training where practical method teaching needs to take place, e.g. training for substitutes regarding transfer and nursing in general, as well as training at lifting, product display from companies where practical screwing, adjustments and settings are to be tested."

3) Challenges while digitizing meetings

The respondents emphasize several challenges with digitizing meetings, where some of them are technical challenges, lack of knowledge, both own knowledge and in the citizen, work assignments that cannot be digitized, and security.

Technology problems arise when access to the "right" technology is missing. Examples include the cases when the technology the user is equipped with is too old and heavy, or there is a limited access to critical documentation systems from outside the workplace, or the network fails on a regular basis. Sometimes, these problems force users to find workarounds:

"I come across small things every day at work from home that get frustrating about technology or anything else that limits. For example, I can't get video calls on teams via my laptop but I had to download teams on the mobile for that bit. "

Another challenge is related to the lack of knowledge of how to use technology. Quite a few communicate uncertainty when it comes to their own knowledge of technology, and that this is a challenge for digitalization. Another aspect of lack of knowledge is related to a shifting knowledge level within work groups. This causes an imbalance between individuals, which hampers efficient use of digital technology. A third aspect is citizens' lack of knowledge in combination with a lack of resources, especially when it comes to older citizens. They often lack

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resources, such as Internet connection or the hardware such as a computer or tablet.

Some respondents especially point to older citizens who have dementia or other cognitive impairment. These impairments cause problems with managing technology or even understanding that it is an ongoing meeting when no one else is physically present. The quality of the meeting is viewed as decreasing and the care workers are afraid of losing or misunderstanding important information from the citizens.

> *"In a profession where a lot is about dialogue and getting the citizen's perspectives and involving them, it is a challenge to get good communication and good meetings through distance independent technology. This is primarily due to the fact that the target group of older people generally does not feel comfortable with technology, and because of some functional impairments make it difficult to communicate as it is."*

More often the respondents described the physical meetings as the basis for their work and that these cannot be changed to digital meetings. The challenges presented are mainly two aspects of the physical meeting that it is difficult to transfer to the digital meeting. The first is that it is challenging to create confidence in digital meetings; for example, the body language does not proceed in the same way. One respondent frames it like this:

> *"Being able to establish a good and trusting relationship is a fundamental factor in my work, and it can be challenging to instil confidence and incorporate nuances and people's small and physical reactions through video and conversation when you have not met them."*

Some of the respondents refer to security as a challenge. They refer both to the content of the meeting, such as personal information, and to the security requirements regarding privacy that software must fulfil. Often, they referred to colleagues' statements, preferable safety officers, while discussing security.

V. DISCUSSION

Before the corona pandemic, ICT was used, but only to a limited extent by professionals in social care and home health care in the actual municipality. The rapid shift towards a wide-spread use of ICT can thus be considered a new initiative in the municipality and as such, the community readiness model [25] provides a framework that can help us understand to what extent the organization was prepared to initiate such change. The results indicate that in relation to ICT use, the municipality´s readiness was situated towards the earlier phases described in the framework. In order to move forward towards enhancing the readiness to implement health promoting initiatives, some strategies could be helpful. These strategies include different modes of informing the community to increase knowledge and raise awareness of the issue, e.g., by newsletters, media and meetings, conduct local surveys and focus groups to discuss issues and identify strategies [26].

Overall, the results indicate that a large proportion of the professionals in the context of Swedish social care and home health care find ICT a feasible way to conduct meetings in face of the corona pandemic. However, based on the answers related to the potential in ICT, a lack of knowledge, and/or support, reported in 1/3 of the sample, seem to be a factor limiting the use of ICT. As indicated by a 99% access to smartphones in the sample, it can be argued that knowledge and support in how to make optimal use of digital technology requires training not just providing equipment to the co-workers. This study, like other studies, shows that technology readiness is a challenge [2][15] and that training and support need to be planned and prioritized.

The results indicate that practical routines, e.g., how technical aids are delivered could be supported by the use of ICT. While technical aid could be delivered directly to the citizens, the process of practical testing, assessment and follow-up could in some instances be made digitally. However, issues related to a safe handling of technical aids is a complex issue that need to be further explored to ensure a high quality of services.

Instability in technology has been researched and covered as one of the most evident challenges for more than one decade (see, e.g. [2][20]). Focusing on the rapid development of ICT, it is surprising that this is still a major challenge in the empirical material, both from the statistics and the open-ended questions. Providing respondents with stable Internet connection and required equipment shouldn't be a problem these days since it was emphasized earlier by [13].

The empirical material shows that instability in technology is handled by work-arounds, even when it is necessary to use private equipment. Handling and solving the problem is of the highest priority.

For the 2/3 of the sample who can and are using ICT-based solutions, social presence is highlighted as an important feature of meetings. Therefore, meetings with no involvement of the citizens are argued as the easiest to digitize, as well as meetings with few participants. In contrast, some results indicate that also meetings with citizens actually can be digitized. Building on a solution-oriented attitude towards digital meetings expressed by some respondents, it seems as if the question of digitizing meetings with citizens is somewhat of a greyzone. If the professional is confident in finding ICT-based solutions and

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the citizen has sufficient knowledge or can access support from staff or relatives, a wider range of meetings can be digitized. One argument for meetings without citizens could be that the citizens they meet often suffer from some kind of impairment, such as dementia or problems hearing. For citizens with functional limitations, their social presence in a conversation is often said to require a physical meeting. For citizens with functional limitations, the digital meeting requires at least colleagues or a relative. Today, social presence solely refers to citizens without impairments, excluding parts of the population. One argument for not digitizing meetings with a lot of participants is that everyone's involvement is at risk [2][15].

Management support is often referred to as a prerequisite for transforming from physical to digital meetings [2] [20]. Of interest is therefore that very few of the respondents mention management's support as a challenge. One reason for that could be that the initial phase of the pandemic required operational action to solve the situation, resulting in totally new ways to handle meetings via distance collaboration. The drastic change that the pandemic entailed forced the individuals to solve their daily assignments and there was little time for asking for strategies or discussing with managers.

VI. CONCLUSION

During the pandemic, the transition towards using digital meetings, like home visits, in social care and home health care in Sweden increased. Therefore, we investigated this transition by a web survey including both ended and open-ended questions. Based on the results from the survey, some challenges to use ICT were reported including problems with instability in technical equipment, the professionals' and citizens' knowledge on how to handle technical equipment, and access to support for technical equipment. Added to this is the process of transition from physical meeting to the digital meeting where not all meetings can be transformed to keep high quality, such as meeting with citizens with hearing or cognitive impairment. Despite these challenges, the overall impression was that the respondents used digital meetings whenever possible and saw a lot of potential in the transition from physical to digital meetings. Their handling and perspectives were operational, solving problems when they occurred and not waiting for strategies or management instructions.

1) Limitations and further research

This study is limited to one mid-sized municipality in Sweden and focuses on some work roles while digitizing meetings, such as home visits. The results indicate interesting results to dig deeper into to digitization of meetings, with or without citizens, as well as what the activities that can be conducted during those meetings. As such, should this study be viewed as an initial step to dig deeper into the digitization and its challenges, as well as how they are embraced. Another limitation is that the conclusions are based on the co-workers' impressions after a short time period of digitization. Our impression is that this knowledge is increased over time and thereby how to digitize, as well as what can be digitized. Therefore, is it of further interest to detail investigations on various perspectives on meetings that can be digitized and the challenges related to digitizing them. One way of doing that is to focus on one group of work roles, as well as deepen the empirical material by interviews. Another interesting focus is that of the shown operational bottom-up perspective on handling the digitization and further investigating operational, as well as management views on the digitization of social care and home care.

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APPENDIX

Survey questions:

1. What is your profession?
2. Which are your main activities while working?
3. What technology for distance-independent meetings do you have access to in your work?
4. What types of distance-independent solutions have you used to conduct VOICE CALLS?
5. What types of distance-independent solutions have you used to conduct VIDEO CALLS?
6. What types of distance-independent solutions have you used to conduct WRITTEN CONVERSATIONS / CHATS?
7. What type of meetings/contacts do you see can be handled through distance-independent technology?
8. What type of meetings/contacts do you see can NOT be handled through distance-independent technology?
9. To what extent do you have access to the knowledge/equipment/support you need?
10. Shortly, is there anything that you think of that can support the use of distance-independent technology?
11. Finally, we ask you to describe what challenges you see in using distance-independent technology?

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Technology Acceptance of an Online Speech and Language Assessment Application for Stroke Patients - the Medical Caregivers' Viewpoints

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***Abstract*— Stroke is a globally increasing disease and speech and language deficiencies are common in stroke survivors. To facilitate medical caregivers in their professional work and to improve patients' quality of life, technology can play an important role. However, the use and acceptance of technology are uncertain, and more research is needed in this direction. This study evaluates the technology acceptance and adoption of an online speech and language assessment application. The evaluation focused Design Science Research strategy was adopted for that purpose. Two physiotherapists, one occupational therapist and three speech therapists participated in the study. The Unified Theory of Acceptance and Use of Technology (UTAUT) was used as the theoretical base for interview questions formation and data analysis. The study findings show that the suggested application is useful and easy to use; however, it should be more synchronised with speech therapists' daily work routines. The speech therapists stressed that functionalities of the application should be designed in close collaboration with them, and it should be compatible with the already existing systems and services in place. Due to the impairments after stroke, the patients have some specific preferences for software and hardware such as a tablet with touch pen is the preferred hardware. Additionally, the interface should have bigger text fonts and pictures, and highly contrastive colours in the graphics should be used for patients' convenience. The user's privacy and security, patient's current health, and their previous knowledge and experience about technology were also found important determinants for intention to use the given technology.**

Keywords-Technology acceptance; Speech and language relearning; Unified Theory of Acceptance and Use of Technology (UTAUT); eHealth; Stroke.

I. INTRODUCTION

In the rapidly growing percentage of older adults, age-related chronic diseases increase [1]. Stroke is one of those diseases where stroke survivors often suffer from both physical and mental impairments [2]. The impairments after stroke have a serious impact on patients' overall daily life quality and often a patient's friends and relatives are affected [3][4]. Stroke impairments and rehabilitation after stroke can be divided into motoric, cognitive and speech disabilities [5]. This study has a focus on speech impairments and the use of a technology-enhanced system to assess the speech and language impairment, and to find a relevant rehabilitation plan.

After stroke patients' ability to read, write, speak and listen can be decreased to different degrees depending on how the stroke has affected the brain [6]. Stroke patients' social and professional life is often severely affected, which can lead to an isolated and depressed state of mind. An important part of a successful rehabilitation process is to early assess the speech and language impairments, and to start the relearning as soon as possible. Speech therapists often work with pen-and-paper based assessment systems where calculating results, storing statistics, and measuring progress are time-consuming tasks. This study evaluates a prototype of the digitalisation of the pen-and-paper based language assessment system 'A-ning'.

Aning is a Swedish word that could be translated to English as 'Clue', symbolising the important idea of getting a clue of which speech and language relearning activities the actual patient needs. The A-ning system has at least three user roles, stroke patients, speech therapists and health administrators. This first evaluation of the digital prototype only involves the speech therapist perspective, and that this must be followed up later by tests with the other user groups. Three speech therapists with a long professional career participated in the tests for this study, where interview questions and data analysis were based on the Unified Theory of Acceptance and Use of Technology (UTAUT) [7].

A. Aim

Despite the fact that several advanced and sophisticated technologies are available in the health sector, the use and acceptance of these technologies are doubtful and more research is needed to find the critical factors that might affect technology acceptance [8]–[11]. UTAUT model [12] has been widely used in research to evaluate the effectiveness and adoption of technology-enhanced systems [11][13][14]. This study is aimed to access and evaluate the technology acceptances of an eHealth application by using the UTAUT as a theoretical model.

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The addressed research question was:
What is the technology acceptance of a speech and language assessment application from medical caregivers' viewpoint?

The remaining paper is structured as follows. In Section II, the UTAUT theory is presented as the theoretical framework of this study. An overview of the Speech and Language Assessment Application (A-ning) is given in Section III. Section IV describes the adopted methodology for this study, while the study results and the discussion about those results are presented in Sections V and VI respectively. Finally, The study conclusion and recommendations for future work are presented in Section VII.

II. THEORETICAL FRAMEWORK: UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT)

The UTAUT model was designed to assess the user behaviour and intention to use technology [12]. It is a synthesis of eight different theories and models that were previously designed for technology acceptance including the Technology Acceptance Model (TAM), a widely acknowledged model to identify the intention to use the technology [11][13][15].

After comparing and synthesizing those eight models, Venkatesh et al. [12] suggested that the intention to use technology depends upon four basic factors: performance expectancy, effort expectancy, social influence and facilitating conditions. Performance expectancy is explained in TAM as "perceived usefulness", and effort expectancy is stated as "ease of use" in TAM. In other words, the UTAUT model can be seen as an extension of TAM as it adds two extra factors, social influence and facilitating conditions. Several studies highlighted that social influence such as the role of important others, and facilitating conditions like education and training are important for technology acceptance [6][16]–[18]. Therefore, the UTAUT model was preferred as the theoretical framework for this study. The UTAUT model suggests the following four technology acceptance elements.

A. *Performance expectancy*

Venkatesh et al. [12] defined performance expectancy as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" [12]. It is considered an important determinant of intention to use technology in many different studies [7]. Venkatesh et al. [12] highlight, the user should have a firm belief that the system will improve his/her productivity and performance, speed up the work tasks and it will make the work easier.

B. *Effort expectancy*

Effort expectancy describes the user's belief in the ease of use of the system. Venkatesh et al. [12] stress that learning to operate the new system should be easy and quick, the use of the system should be effortless, and the interaction with the system should be understandable and clear. The system should take less time and effort to perform mechanical operations such as data input [7].

C. *Social influence*

Venkatesh et al. [12] described social influence as "The degree to which an individual perceives that important others believe he or she should use the new system". The beliefs of the other influential and important people have a significant effect on the intention of use of the system. In an organization, the viewpoints of co-workers, supervisors and senior management play an important role in the acceptance of a technology-enhanced system.

D. *Facilitating conditions*

Venkatesh et al. [12] defined facilitating conditions as "The degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system". The new system should be compatible and synchronized with the existing work routines and work style of the user. Guidance, clear instructions to use, and personalized support are the essential determinants for technology acceptance [7].

III. SPEECH AND LANGUAGE ASSESSMENT APPLICATION (A-NING) OVERVIEW

Speech and language relearning starts with an initial test of the patient's communication loss after stroke; the test is called A-ning [19]. Despite the test is being developed a long time ago (in 1995), it is still the most used and comprehensive test for language impairments in Sweden [20]. The test is a standardised process conducted by speech therapists, and it consists of different assessment tasks. For example, the patient is asked to look at an image (see Figure 1) of an outdoor restaurant and describe the different activities there.

Figure 1. An example of a Patient's task

During a session with the patient, the speech therapist gives some points from 0 to 5 on each task. Those points are then calculated according to different language categories and the average of all those categories is calculated to summarize the assessment, which is quite a time taking process. Figure 2 presents the manual evaluation after the test.

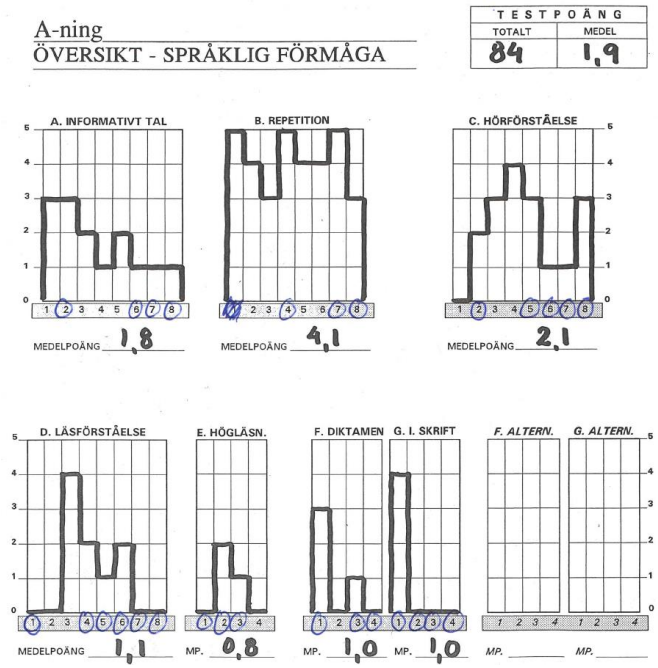

Figure 2. Manual and paper-pen based evaluation

The speech therapists (Participants 1-3, Table 1) emphasised the need of converting this old paper-pen system to an online application. The application was co-created in close cooperation with speech therapists. As presented in Figure 3, after the session with the patient, the application presents auto-generated graphs.

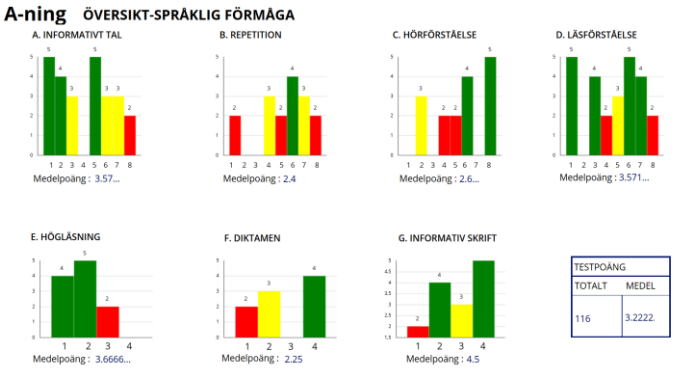

Figure 3. Digital Speech and language Evaluation System

Each graph presents a set of exercises that are related to a specific category. Different colours in the graphs present a patient's deficiency level; the green colour presents minor impairments, the yellow colour presents mild impairments and the red colour presents some major impairments.

IV. METHOD

To explore and evaluate the technology acceptance of an online aphasia assessment application, the Evaluation Focused Design Science Research strategy was followed [21]. The assessment application was developed in collaboration with speech therapists at regional municipality rehabilitation. Six therapists participated in the study. Their location and years of experience in speech and language rehabilitation are presented in the following Table 1.

TABLE I. STUDY PARTICIPANTS

Participants	Professional role	Region	Years of experience
Participant 1	Speech therapist #1	Stockholm	25
Participant 2	Speech therapist #2	Mid Sweden Region	4
Participant 3	Speech therapist #3	Mid Sweden Region	5
Participant 5	Occupational Therapist	Mid Sweden Region	5
Participant 6	Physiotherapist #1	Mid Sweden Region	8
Participant 7	Physiotherapist #2	Mid Sweden Region	3

Participants 4-6 work as the mobile stroke-rehabilitation team at the regional hospital. They offer rehabilitation services at the patient's home for those who are living within the 70 Km range from the hospital. The main reason to involve these participants was to explore the effect of social influence on technology acceptance.

Following design science, the evaluation is conducted in two steps. First, the artefact was demonstrated for an initial evaluation and a detailed evaluation was conducted in the next step.

A. *Demonstrate artefact*

The purpose of this activity was to demonstrate and test the artefact in one case. In this activity, the application was tested and evaluated for technology acceptance with only one speech therapist (Participant 2). This type of initial demonstration gives us an idea about how well the artefact addresses the identified problem in one scenario. Johannesson and Perjons [21] argue, if an artefact performs

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well in one case, there are some good possibilities that it might perform the same in many other cases.

Figure 4 presents an overview of the artefact demonstration activity. The activity was carried out in two sub-activities. First, a test case was designed that contains five tasks followed by some interview questions (see APPENDIX I). The interview questions were developed using UTAUT as base knowledge [7][12].

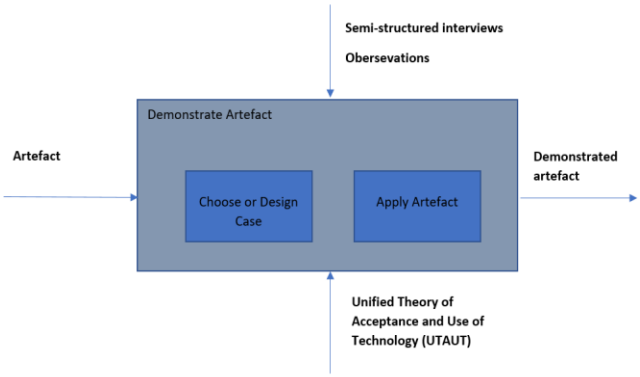

Figure 4. Demonstrate artefacts Activity

The activity was performed at the local municipality rehabilitation centre, one speech therapist (Participant 2) and all the three researchers participated in this activity. After the session, the researchers discussed and analysed the data, and found that the application was effective for aphasia assessment; however, some changes and additional functions were suggested. The application was updated by implementing the suggested alterations and it was ready for a detailed evaluation.

B. Evaluate artefacts

After demonstrating the artefact, the next step was to make a detailed evaluation of the artefact. As suggested by Johannesson and Perjons [21], this activity aimed to evaluate whether the developed artefact solves the defined research problem or not. As presented in Figure 5, the activity was conducted in three sub-activities; analyse the context, select goals, and finally conduct the evaluation. The old aphasia evaluation system was paper-pen based while the new system is technology-enhanced; therefore, technology acceptance was analysed as a context and exploring technology acceptance of the new system was highlighted as an important goal for conducting the evaluation. As described in the artefact demonstration activity, UTAUT was used as theoretical base knowledge for data collection and analysis.

Four sessions were conducted with all three speech therapists. In both demonstration and evaluation activities, the same interview questions and evaluation tasks were used (See APPENDIX I). Because of the Covid-19, some participants were working from home, therefore, three sessions were conducted at the municipality rehabilitation centre, where two researchers participated online and only one researcher conducted the session at the rehabilitation centre. However, the last interview was entirely online where all the study participants and the researchers participated online. For data collection and recordings, the Zoom Meetings Platform was used [22].

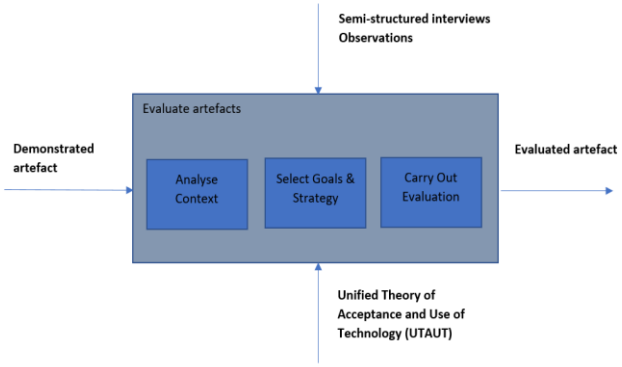

Figure 5. Evaluate artefacts Activity

Deductive thematic analysis was performed for data analysis [23]. First, the transcripts and audio recording were thoroughly examined and initial codes that were relevant to technology acceptance of the artefact were selected. The defined codes were then categorised according to the determinant factors of the UTAUT model as initial themes. Thereafter, the important findings that were relevant to answer the research question were identified and presented in the findings section.

C. Ethical considerations

The rules and regulations from the Swedish Research Council (Codex) were followed for ethical considerations [24]. Before the interviews started, all the participants were informed that they could refuse to answer any question and cancel the interview at any time (before or during the interview). The privacy and anonymity of the study participants are also important to consider in research ethics

where people are involved [25]. The interviews were recorded with the participants' permission and their anonymity was ensured. The interviews recordings were stored in the secure database at the university that is only accessible by the relevant study researchers.

V. RESULTS

To evaluate the technology acceptance, the results were thematically analysed and categorized according to the UTAUT model's determinants: performance expectancy, effort expectancy, social influence and facilitating conditions. However, these categories were not enough to cover the contents of the interviews. Therefore, privacy and security, and previous knowledge and experience about technology were added as extra categories.

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A. *Performance expectancy*

This category explains the perceived usefulness of the online assessment application. All the study participants mentioned that the online application is beneficial for speech and language assessment (Participants 1-3). The automatically generated points-based evaluation of language impairment was the most valued function in the application. The paper-pen based and manual assessment involves several calculations that take a lot of time after the assessment session with patients (Participants 1, 2). Speech therapist 3 described, "*The manual evaluation system was time taking and boring; it takes 40 minutes for me to conclude the evaluation and to transfer it to the hospital journal system*". Speech therapist 1 mentioned, "*The assessment tasks and exercises with the patients are performed in a different order and the final evaluation is categorized in a totally different sequence of exercises. Therefore, it is quite hectic to rearrange everything after the session with the patient and to calculate every point in a different sequence.*" Figure 2 gives an overview of the paper-pen based evaluation.

Based on the speech therapist's input during a session with the patient, the new calculation system diagnoses speech and language deficiency automatically. Participant 3 described that the new system will help her with point-based diagnosis, and to save data digitally. Figure 3 demonstrate the new digital assessment system. All the speech therapists acknowledged the usefulness of these coloured graphs as they make it easy to discuss with patients their health condition (Participant 1-3). The patients will get a better idea of their impairments in different language categories and it will be easy for speech therapists to highlight in which category the patients need to put some more effort (Participant 3).

B. *Effort expectancy*

This category explores the ease of use of the software application. A continuation of the performance expectancy is the new calculation system, where participants 1-3 discussed the necessity of individualizing the traffic light metaphor as well as interpreting it. There is a need for individualizing the speech training, both relating to the patient's current health condition and goal with the speech training. Based on the latter, the system should allow follow-ups and comparisons between the various test occasions. The speech therapists 1- 2 declared that they hoped for the patient to improve, shown in the statistics, and that the system should help them to increase the degree of difficulty at each test occasion. The ultimate goal should be to get a detailed assessment system that could find more linguistic defects. The speech therapists 1 - 2 declared that such a system would take at least five years to develop, but as brought up by Participant 1, there are several words and expressions in A-ning that today are obsolete and difficult to understand for younger patients, and for patients with a foreign background. An alternative is to update the existing A-ning system, or as suggested by Participants 2 and 3, the digitalization could be carried out based on A-ning, but with the possibility to replace the A-ning tests with some other test system in the future.

Aforementioned is that the statistics are the obvious gain of digitalising the assessment. To gain more efficiency should there be an overall workflow, with a starting point and the next assignment showing up, without interference. Participants 1-2 emphasize that they should be the ones choosing the assignments and that the order should be shown on an overview. Emphasized by all participants are that there should be possibilities to add individual notes, both for each assignment and on a general level, e.g., when an assessment is completed. Another important aspect of the system is that each category should be marked with one colour, improving the possibilities to interpret the test results. One suggestion from Participant 1 -2 is therefore to create folders with descriptive headlines, where assignments from each category could be stored

C. *Social influence*

This category explains the other co-workers' views about the usefulness of the system. The viewpoints of speech therapists' colleagues (Participants 4-6) were used to assess the social influence. Moreover, speech therapist 2 discussed the usefulness of the applications with their fellow therapists; all the co-workers acknowledged the usefulness and a positive intention to use the assessment application (Participant 2). Stroke patients feel comfortable and motivated by getting treatment in their home environment and living independently (Participants 4-6). The rehabilitation process is faster and more effective when the patients are at home with their significant others (Participants 3, 4-6). Since the application provides the possibility of online sessions, the application will be useful for the patients as well as for the speech therapists (Participant 1).

D. *Facilitating conditions*

This category discusses the availability of facilitating conditions such as technical infrastructure, education and training about the application functions, and personal support for the system. The requirements on technical infrastructure are several and focus on not solely converting the assessment from a paper-based assessment to a digital system. One example is the participants' emphasis on having different views for the patient and the speech therapist on every given occasion. Therefore, the patient's screen should show, e.g., one image, while the speech therapist should see several images and pick one for the patient. Another aspect is the possibility to change the size of the patient's image to offer him/her the best possible resolution.

One part of the assessment is for the patient to write, e.g., what is shown on the screen. Therefore, a touch pen is necessary, preferable on a tablet (Participant 1 - 3). The tablet's size should allow both the patient and speech therapist to write on it. On occasion, the speech therapist needs to give written instructions, adding requirements on immediate digital interaction. Another patient assignment describes what is shown on the screen and creates a story,

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preferably recorded. The recording also needs to be played for further evaluation by the speech therapist.

Previously described is that stroke patients often suffer from brain fatigue, offering small time slots of total energy. Therefore, there is a need to save the solved assignments and continue at another session not related to a specific speech therapist. Related to partly finished or fully finished assessment is the integration to any journal system. Participant 3 emphasizes the importance of this requirement, describing that it takes 40 minutes of administration to cover this manually.

E. Privacy and security

Trust on privacy and security of the users' data was also a matter of concern for the participants. One part of privacy and security is that other speech therapists should be able to see the results from one assessment to create efficiency in the flow of patients. Still, the patient's privacy and security should be in focus for the system. Somewhat contradictory to the patient's privacy and security is the involvement of relatives or other secondary users. The secondary users are essential, depending on the patient's condition and the wish of distance use. They should be able to help the patient, still not affecting the results of the assessment.

F. Previous knowledge and experience

The user's previous knowledge and experience about related technologies was another important factor for technology acceptance. During the interviews, it was observed that the participants who have previously used relearning applications in their work, showed more interest in using the suggested application. The users' participation in the design and development also enhance their knowledge and interest in the given technology. The speech therapist (Participant 2) who was involved throughout the process of the application's co-creation showed the most enthusiasm and intention to use the application. However, the speech therapist (Participant 3) who was involved only in the evaluation phase, showed the least interest in using the application.

VI. DISCUSSION

The study aimed to explore the technology acceptance of the speech and language assessment application from medical caregivers' viewpoints. Since the medical caregivers(speech therapists in the study context) play an important role in the patient's recovery and relearning, their viewpoints and participation in the system development are important [26]. The same phenomena are observed in this study; the participants with the most participation showed the most intention to use the application. The technology acceptance also depends upon the expected benefits of using the system. The unawareness of the potential benefits of a given technology and a fear to use that technology negatively affect the medical caregivers' performance expectancy [27]. Therefore, continuous technical support and training are of great importance.

There are several options while creating a digital version of the A-ning assessment system. One is to convert the paper-based system to a digital version, adding the feature of creating better possibilities for the speech therapist's to use statistics, both for individual patient's or synthesising statics for specific categories of patients or on an assignment level. The prototype adds such features, improving parts of the work for the speech therapists. Another option is to, still based on the involvement of the speech therapists, create an online system, separating features for the speech therapists and the patient. Examples are immediate written interaction between the speech therapists and the patient's screen or showing different images. The development could be done in steps, where one initial step could be integrations to various journal systems, offering immediate efficiency for the speech therapist. Creating an online system relies on various technical solutions, like recording or writing on one screen and reading on another. The interaction of being in the same room simultaneously needs to be replaced by other interactions and be based on the patient's varying condition.

A-ning is the most frequently used and comprehensive test for speech and language impairment in Sweden, and all participants find the system to be of high quality. However, natural languages like Swedish are entities that change over time and the test vocabulary involves some words that today must be classified as obsolete. Important for the younger generation of patients in a country where 20% of the population have a foreign origin. In the same way, as a thesaurus needs continuous updating, a language test system also needs updating. This looks like the most realistic alternative for the moment, since the development of a new test system would be both costly and time-consuming. Authors find the analogue A-ning system to be a thorough and high-quality test system, and a good foundation for further digitalisation. Some obvious contributions to the language relearning process in a further digitalised version of the system would be features for statistics and for measuring relearning progression.

VII. CONCLUSION

The study explored the acceptance of an online speech and language assessment application. The factors that might affect the adoption and use of technology were also discussed in the study. The online evaluation seems more effective and efficient than the traditional manual system for speech therapists and it enables independent living for the patients. To enhance the performance expectancy, the potential users (speech therapists) should be involved throughout the application development process and all the application functionalities should be comprehensively discussed with them. The intention to use the application depends upon patients' medical condition, active users' participation in the application development, trust about privacy and security of personal data, and providing users with proper education and training about the system.

This evaluation was carried out with a speech therapist and caregiver perspective, which is an important part of the process. The next important step is to get the patient perspective, in an evaluation that preferably also should involve some patients' relatives and friends. Furthermore, the multi-stakeholder approach should include administrative

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staff at health centres and hospitals to get their view on statistical features and security aspects. Finally, what seems like the most valuable contribution of a further digitalised system would be to implement more features for test result statistics, and for visualisation of relearning progression.

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APPENDIX 1

A. *Evaluation Tasks of A-ning application*

1) Task 1

Preplanning for a new patient

- Create a new patient by giving information:
- First name: Awais
- Last Name: Ahmad
- Personal no. : 8111150000
- Speech therapist Name: Tove
- Select the exercises

2) Task 2

Performing the exercises A2, A6, A7, A8

- Complete the tasks for all the
- Select an exercise
- Write some comments in the comments box
- Give some points

3) Task 3

Describing the evaluation

- Select the graph sign from the main page
- Describe the evaluation for different categories
- Describe the overall aphasia evaluation

4) Task 4

Changing the selected exercises during an ongoing evaluation

- Select some exercises, which are not selected
- Deselect some exercises, which are selected
- Update the Information

5) Task 5

- Resuming a previously started evaluation

B. *Technology acceptance Interview questions*

1) Question 1.

How easy-to-use was the system as compared to the old system?

2) Question 2

Which feature was difficult to use and what was easy to use?

3) Question 3

What are your recommendations to improve the interface?

4) Question 4

How do you see the usefulness of this system for the patients and other speech therapists?

5) Question 5

What help do you need for the use of this system in terms of:

- Infrastructure
- Education/training

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Internet of Medical Things for Independent Living and Re-Learning

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***Abstract*— This position paper gives better insight about the role and importance of Internet of Medical Things (IoMT) for independent living and re-learning for older adults. Sensing Technologies are the paradigm shift for transforming conventional healthcare practices into the smart, and self-assisted activities, which are envisioned for today's medical world. Internet of Things (IoT) and IoMT are the inter-related technologies for promoting independent living and re-learning practices. In this paper, re-learning is defined as the process for adults to recover useful instrumental activities of daily living skills that have been lost after an impairment.**

Keywords: **Internet of Medical Things; Independent Living; Re-Learning; Smart Homes; Older Adults.**

I. INTRODUCTION

The aim of this positional paper is to show how the Internet of Medical things (IoMT) can be used for independent living and re-learning. In addition, the paper shows how healthcare is revolutionized with the help of the Internet of Things (IoT) and advanced sensing technology. This paper presents the role of IoMT in independent living of elderly people both in their own houses and in retirement homes, and the utility of embedding sensing technologies in everyday life objects. Thus, IoMT can reduce the expenses for healthcare due to the lower need for personal assistance, and provides a better Quality of Life (QoL) to the elderly users [1][2].

In the modern world, a better healthcare system is one of the main challenges of a growing world population. The IoMT is a collection of Wi-Fi-enabled medical devices intended to collect data on health parameters such as heart rate or blood pressure. Wireless sensor networks (WSNs) enable device-to-device (D2D) communication, necessary for the synthesis of multiple types of medical data. In addition, IoMT is the vision of providing a better healthcare system. The main requirements for WSNs are increased data rates, high speed and more bandwidth. Ongoing development of consumer technologies not only have enhanced the speed of Internet driven platforms, but also encouraged and promoted the markets of IoT devices such as smartphones, Personal Digital Assistants (PDAs), and many types of sensor-enabled wearables [3]. In addition, the technology company Ericsson claims advanced technologies that manage the massive data amounts, bandwidth, delay, and data rate will entirely transform and reshape the healthcare world. There are various advantages of the IoMT based smart and pervasive healthcare; for instance, better Quality of Service (QoS), adaptive and scalable features to other heterogeneous networks, high and cost-effective capacity, high reliability, lower delay, longer connectivity with intelligent data traffic management, and high energy-efficiency [4].

The IoMT is a collection of various sensor nodes, which collect data and transmit to a gateway (i.e., the platform or a medical office) for proper connection and communication with the help of the cloud and the Internet. The main task of the IoMT is to incorporate lightweight portable sensor technologies to support healthcare systems with impressive and integral capabilities for ongoing data collection and synthesis to support accurate monitoring and diagnosis of older adults. The physician can efficiently access and review patients' data and analyse which patient needs more attention. The IoMT is a promising technology for remote older patients monitoring where it improves medical care with the key focus on 'healthcare for anyone everywhere' [5].

The remaining of the position paper is organized as follows. Section II presents Internet of Things, Section III discusses Internet of Medical Things. Independent living is described in Section IV and Section V reveals the re-learning. Discussion, conclusion and future research are given in Sections VI and VII, respectively.

II. INTERNET OF THINGS

Longer lives and better healthcare facilities are cornerstones for an increasing aging society, and in several parts of the world healthcare is becoming challenging with high cost and poor economic status, which affects many generations. The recent trends in emerging Information Communication Technologies (ICTs) have reshaped the entire healthcare world by providing easy and effective data-collecting, diagnosis, and treatment facilities [1]. It is necessary to manage and preserve the patient's experience for efficient monitoring of the healthcare applications for instance, home health monitoring, and Personal Health Records (PHRs). Several IoT-based wearable devices for instance, smartwatches, smart rings, smart necklace, and Fitbits can be used with the human body (i.e., on/inside/implant) to collect vital-sign signals for effective diagnosis and cure. The service providers can access the data for accurate diagnosis and treatment to give convenient, cost-effective and timely treatment [2].

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It is also essential for the healthcare system to assure the availability of accurate and error-free critical information to intended users (physicians and patients). The mobility of IoT devices and pervasive features of integrated technologies adopt different healthcare applications with wide coverage and sustainable connectivity. Thus, it is important to effectively monitor the lives of elderly people while exchanging the data through IoT-based portable devices [6].

III. INTERNET OF MEDICAL THINGS

The rapid increase in the number of elderly people at present gives clear insight for future population record and healthcare status that about 15.7% population shall be in the age range of 65 or older by 2030 [7]. The flexible and scalable features of IoMT easily integrate the wearable medical devices with existing and advanced technologies for independent living, sustainable, reliable and better connectivity with improved efficiency, accuracy and economy [8]. The services offered by IoMT require less cost, are simple, accurate and have an effective mechanism with sustainable battery capacity at fast speed and with reliable connectivity. The IoMT system must be well-equipped with advanced network and continuous connectivity of devices. For scanning and connectivity with doctors, patients must have a valid identity. The rapid growth in smart cellular technologies have revolutionized the notion of healthcare with the support of IoMT [9].

The collected patient's data must be preserved privately for better analysis and diagnosis. Because of its sensitive nature, it is necessary to properly monitor and draw the reports. There is a big impact of IoMT in our daily life and its role increases as life goes on. It also provides solutions to chronic diseases as well as those patients who suffer a lot from constant and long-term pain [10]. The medical data of patients like electrocardiography (ECG), heart rate, and electroencephalogram (EEG) signals can be monitored within e-health applications through recent wearable IoT devices. An important issue in these IoT devices with the transmission of signals is power consumption and the devices need battery resources; there are serious limitations for the continuous observation of signals. To extend the battery lifetime, lossy signal compression is used to reduce the size of collected bio-signals data and, in return, increase the battery lifetime of wearable devices for continuous and long-term monitoring. One-dimensional bio-signals like EEG, ECG and respiratory data are usually available in commercial IoT devices. [11] gives the review of some existing medical data compression algorithms.

IV. INDEPENDENT LIVING

The emerging notion of independent living or ambient assisted living is realized due to the vast and revolutionary role of the Internet of Things (IoT). Due to the lightweight nature and cost-effective features of sensors, it is easy to provide quality of life to elderly patients even at remote locations. Thus, IoT can be considered as promising and vital for various fields such as smart healthcare, smart transportation, and smart cities [12]. The rapid progress and advancement in smart technologies have not only facilitated the lives of every age group, but also reduced the costs of healthcare to reasonable rates. Hence, longer and better life expectancy is the result of emerging and user-friendly IoT-based wearable devices [13].

Over the past two decades, the population of older adults has been rapidly increasing all over the world [14]. Due to these changing demographics, healthcare providers are facing an increasingly massive workload; as time goes on, the need to alleviate their workload becomes more critical [15][17]. On the other hand, despite age-related physical and cognitive problems, older adults like to live independently in their home environment [18]. Several studies highlighted that patients not only recover more quickly in their home environment, but their quality of life is also improved [15][19]. The Internet of-Medical Things (IoMT), which includes technologies and devices such as sensors for windows, doors, temperature, humidity, luminosity, and smart audio and video cameras, might be used to achieve a better QoL and independent living [20].

Several researchers emphasize IoMT as a foundation for independent living, called ambient assisted living; sometimes, the integration of IoMT throughout a house is referred to as a smart home [21]. Researchers focus on requirements for the technology and smart home applications and explain that devices and applications should be flexible, adaptive and changeable over time [21]. The authors of [22] focus on the middleware, which serves as a collection point on the one hand, and as a processing and distribution centre, on the other hand. The data is collected via tailor-made parameter monitoring devices and home sensor-technology and further distributed to care givers. The authors in [20] address problems with IoMT for independent living in terms of user interfaces, easy-to-use features, size, weight, and obtrusiveness. Besides these problems, [23] addresses lack of interoperability causing problems while connecting to caregivers or relatives.

The IoMT implementations for older adults focus on preventing falls and supporting Activity of Daily Life (ADL) [22][24]. Starting with falls, [25] express fall prevention as important for older adults. They built a prototype using an accelerator and sensors. In this case, the accelerometer detects if a fall has occurred and if it does happen, the server will automatically notify the caregivers or relatives. There are several examples focusing on supporting ADL, where one is to add awareness of older adults' decreased physiological resilience and weakened response to stressors [24]. The authors frame their study by collecting data from the participants' activity when moving around the city. The data from older adults is linked with data collected from smart city implementations, such as geographical positions. Another example is predicting upcoming or ongoing disease attacks for noncommunicable diseases and cognitive assessment [20]. They base their system on correlations between physiological and cognitive data and frame it as predictive analysis.

V. RE-LEARNING

In the e-health area, re-learning has been described as the process for an adult to recover useful instrumental activities of daily living skills that have been lost after an impairment

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[26][27]. This is a process with the aim of improving the quality of life and well-being of patients, to increase their potential for an independent living. Often, re-learning consists of an unstructured process that has been referred to as the Trial-and-Error method, with skills acquisition by guessing correct responses and learning from errors. However, more structured methods have been tested and the study by [28] found an advantage for errorless re-learning when compared to errorful re-learning among memory-impaired patients.

Errorless learning refers to the use of feed forward activities to prevent learners from making mistakes. Therapists present the different steps in a re-learning activity with detailed instructions and visual cues. Another structured re-learning method is the spaced retrieval approach, a technique that requires a patient to memorise and reproduce task sequences. These methods have been tested and found successful for patients with memory impairment [26][27][29]. In addition to older adults' need for cognitive re-learning, there are also needs for motoric re-learning and speech re-learning [15]. For all these three branches of re-learning, it is essential to adapt the more general instructional design for the older adult target group. A frequently applied approach is to extend pedagogy with the principles of adult learning [30][31].

Cognitive and motoric re-learning are today, to a high degree, technology enhanced, but speech re-learning could also possibly be technology enhanced. However, the condition is to tailor software and hardware solutions to the actual target group [32]. This should also be a condition for instructional design and pedagogy, where the important adult learning principle 'learning to learn' [33] is not exclusively for older adults. For e-health in general and for IoT solutions in particular, there is also a need for upskilling the staff [34]. Finally, for re-learning in the growing number of older adults, it seems worth to consider an extension of the pedagogy–andragogy–heutagogy continuum [35], in the direction towards geragogy, with the idea of facilitating their e-health media literacy [36].

VI. DISCUSSION

A. Smart healthcare

Rapid progress in IoT-based wearable devices has revolutionized the entire traditional healthcare perspective into a smart and pervasive fashion. IoMT is the cornerstone to achieve the required and standard needs of the elderly patients. Intelligent features of the IoT-based IoMT devices not only provide ease and comfort to the patients, but also lead to cost-effective and smart healthcare anywhere and for anyone. Thus, it can be claimed that sensors within IoT and IoMT based wearable technologies, are the vital entities for promoting smart and ubiquitous healthcare.

B. IoMT and older adults independent living

For older adults to live happily and independently, IoT seems to be a cornerstone and it is widespread in its functionality. This claim is built on transforming the traditional homes of the elderly into smart homes using sensing technologies for sending information to caregivers. IoMT allows the possibility to prevent common falls among older adults as well as predict various diseases. Besides, in smart homes, IoMT can be useful for geographical monitoring, combining smart city approaches with older adults' data while conducting physical activities. Still, IoMT for independent living of older adults seems to be in its infancy, and the development potential is not fully utilized.

C. IoMT and Re-learning

Amongst many other things related to e-health and independent living, re-learning can benefit from IoMT enhancement in several aspects. One aspect is the possibility of measuring the progression in the various branches of re-learning. For cognitive and motoric re-learning, there is also the opportunity of monitoring re-learning, both for assessment of exercises and for avoiding accidents. Furthermore, the general technology enhancement can realise the idea of re-learning anytime and anywhere and support the andragogy-heutagogy concept of self-directed learning.

D. Usability and technology acceptance of IoMT for older adults

Although the IoMT based devices have several potential benefits for older adults, the usability of and technology acceptance for these devices has been a matter of concern. Particularly, the older generation who have not used the technology frequently in their entire life might have problems with adapting and using these devices. Age-related impairments and chronic diseases also limit the use of technology in older adults. Therefore, it is of great importance to design and develop IoMT based devices and services according to the special needs of older adults. A User-Centred Design (UCD) approach should be adopted where the users are involved throughout the design and implementation process.

VII. CONCLUSION AND FUTURE RESEARCH

Independent living and re-learning are main activities to be practiced effectively by the older adults on a daily basis to keep themselves happy and healthy. This can be possible through the emerging sensing technology, IoT and IoMT driven wearable devices. Besides, smart and pervasive healthcare is based on the fundamental characteristics of these unobtrusive portable and lightweight devices. Due to its highly intelligent sensing and processing capabilities, IoMT easily provides the 'smart and cost-effective healthcare for older adults'. Finally, the implementation of IoMT to support re-learning and independent living share the same concerns as other e-health technologies: trust, security, personal integrity, user acceptance, and accessibility of ICT.

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How to Promote Patients' Adherence to Treatments based on Virtual Reality?

A Preliminary Exploration of Virtual Environments Preferences according to Socio-demographic Factors

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***Abstract*—In the current study, we carried out an online survey that aimed to determine which Virtual Environments (VE) are the most suited to individuals' socio-demographic characteristics such as age and gender. Our preliminary results notably demonstrated that the participants' age influenced preferences concerning the four following VE dimensions: esthetics, the will to spend some time in it, the will to further explore it and its relaxing aspect. Thus, our results provide interesting criteria to comprehensively select a relevant VE regarding the targeted population or patients. By adapting Virtual Reality (VR) tools to maximally fit the population characteristics, patients' adherence to the VR treatment should consequently be enhanced.**

Keywords*—*Virtual Reality (VR); Virtual Environment (VE); Socio-demographic characteristics; VR clinical tool.

I. INTRODUCTION

During the last decades, the emergence of Virtual Reality (VR) technology has provided new opportunities for developing innovative and relevant clinical applications, adapted to numerous medical contexts and pathologies [1]. Indeed, the ability to create and control dynamic 3-dimensional (3D) environments and stimuli, which are naturalistic and ecologically valid, makes the VR technology extremely valuable for the clinical field [2]. For instance, VR is currently used as an exposure tool in patients with anxiety and post-traumatic stress disorders [3]. Through serious games, VR is also getting employed to promote rehabilitation of motor disorders in post-stroke patients [4], or to enhance training in children with Attention-Deficit Hyperactivity Disorder (ADHD) [5].

Thus, given the myriad of pathologies and clinical applications, one might expect that the Virtual Environment (VE) characteristics (e.g., kind of landscape and atmosphere, virtual 3D or real 3D, etc.) could influence patients' adherence to the VR clinical tools. More specifically, we believe that socio-demographic factors such as the individual's age, gender and socio-professional category - which can be related to the pathology [6] - could have an impact on patients' preferences regarding the used VE, and consequently, on patients' adherence to VR treatments [7].

To test this hypothesis, we conducted an online survey using different samples of Virtual Environments on adult participants, aged from 20 to 85 years old. The visual samples consisted in 2D pictures of various types of landscapes (e.g., mountains, forests, sea, etc.) and were presented in synthetic and real versions (coming from real images) on a computer screen. For each image corresponding to one VE, participants had to rate the four following dimensions: the esthetics of the environment; the will to further explore the presented environment; the will to spend time in the environment and the relaxing power of the environment. Our results demonstrated that some sociodemographic variables such as the participants' age influenced significantly the preference ratings. To our knowledge, the current study is the first to provide statistical results that could be useful to properly select the VE in order to maximally fit the targeted population (in terms of age, gender, etc.). This optimization of VE selection regarding patients' preferences should necessarily increase patients' adherence to the VR treatment. An additional survey targeting children, teenagers and neurological patients is in progress. Moreover, supplementary analyses will be performed to further examine the impacts of gender, socio-professional level and practice of VR technology.

The rest of the paper is structured as follows. The research methods are described in Section 2. Then, we provide the preliminary statistical results in Section 3. Finally, we discuss the data in Section 4 and we suggest future research directions in Section 5.

II. METHODS

A. Participants sample

We recruited N=105 healthy participants (63 females) with a wide range of ages ∈ [20, 85], (M=45.85, SD=17.12) and various Socio-Professional Levels (SPL), going from no higher education (Level 1) to doctorate level (Level 6), as indicated in Table 1 below.

TABLE I. NUMBER OF PARTICIPANTS (N) PER SOCIO-PROFESSIONAL LEVEL (SPL)

SPL	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
N	3	15	13	22	36	16

B. Material & Procedure

The survey – We used the Google Form platform to build and spread the survey without any restriction criterion. The collection of responses followed a strict anonymous procedure since the participants never gave their names or any kind of information that would have allowed their formal

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identification. The first questions concerned the following socio-demographic characteristics: age, gender, profession and education level. Then, 2D pictures representing samples of VR environments were presented one by one with a landscape orientation. Each image was followed by 4 questions, that could be rated on a 7-point scale going from 1 (lowest score) to 7 (highest score). Those questions aimed to collect participants' opinion regarding 4 different dimensions: the esthetics of the VE, the participant's will to spend more time in this VE, the participant's will to explore further the VE, the relaxing aspect of the VE.

Figure 1. Overview of the 24 virtual environments used for the survey. The letters A-L indicate the matched images. The letters R and V indicate Real 3D and Virtual 3D respectively.

The VE samples – Twenty-four VE images were presented in the survey. Half of them came from "real" 3D environments and were developed by Wake Up & Smile enterprise in Madrid. Those real 3D samples were matched with virtual 3D samples that corresponded in terms of landscape types and atmospheres, as presented in Figure 1, where virtual and real samples were coupled by letters. Then, seven main types of environments/atmospheres were analyzed: snowy lands (images A), forest & jungle (images B, G and L), mountainous lands (images H & J), city/town (images E), Buddhist temple (images F), pastures (images C), beach & sea (images D, I, and K).

C. Data analysis

We examined how VE features such as the type of VR content (real 3D vs. virtual 3D) and landscape kinds (e.g., sea, mountain, etc.) could interact with participants socio-demographic characteristics (i.e., age, gender and Socio-Professional Level (SPL)). The factor age was split into three bins of equivalent length and equal distance. Thus, the first group of "young participants" (n=35) showed a mean age of 26.2±4.51 , while the second group of "medium age" (n=38) had a mean age of 46.71±7.02, finally the third group of "elderly participants" (n=32) showed a mean age of 66.31±6.23.

We standardized participants ratings and we ran linear mixed models using the R package lme4 [8]. The following five factors as well as their interactions were entered as fixed effects: VR content, landscape type, participants' age, participants' gender and SPL. The random intercepts associated to subjects' and items' (i.e., VE) effects were entered as random effects.

We used the same model's structure for all the four measured dimensions (esthetics, will to spend time, exploration will, and relaxation).

Regarding the results presented in the next section, degrees of freedom (df) and p-values were approximated with the Satterthwaite's method [9].

III. PRELIMINARY RESULTS

A. Etheticism ratings

We found a main effect of the landscape type ($F(6, 10.04) = 3.36$, $p = 0.044$), regardless of the participants' socio-demographic factors. More specifically, participants preferred the esthetics of mountainous lands samples relative to the town images ($t(10) = 1.35$, $p = 0.0302$), whatever their age, gender and SPL. More interestingly, we found a significant interaction between the group of ages and the landscape kind ($F(12, 2468) = 9.75$, $p < 0.0001$), meaning that esthetics preferences for landscapes were influenced by participants' age. For instance, as presented in Figure 2, young participants were more inclined ($t(2309.4) = 5.914$, $p < 0.0001$) to find snowy lands esthetic than older participants, who preferred Buddhist temple images.

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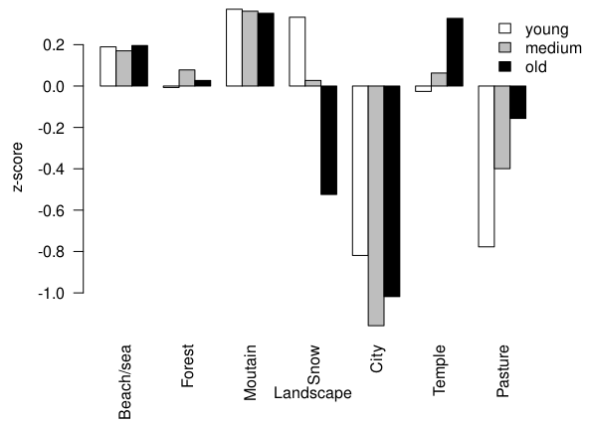

Figure 2. Esthetics ratings according to the group age.

B. *Exploration will ratings*

We found a main effect of the content type ($F(1, 10.04) = 8.448$, $p = 0.014$), regardless of the participants' socio-demographic factors. More specifically, participants' ratings concerning their exploration will were significantly higher for real 3D VE than for virtual 3D VE ($t(10) = -2.91$, $p = 0.016$), whatever their age, gender and SPL.

We also found a significant interaction between the group of ages and the landscape kind ($F(12, 2449) = 2.95$, $p = 0.0004$), meaning that landscapes' exploration preferences were influenced by participants' age, as presented in Figure 3.

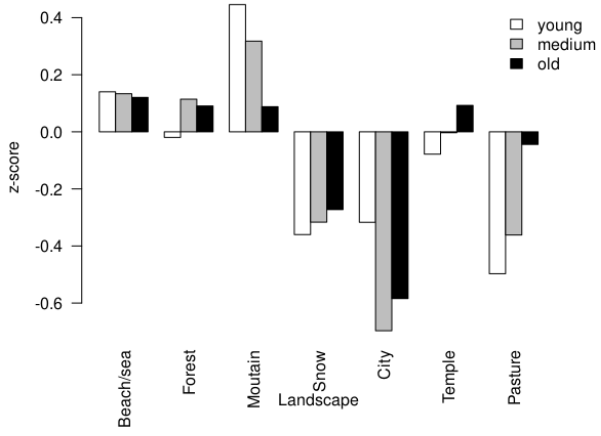

Figure 3. Exploration will ratings according to the group age.

Finally, we observed a significant interaction between participants' gender and the landscape kind ($F(6, 2449) = 2.23$, $p = 0.038$), meaning that landscapes' exploration preferences were influenced by participants' gender. However, due to Bonferroni corrections, our post-hoc analyses were not significant.

C. *Relaxation dimension ratings*

Interestingly, we observed a significant interaction between the group of ages and the landscape kind ($F(12, 2449) = 2.95$, $p = 0.0004$), meaning that the relaxing aspect of landscapes depended on participants' age, as presented in Figure 4. Notably, older participants found the snowy landscapes less relaxing than young participants ($t(2449)=-5.85$, $p < 0.0001$).

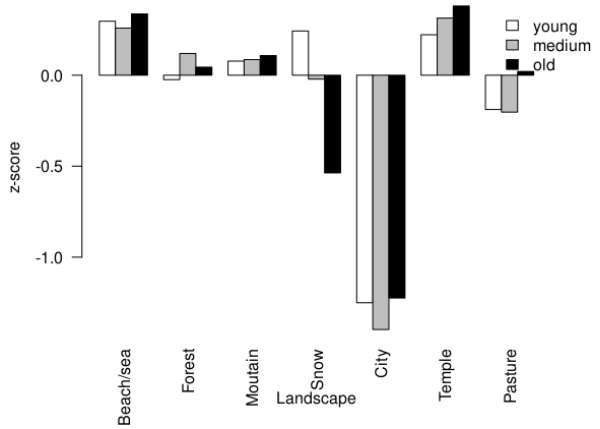

Figure 4. Relaxing dimension ratings according to the group age.

D. *Time dimension ratings*

Regarding the time participants were ready to spend within the different landscapes, we observed a significant interaction between the type of landscape and the group of ages ($F(12, 2449) = 4.08$, $p < 0.0001$), as presented in Figure 5. For instance, older participants preferred to spend less time in snowy landscapes than young participants ($t(2449) = -3.1$, $p = 0.002$), while young participants were even less inclined to spend some time in VE representing pastures than medium age ($t(2449) = 2.31$, $p = 0.021$) and older participants ($t(2449) = 3.14$, $p = 0.0017$).

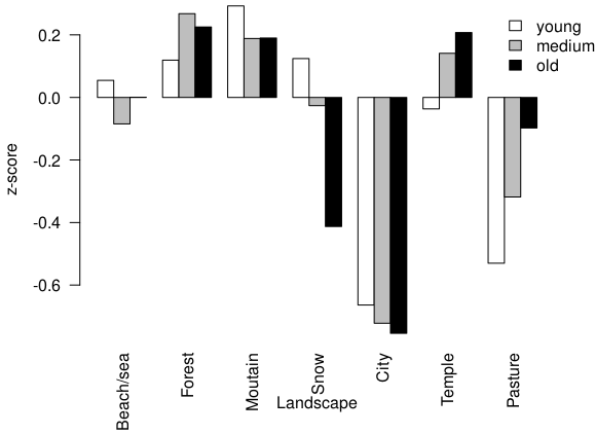

Figure 5. Ratings relative to the time participants are ready to spend in VE according to the group age.

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IV. DISCUSSION

The present study aimed to explore whether specific socio-demographic variables could influence users' preferences regarding different types of Virtual Environments (VE). We found that participants' age had a significant impact on all the rated dimensions, relative to VE esthetics, exploration will, relaxing aspects and the will to spend time in the presented VE. Thus, these preliminary results could guide clinicians and developers to select the right VE while creating serious games or VR therapeutic contents, in order to design a task and a gameplay that would fit the patients' characteristics. For instance, a rehabilitation program designed for post-stroke patients could take into account the preferences that were expressed by the group of elderly participants. Such adaptation of gameplays and programs would necessarily increase the patients' adherence to the VR tools and consequently the efficiency of the clinical application.

However, we recognize that the generalization of the current results is limited by several aspects. First, even if the VE items were counted as random effects in our statistical models, the selected images could not be completely representative of a whole landscape category such as forest or sea. Second, to facilitate the survey spread, VE samples consisted in 2D images so that we can not guarantee that the exact same effects would be observed with 3D images displayed through VR headsets. Finally, for ethical and practical reasons, this survey was completed by healthy adults only.

V. CONCLUSION

Socio-demographic variables, and more specifically users' age, are linked to specific preferences in terms of Virtual Environments. Such preferences must be considered while designing VR programs and gameplays intended for clinical applications, to notably improve patients' adherence to treatments. Further studies are now required to specifically evaluate patients' adherence to treatments using VR headsets.

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Automated Drug-Related Information Extraction from French Clinical Documents: ReLyfe Approach

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***Abstract*—Structuring medical data in France remains a challenge mainly because of the lack of medical data due to privacy concerns and the lack of methods and approaches on processing the French language. One of these challenges is structuring drug-related information in French clinical documents. To our knowledge, over the last decade, there are less than five relevant papers that study French prescriptions. This paper proposes a new approach for extracting drug-related information from French clinical scanned documents while preserving patients' privacy. In addition, we deployed our method in a health data management platform where it is used to structure drug medical data and help patients organize their drug schedules. It can be implemented on any web or mobile platform. This work closes the gap between theoretical and practical work by creating an application adapted to real production problems. It is a combination of a rule-based phase and a Deep Learning approach. Finally, numerical results show the outperformance and relevance of the proposed methodology.**

***Index Terms*—Drug related information, French clinical document, Natural Language Processing, Rule-Based system, Recurrent Neural Network.**

I. Introduction

Today, the main source of mistakes in medicine is due to the lack of information that doctors have on their patients, especially when multiple doctors treat the same patient. The information flow has to be as efficient and smooth as possible, especially when patient is transferred from one doctor to another. When making a medical decision, it is necessary to avoid wrong actions that are incoherent with the patient's status, such as incompatibility between medication and their medical condition. Consequently, doctors need to have access to all of the patient's information and background. However, this is not always the case since healthcare systems do not have patient's information gathered all in one place: medical information only exists in silos. For example, the main source of medication errors is related to wrong drug prescriptions having severe consequences on a patient's health [1].

Based on the arguments mentioned so far, we see that there is a crucial need to gather patients' information in one unique system/platform to be easily retrieved, understood, and shared. Electronic Health Records (EHRs) provide healthcare workers with a better understanding of the patient thanks to the stored information. However, the information not only needs to be stored, it also needs to be structured to be used efficiently. Indeed, when clinical data is extracted from a document and structured, it is easier to be examined and interpreted. Today, 80% of relevant clinical information exists only in an unstructured form [2], which results in a massive loss of helpful information. We decided to focus in this paper on the structuration of medical prescriptions. They contain valuable information about a patient's drug history and, when structured, can be used for pharmaco-vigilance and epidemiology. Manual extraction would be too difficult and time-consuming, which explains why clinical Natural Language Processing (NLP) and entity extraction are of genuine interest in the field of research. Considering the lack of solutions available in the French health care system, we propose our algorithm and put it at the service of any other solution that enhances the health care system.

The rest of the paper is organized as follows. The problem formulation is presented in Section II. In Section III, the proposed methodology is described. Experimental results evaluating the efficiency of the proposed method are presented in Section IV. Finally, conclusions are drawn in Section V.

II. Related Work

The majority of NLP research work on medical data has been carried out on texts/documents in English, whether it is to structure or analyze them [3]–[9]. In fact, the need to structure medical documents in any language is as strong as in English. In French specifically, many policies advocate for a better healthcare system while there is still a lack of structured data and research. One of the principal methodologies in NLP

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applied to medical data is the Named Entity Recognition (NER), whose purpose is to extract relevant medical information from unstructured medical text. To our knowledge, since 2010, there have been less than five pertinent papers talking about the extraction of drug-related information from French clinical prescriptions [2], [10], [11]. In addition, none of them is open-source, or a paid service or can be used as a real application. One of the most known method applied in practice is the Amazon Web services (AWS) medical service (Amazon Comprehend Medical); however, its initial release can only detect medical entities in English texts [12]. Therefore, the idea is to use our expertise to achieve something similar for French medical documents. The major approaches in NER for medication are based on lexicon/rules and machine learning and can be combined into a hybrid model.

First, lexicon-based approaches use predefined lexicons or regular expressions to match parts of the text to recognize predefined entities. They aim to model expert knowledge with dictionaries. Examples of such approaches for English clinical texts are MedEx [13] and MedXN [14]. These models are built to recognize seven categories: drug name, route, frequency, dosage, strength, form, duration. They have shown a good performance compared to other methods. Indeed, MedXN gives a F1-score of 0.975 for medication name and over 0.90 for attributes for a dataset of 397 medication mentions. Regarding the rule-based approaches for French clinical texts, the extraction also relies on a system with specialized lexicons and extraction rules in a similar approach to English. Some research has shown that the same methods in English can be applied to French [10], however, they does not perform as well as in English.

Regardless of the considered language, in a rule-based approach, the rules have to be extremely fine-tuned to fit the entities that will be extracted. Most researchers agree that this can be challenging when working with a very large dataset [15]. Additionally, it gives poor results when applied to texts deviating from the ones referenced in the dictionary. However, in case the whole entity is well predefined, this method provides precise results. That is why, in our approach, we have applied this method to get the drug name: we are connected to a database with all drug names in the French market [16]. In addition, based on the solid expertise of our physicians, we have been able to design and build rules and patterns covering drug-related information with a variety of abbreviations, grammatical errors and physicians' common mistakes.

There exists a second approach that uses machine learning in order to extract entities (dosage, frequency, duration, route, drug name) from clinical texts in [17]. The system proposed in [17] is a NER model relying on a bidirectional long-short term memory with conditional random fields (BiLSTM-CRF) architecture composed of 3 different layers: embedding layer, bidirectional long-short term memory layer, and conditional random fields layer. Different deep learning-based approaches were explored. All of them rely on a bidirectional long-short term memory with conditional random fields but with various embeddings such as word embedding, character embedding, and semantic-feature embedding. This system achieved encouraging results and demonstrated the feasibility of using deep learning methods to extract medication information from raw clinical texts. Several other research papers have proposed BiLSTM with conditional random fields for their NER model [18], [19]. However, this type of approach requires working with words and phrases that have meaning in their sequence. However, in French prescriptions, the information is presented as a distinct set of words, where each set is generally made up of three or four words that are always in the same order. In order to leverage the advantages of these methods and the rule-based approaches, researchers combined both methods, which shows a better performance. An example of such a combination can be found in [7], where the authors use a conditional random field for the NER model along with a support vector machine extracting related entities combined with a rule-based context engine. These approaches were designed for text written in English. To the best of our knowledge, there are only a few research works done for French clinical texts. In [2], a hybrid system combining a rule-based approach with contextual word embedding trained on clinical data with a deep recurrent neural network was developed, and it outperforms other approaches based on a token-level evaluation.

In this work, we combine deep learning techniques and rule-based approaches to create our NER model from a different perspective. A deep learning approach is used to classify sentences into three categories (drug, posology, or useless sentence), and then a rule-based approach is crafted accordingly to the identified category. Indeed, applying the sentence classification model beforehand improves the output of our global model since it applies the rule-based extractor on the appropriate sentence containing the required information, i.e., prevents applying rules-based patterns on a confusing sentence that may or may not contain the desired entity. In addition, we then link the sentences that are classified as drugs to a unique ID in the Vidal database [20]. That way, the drug is recognized in an international database, and additional information is fetched. By matching the extracted drug with the Vidal database, we can also deal with the potential errors occurring when running the Optical Character Recognition (OCR) on the scanned document. Indeed, even if the drug name is not complete, our algorithm can still recover the official drug name. Finally, we designed a geometric approach to build a relation extractor system that matches a drug and its associated posology. In the following section, we present a detailed explanation of each part of our method.

III. Materials and Methods

This section presents in detail the explicit steps and tools used and applied to achieve our desired goal. First, we describe the employed data. Then, we define the tools and libraries used to annotate the data and establish its utility. Also, we determine the referenced databases used in the project. Lastly, we explain the steps developed in our algorithms to extract a drug and its

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related information (dose, frequency, duration, and comment) and how we connect them.

A. Data

Almost all medical prescriptions in French have identical structures. Based on our database and the knowledge of our physicians, we visualized and concluded that 90% of the prescription could be categorized into three types of formats. The rest have either a unique structure or are handwritten. Hence, this insight helps us choose the right way to achieve the desired goal, which we will develop in the following sections. Figure 1 shows the variety of prescriptions that are the subject of focus.

We had more than 2000 medical documents classified between blood work, medical reports, and prescriptions in our internal databases. 500 of them are medical prescriptions. Upon examination, we found out that only 70 users accepted that their documents could be used in our research work, although they have already gone through our anonymization algorithms.

Therefore, we launched a campaign to collect data from our work colleagues and our families (47 persons), and we got over 100 prescriptions from 10 different cities and different clinics. Briefly, for the training dataset, we obtain 170 prescriptions where each of them has at least five drug names followed by 1-3 sentences describing how it should be taken (posology). Practically all of them have a well-defined structure with some changes in the header and layout of the document frame. Again, we can find prescriptions that have a unique format.

B. Annotation tools

For the project development, it was decided to apply a textual classification model to the prescription before extracting the drug-related information. To proceed with this plan, the first step consists of using annotation tools to create the labeling data. This step was carried out by the Prodigy web application developed by the same Spacy team. It is a paid tool. It offers a streaming display of all the document sentences one by one. The data scientist's role is to choose one of the predefined categories for each sentence as a label. Ultimately, this results in a database of all of the sentence-level annotated texts. Prodigy proposes several training functions and a continuous active learning system, but we did not use this system in our project.

C. Drug names database

In this work, we are not just looking to extract the name of the drug from the prescription. One of the main objectives is to link the detected drug to an official reference database where a drug can have a unique ID and a description of its medical information. In addition, we are looking for an international solution as we are working on an international project. Thus, we relied upon two drug databases. The first one is the Vidal Drug Information Systems database [20]. This database contains drug information in several languages, and it can be used for many other functionalities that will be useful for the project in future work. The second database we used is the French Government drug database [16].

D. Methods

Our objective is to develop a drug-related information extraction system and deploy it in an actual web/mobile application. In this section, we will describe the adopted solution for each task in this project. Figure 2 shows the sequence of operations that have been applied to obtain the final output.

Since this solution is intended to be used in a real-time application, it is crucial to develop a design with a precise and trusted outcome. This is one of our main contribution. To our knowledge, no one has yet developed such an application. The existing state-of-art is academic, and it is implemented on data from hospitals or clinics, unlike ours, which is composed of scanned documents by the patient using different smartphone cameras. That represents a higher challenge due to the document quality and the versatility that does not exist in other work.

As shown in Figure 2, firstly, we implement the OCR technique to extract text from documents in pdf or image format, which includes the skew correction. Then we apply the deep learning method from the Spacy library to classify sentences between drug, posology, or useless sentences. Depending on the predicted class, if it is a drug sentence, we apply a particular matcher to find out the drug's name and attach it to a unique ID in the Vidal databases. Otherwise, a Spacy rule-based matcher is applied to extract the drug-related information (dosage, frequency, duration, comments) if it is a posology sentence. These matchers are highly customized to fit only French prescriptions that have specifics formats. We follow this step with a geometric relationship approach to assign each posology to its corresponding drug. At the end, we display the result in a structured user interface for a mobile/web application. In the following sections, a detailed description will be presented for each of the proposed tasks.

E. Optical character recognition

In the existing research work, most projects operate either on pure medical text or PDF documents. Nobody needed to examine the quality of the documents or process the noise in data to extract the texts. That implies they had no limitation regarding the document's quality or the method used to extract the text. Despite the limited number of documents in our database, there is a diversity in the quality of photos and how the posology is drafted for each drug. Therefore, the extraction of texts is the fundamental step to have a clean data to process in the coming phases. For this purpose, we use the service of AWS to carry out this task. We compared it with other open-source methods, but the AWS results were persuasive enough regarding their performance on the text extraction quality with all its details. This functionality takes as input a document's photo and returns a JSON file containing the text and its geometric-related information in sentence level and word level.

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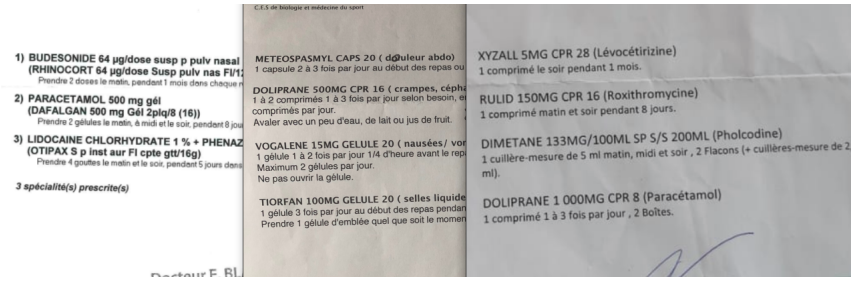

Fig. 1. Example of scanned documents. These prescriptions were scanned with a smartphone camera. They vary in terms of quality, orientation, and color. Some documents contain the drug and its equivalent in case it is not available. Our algorithm should be clever enough to detect this case and choose only one of them.

F. Text pre-processing

Due to the low quality of the scanned document, OCR may return unclean texts. For this reason, a data cleaning step is crucial to make the texts more useful. We have applied the following treatment to the extracted text:

- Remove the accents.
- Transfer words to lowercase format.
- Unify the format of the number. Remove space and unnecessary punctuation between them if they exist.
- Remove the stop words.
- Remove sentences with one word of less than two characters (we got many of them).

G. Sentence classification

Before we started extracting the desired entities from the text, it was more efficient to categorize the text sentences and exclusively use those containing the drug and its information. This step will increase the efficiency of our NER model since it will only focus on sentences that contain the desired entities. Moreover, with limited databases, learning a model to classify the sentence is more realistic and doable than learning a NER model.

To accomplish this task, we downloaded 15000 drug names from the government public drug database. We also generated 15000 synthetic sentences that describe how a drug should be taken (these sentences are called posologies). Moreover, we have produced over 15000 sentences carrying medical information, patient information, names, and all kinds of information that may be present in a prescription other than the drug and the posology.

We trained our classifier using these 45000 sentences with a bidirectional LSTM architecture. It is used to classify sentences into three categories; drug, posology, and useless sentences. This classifier achieved an accuracy of 95.23%. The remaining 5% will be automatically ignored by the drug extraction model due to the rules-based approach.

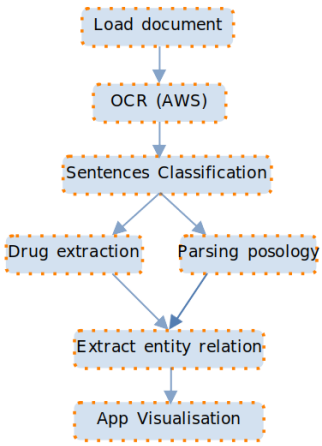

Fig. 2. Flowchart of our appraoch.

H. Drug detection

In a French prescription, the text is structured in a particular way. A drug is located on a separate line or on the same line with the posology. So, after getting the classified sentence from the previous model, we will know in advance that there are two choices for the sentence classified as ”drug sentence”; either this sentence contains only the name of the drug, or it contains both the name of the drug and its related information (posology). In addition, generally, between two drug sentences, there is only one or more posology. We have never seen any information unrelated to posology.

Moreover, one of the main points that generally holds true in French prescriptions is that the names of the drugs are consistently among the top three words in the sentence. That information led us to minimize the search within a window in the sentence. Hence, we have created a drug-matcher that relied on a rule-based approach using the French Government drug databases [16]. Once we have detected the first word of the drug name, it is used to send a query to the Vidal Drug Databases and extract a list of all similar names and features. Then, we apply similarity measurements to determine the closest and longest contiguous matching sub-sequence to the name in the prescription. Indeed, this task is not evident since the name of each drug is composed of up to five words including numbers and units. We can see that clearly in Figure 1. We often obtain the closest match despite the difference in word succession or the spaces between numbers and units.

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```
{"label":"DOSE","pattern":[{"LIKE_NUM": True}, {"LOWER" : {"REGEX":"(graduation[s]?)"}}]}
{"label":"DOSE","pattern":[{"LOWER": {"REGEX":"([\d]amp)"}, '_': {'position_token':True}}]}
{"label":"DOSE","pattern":[{"LIKE_NUM": True}, {"LOWER": {"REGEX":"(ampoule[s]?)"}}]}
{"label":"DOSE","pattern":[{"LOWER": "une"}, {"LOWER": {"REGEX":"(ampoule[s]?)"}}]}
```

Fig. 3. Patterns that have developed using the rule-based matching Spacy library.

I. Posology detection

Similar to the previous section, after the sentence is classified as a posology sentence, a rule-based matcher will be applied over the sentence to extract the related drug information. We used the 170 prescriptions introduced in Section III-A to produce the related information pattern. We employed the rule-based model from the NLP Spacy library to create the entity matcher. We designed four matchers for the four different features we search for (dosage, frequency, duration, comment). Figure 3 shows the rules created for the "dose matcher". Our physicians designed more than 100 patterns for each feature. They include abbreviations, miss-writing, and common mistakes.

J. Drug-posology relation extraction

The AWS "textract" API output format includes geometric coordinates of the polygons enclosing the words and the sentences. Based on this information, we created an algorithm to assign each entity to its corresponding drugs using the geometric features. We relied on human linguistic intuition in this approach. Each posology is assigned to the closest top drug while respecting a given distance threshold between their polygons. A drug can have a posology composed of several lines. So, for a given text, if the successive sentences respect the given distance threshold, they are considered in the same section and associated to the same drug. Otherwise, when the posology is aligned horizontally with a drug, it will automatically be assigned to it.

IV. Evaluation and Results

In order to evaluate our method, we used the standard metrics for this task. We measure the recall, the precision, and the F1-score on our test dataset for each feature by itself. An entity is considered a true-positive when it was annotated with the correct label, a false-positive when a token is falsely annotated with respect to each feature. A false-negative is considered when it was not annotated at all, or it was annotated with the incorrect label [2].

Regarding the testing data, we gathered documents from 20 colleagues at work. These 20 colleagues are located in different cities in France and work remotely with the Re-Lyfe group. The majority are in Paris and Reims. The data constituted of 33 prescriptions. This data is composed of 1096 sentences with 4572 words. It contains in total 75 drug names and 61 posology sentences. Some of the drugs do not have an associated posology, where others have multiple ones. Despite the limited number of documents for testing, these documents are characterized by their diversity. Each one has a different drug and a different way of representing how to take it (posology). Table I summarises the results of each different entity matcher. We can see that the model results are higher than 90%, which is not unexpected due to the high number of patterns that we have created to cover the maximum number of cases and sentences. In addition, as mentioned in the previous section, more than 80% of the prescription documents have the same structure and format, which helped us get these good results. We can notice that the precision for all models is approximately 100%. That may be due to the accuracy of the sentence classifier model that is applied beforehand. This model eliminates the confusion presented when we apply our NER models to sentences that do not fit into the posology category.

TABLE I: Medication information predictions metrics results.

Label	F-measure	Precision	Recall
Drug name	94.33	100	89.33
Dose	93.91	100	88.52
Duration	94.91	98.24	91.80
Frequency	96.60	100	93.44
Comment	91.10	100	83.60

Figure 4 shows the results of getting the drugs and their medical-related information from a prescription. This document has seven drug names and four posologies. After getting all the desired entities, they will be the input of another algorithm to differentiate between numbers and units, as shown in the photo. Moreover, sometimes physicians provide equivalent to each drug if it does not exist, so our algorithm works to choose one of them to make it the reference. Figure 5 displays the extracted entities in our web/mobile application where the user can upload a French prescription and get the structured data.

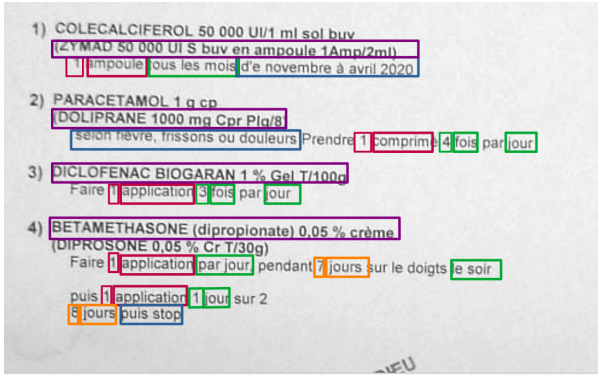

Fig. 4. The extracted entities from our approach. Despite the low quality of this photo, we were able to extract the text and apply the relation entity extraction models.

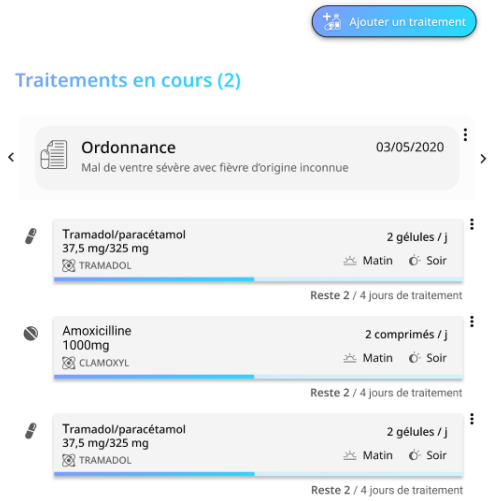

Fig. 5. The display of our results in our mobile application after getting the drug and its related information.

V. Conclusion

This paper presents a functionality created to be applied in a real application to extract drug-related information. This work is one of the few that contributes to the French medical documents. Our approach is a series of methods concatenated together to achieve a high-performance system capable of coping with the constraints of real applications. We have applied a deep learning technique to classify the prescription sentences into three categories: drug, posology, and useless sentences. Then, we applied the corresponding rule-based approach to extract the targeted features for each of these categories. A unique international ID is associated with the detected drug name via the Vidal databases. Lastly, an algorithm based on human intuition and the sentence's geometric position was designed to build a relation extractor system to associate the detected entities to their corresponding drug. Theoretical and practical tests have proved the outperformance of our approach.

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Patient Feedback during an Awake Craniotomy Using Virtual Reality

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***Abstract*—The goal of this work in progress project is to provide an improvement to the currently used procedure of physician-patient interaction during the awake craniotomy using Virtual Reality (VR) technology. The proposed procedure will evaluate the patient's response to the visual and auditory stimuli, provided via a VR device. We will highlight the functionality of the setup, its advantages and shortcomings, and discuss possible risks of the used technology. Our approach provides a complete virtual environment, including situations and combinations of stimuli that can test complex reactions of the patient, and, on the other hand, is completely under control of the neuropsychologist. We conclude by showing that the benefits of the approach significantly outweigh the downsides, so that the presented technology is not only a new opportunity, but also the future.**

Keywords-Virtual Reality; Awake Craniotomy; Patient Feedback.

I. INTRODUCTION

For some patients, awake surgery is the best way to avoid the risk of surgical neurological deficits [1]. "The main advantage of awake craniotomy is to allow for intraoperative electrocorticography and cortical mapping to identify eloquent brain areas" [2]. This advantage also outweighs the psychological disadvantages that can arise from this method. For this reason, awake surgery is used more and more frequently [1]. Current brain mapping, for example, uses images that the patient has to recognize and name or texts that the patient has to read aloud [3].

We propose an improvement to the currently used procedure of physician-patient interaction during the awake craniotomy using Virtual Reality (VR) technology.

The state-of-the-art procedure currently involves testing of the visual and auditory senses during the stimulation of the corresponding brain area with a surgical instrument. The aim is to ensure that no sensory degradation will take place during the operation. The testing duration has to be as short as possible to reduce the risk of epileptic seizures.

The visual stimulation usually involves placing pictures in front of the patient, optionally on a laptop or tablet screen, accompanied by a request to describe the situation. The current procedure tends to be cumbersome, error-prone, and has the additional limitation that the physician is not able to see the test at the same time as the patient, thus not being able to verify the correctness of the answer. Figure 1 shows the surgical area during an awake craniotomy with the numbered areas for stimulation.

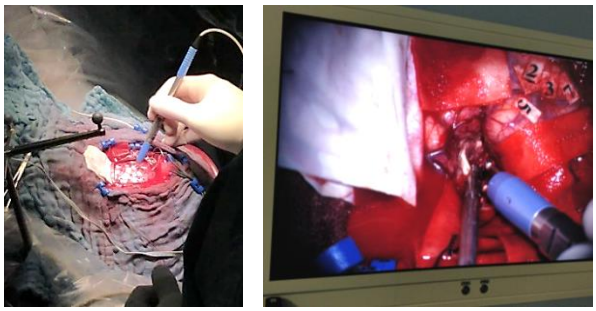

Figure 1. Surgical area during an awake craniotomy.

In the proposed setup, we use the VR technology as in [4], but generate much more expressive and complex stimuli in order to evaluate the possible degradation of brain functionality.

In Section 2, we show the features of the developed application. Section 3 deals with the hardware and software requirements. In Section 4, details of the implementation are briefly presented. Section 5 contains the conclusion, currently still occurring problems, and possible further developments.

II. APPLICATION FEATURES

The major goal of the setup is to support the physician during the brain surgery and to give him the possibility to test affected brain regions. For this task, a preferably full spectrum of sensory stimulations and corresponding responses is desirable. The sight is the most important sense for human beings, so the majority of the tests address the visual stimulation with the last two including hearing as well.

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In the first prototype, the following features have been selected for the implementation:

- Image recognition
- Interaction with a complex situation/environment
- Memory function
- Reflex and reaction
- Hand-eye coordination
- Auditory perception
- Combination of visual and auditory perception.

The usage of the novel technology will also force the personnel to change their routine, albeit not in a very significant way. The patient has to familiarize himself with the app and the displayed virtual world, and he has to perform the tests in advance in order to have a baseline or reference point of his performance. The patient should display no anxiety controlling the app. It should also be taken into account that the patient's awareness of being operated on his brain may induce high stress levels during the operation.

This preoperative procedure is also necessary to test patient's sensitivity to the so-called Virtual Reality sickness. In this case, the approach is not applicable.

A. Image Recognition

Figure 2. Image recognition of 2D and 3D images.

The basic configuration of the app already provides about 80 different two- and three-dimensional images, an amount that can easily be extended to include for example patient-specific images. 3D-objects even allow a complete 360-degree view, which is impossible with the currently used 2D-representations. Figure 2 shows a small selection of sample images from the application that the patient should recognize.

B. Interaction with a Complex Situation/Environment

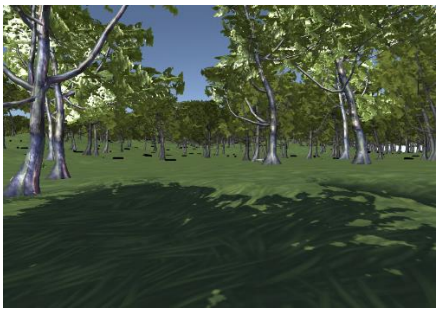

Figure 3. Forest 3D-scenery.

In our application, we implemented a forest (as shown in Figure 3), a desert, and a town scenery, all three with their typical vegetation, earth conditions and animals. Additionally, we provide two uncommon and more challenging environments - a space station, and a room made of colored cubes. The different environments can be selected according to the patient's preferences and can help to reduce stress during the operation [4]. The patient is able to move freely and interact with the environment, which extends the range of possible questions significantly from the basic recognition to the deeper understanding of the given situation.

C. Memory Function

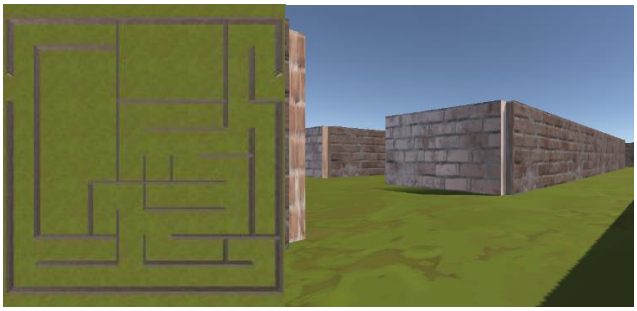

Figure 4. Memory game with bird's eye view (left) and first person's field of view (right) [5].

The memory and especially the short-term memory, is of utmost importance to human beings, thus it should be tested during the awake craniotomy.

We implemented the well-known memory game "pairs" and a labyrinth escape situation. In the latter, the patient is asked to memorize the path from entrance to the exit for a few minutes from the bird's eye perspective as shown in the left part of Figure 4. After that the app switches to the person's field of view as shown in the right part, requesting him to navigate to the exit of the maze. This test also aims to estimate the spatial ability and the sense of orientation, i.e. if the patient uses the same dead-end repeatedly.

D. Reflex and reaction

Figure 5. Arachnophobia scenery.

In the previous test procedure, there is neither a standardized test nor a measurement of patient's reaction time, which can be an important indicator of his condition. In

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our app, we addressed the problem by implementing two tests to estimate the patient's reflexes and reactions:

- The supervising physician lets a spider appear in the field of view of the patient whilst he walks in a forest. This is shown in Figure 5. If there is any reaction, the patient did not lose his reflex.
- In a second test, the patient is on a grass pitch and a ball appears from a random direction with varying speed. The patient is asked to stop the ball in the middle of his field of view by pressing a button.

E. *Hand-Eye Coordination*

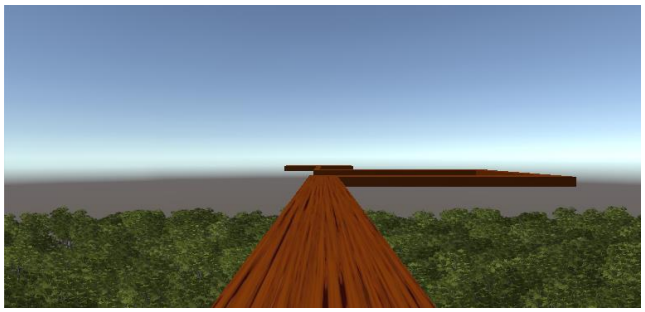

Figure 6. Test for hand-eye coordination and acrophobia [5].

This specific part of the app tests the accuracy of the coordination ability and of the user interaction and its possible degradation during the operation. The patient has to walk virtually on a narrowing wooden beam placed in midair as shown in Figure 6.

F. *Auditory Perception*

The app provides a typical hearing test. A sound is coming from the left, right or both sides and the patient has to choose the corresponding button with the controller. Correctness of the answer is visualized by the change in the button coloring or communicated by the physician.

G. *Combination of Visual and Auditory Perception*

Figure 7. Combined tests [5].

One final test combines seeing and hearing. The patient has to decide if the presented 3D-object matches the sound by selecting a corresponding screen area and the correctness of the choice will be indicated by the change in the button's color. An example can be seen in Figure 7. A short sound file is played at the same time. For example, if the patient hears a car horn, he has to select the red tick on the right; if it is a bird's song, he must select the turquoise cross on the left. If the patient makes mistakes during the stimulation or gives no answer at all, this is an important sign for the operating team as they continue to perform the awake craniotomy.

III. REALIZATION

In this section, we will show the technical realization including the necessary hardware and the software requirements.

A. *Technical Setup*

Figure 8. Used VR glasses (left) and controller (right) [5].

The project setup contains an Android-based smartphone as a central processing and visualizing gear, the VR app, a pair of Destek V4 VR glasses, and a gaming controller, used as a steering device for the app. This equipment, excluding the smartphone, can be seen in Figure 8. An additional control screen for the surgical team is also needed for the verification of test results. A pair of headphones or small speakers is necessary for the auditory tests.

We chose a smartphone VR holder instead of full-fledged VR glasses due to the cost factor and higher flexibility. The Android Operating System, being the most common mobile OS, was selected for the development of the VR app.

An additional focus needs to be put on the controller. Since the head tracking, as the regular way of navigation in the VR environment, is not possible due to the head fixation, the steering has to be done with an external device. A game controller emerged as the best-suited device so far. To meet the requirements on the wireless signal interference in the medical setting (s. below) it can be connected by wire instead of Bluetooth.

B. *Implementation Requirements*

In order to develop a user-friendly VR app, the scope of all possible users has to be determined - it includes different physicians - surgeons, anesthesiologists, neuropsychologists, nurses, and, on the other hand, the patients. An intuitive and easy to use user interface has to be developed for both of these user groups with a special focus on the latter, to avoid contributing to the heavy stress during the operation. In addition, of course, the approach has to improve the current patient-physician interaction to justify its development.

The following functional requirements were considered:

- The use of the app should not require any special knowledge or experience.
- The patient should not endure any additional risks compared to an awake craniotomy without the app.
- The app should never cause any hassle or stress for the patient.

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- The app should be reliable and robust with respect to system crash.
- Software has to be extensible and modifiable to fit different use cases.
- The app should be able to deal with wrong interactions.
- All the information presented to the patient should be synchronized to the control screen.
- Additional constraints arose due to the medical environment (and were met):
- The number of signal transmissions should be reduced to a minimum.
- The app must not interfere with any other device in the operating theater.
- The app should be implemented with special regards to IT security due to the highly health-critical environment.
- The data protection act has to be respected.
- The code quality should meet industrial standards typical for medical software.
- The entire setup and its components have to be accordingly certified ("work in progress").

One final note should address the general usability - the VR glasses and, optionally, headphones are head-mounted, so that they may interfere with surgeons' access to some regions or the sterility requirements. It should be obvious that in these cases, the setup is unusable and other methods should be employed.

IV. Implementation Details

The app and the 3D-scenery were implemented using Microsoft Visual Studio with Unity. Unity is a set of tools primarily used for the game development, allowing creating feature-rich environments with natural physical conditions, which are necessary to make the user feel comfortable using the app. The main user interface was also designed with Unity. To create the stereoscopic images, we used the Google VR SDK for Android.

V. Conclusion and Future Work

During a demonstration and following discussion with three participating surgeons they agreed that our approach shows promising potential, however further development of the technical setup is necessary to meet the specific requirements of awake craniotomy and other types of awake surgeries.

One conclusion was that the highest benefit could be seen in the availability of more specific and flexible tests than with state-or-the-art procedures. Especially, further brain functions, for example short-term memory, situational perception and combination of senses, can be tested. Additionally, the ability to adapt the VR environment to patient's personal or professional interests and preferences is a great improvement. In addition, it could potentially reduce the stress and anxiety during the surgery at the same time as in [4], so patients might prefer our approach, but this needs further evidence in future work.

Another insight resulting from the discussion was that our approach is one step ahead of the current state of the brain mapping, since it adds the possibility to test currently unmapped functionalities, for example, it is still not fully understood which brain regions affect spatial ability. Additional research is necessary in this area to tap the full potential of this approach.

The consensus was that this is not only a new opportunity but also the future.

In our future work, we will:

- Address the setup's shortcoming, that in contrast to the regular interpersonal communication, the usage of VR prevents the eye contact between the neuropsychologist and the patient.
- Extending the supervisor interface with additional information and better test control.
- Test the setup under clinical conditions.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

This article does not contain any studies with human participants or animals performed by any of the authors.

This article does not contain patient data.

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Approaches for Promoting Telemedicine Utilization in Japan

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***Abstract*— Telemedicine comes in many shapes. It aims to offer many benefits to both patients and clinicians, but until today, it is not widely utilized. This study aims to investigate public willingness to use telemedicine service, and identify cases/situations it is preferred to use for. It also identifies community views to increase actual use of telemedicine. To achieve our goals, 84 participants in the age ranging from 20 to 64 years were randomly selected, and data were collected from them using a questionnaire. The survey results reveals that all participants had never experienced telemedicine despite COVID-19 state of emergency. Less than half (46%) of participants stated their willingness to use the current telemedicine service. About 77% of participants preferred to use telemedicine service in a state of a personal emergency "with mild illness". This study also indicates two approaches to promote telemedicine utilization. First approach aims to expand the scope of telemedicine, so that encompasses various issues/conditions, which currently concern the community. Second one focuses on improving a telemedicine platform through 6 actions relevant to the service usability, availability, value, and accessibility. At present, there are many issues impact on telemedicine growth in Japan. Learning about the community's views and needs play an important role in increasing the use of telemedicine service.**

Keywords - Online Healthcare; Telemedicine; Service Development; Public Needs

I. INTRODUCTION

Telemedicine provides healthcare services when patients and healthcare providers are at different locations using Information and Communication Technologies [1]. Since 2018, telemedicine has been covered by Japanese insurance, but the incentive to promote telemedicine is weaker than that of other countries partially due to free access to medical institutions and other issues [2]. In April 2020, the COVID-19 crisis has prompted Japan to ease regulations on telemedicine [3]. However, the use of deregulated telemedicine has been sluggish compared to the US and UK. In Japan, only 15% of medical institutions have deployed telephone or online consultations [4]. Therefore, this study investigates public willingness to use current telemedicine services. Furthermore, it identifies community perspectives and needs to develop telemedicine program and increase the rate of its usage. The rest of this paper is organized as follows. Section II explains the method of this study. Section III shows the major results of the survey. Section IV includes discussion and limitation of a study. Section V includes conclusion.

II. METHOD

To achieve our goals, a semi-structured questionnaire (9 multiple-choice questions) was undertaken with 84 participants (63 Female and 21 male) between February and April 2021. Selecting the survey participants was based on their busy works with limited vacations time (about 10 days in a year) to visit hospitals. Participants were provided with an explanation of telemedicine and all information regarding the study, including the reasons for undertaking the survey. The questionnaire sheets had been given to the person in charge of the department by hand in order to distribute it to all the employees. Based on the literature review [5] [6], the questionnaire was designed, and then piloted on 5 individuals. From the responses of 5 people, the questions were revised and determined. Probing questions were used to determine the best patterns and circumstances for making telemedicine services more usable and efficient. Ethical approval for this study was obtained from the Kyushu University Hospital, permission no 2021-15.

III. RESULT

A total of 84 administrative employees of which female (63) and male (21) completed the questionnaire. The following are the main results of the questionnaire.

A. The Characteristic of Participants

The participants' ages are ranging from 20 to 64 years. They are administrative employees working (full-time job) in different business sectors at 2 public universities in the Fukuoka city. The results of this survey indicated that all participants have no physical disabilities, and are not telemedicine users. Fifty-nine (70%) of them are somewhat aware of telemedicine. The majority (29%) visit the hospitals about 2 times a year (Table 1).

B. Opinions Towards the Use of Telemedicine Service

The participants were asked about their willingness to use telemedicine service (see Figure 1). Less than half (46%) of participants answered with "yes". About 37 (44%) of participants chose "I'm not sure", and 8 (10%) of them

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TABLE I. CHARACTERISTICS OF PARTICIPANTS (N=84)

Gender N=84	Age	N=84	Physical Disability	City	Occupation Administrative Employee	N=84	Hospital Visit	in a year	N=84	Awareness of Telemedicine	Experience of Telemedicine
Female	20-29	17 (20%)	No	Fukuoka	University A	N 53 (63%)	Once a week	52 times	2 (2%)	Very much	No
N 63 (75%)	30-39	16 (19%)			University B	N 31 (37%)	Once every 2 weeks	26 times	2 (3%)	N 14 (17%)	
	40-49	28 (34%)					Once a month	12 times	16 (19%)	Somewhat	
	50-59	17 (20%)					Once every 2 months	6 times	6 (7%)	N 59 (70%)	
Male	60-69	6 (7%)					Once every 6 months	2 times	24 (29%)	Not at all	
N 21 (25%)							Once a year	One time	12 (14%)	N 11 (13%)	
							No visit	0	0		
							No answer	—	22 (26%)		
100%	100%	100%			100%				100%	100%	

responded with "no". Regarding the situations/cases which the participants may use a telemedicine for, 65 (77%) of them would prefer to use the service in the state of a personal emergency "mild illness", while 30 (36%) participants might use the service when it is imposed by policies or other means. Twenty-five (30%) participants answered that when a hospital is far from home, while 15 (18%) participants responded that it might happen for prescription renewals and chronic care management. A few (7%) participants indicated that in all cases, they will not use telemedicine, and 3 (4%) participants chose "other".

C. Expanding the Scope of Telemedicine

The participants were asked about their issues/concerns, which could be well addressed through online care services (see Figure 2). The majority (62%) of participants indicated that telemedicine is a good tool for virtual visits to inpatients by their loved ones and/or conducting remote follow-up meetings with the family members who are unable to be with their hospitalized patients. Forty-two (50%) participants stated that telemedicine could be effectively used for following up care, including post-operative follow up, while 39 (46%) participants mentioned that the service is a suitable way to educate people about lifestyle diseases. Twenty - two (26%) participants indicated that telemedicine can be used for patients on board (such as emergency medical care on the express train or at the sea by providing medical advice for the passengers on board ships), while 19 (23%) participants stated their needs to school-based telemedicine program for providing access to high-quality healthcare in the school setting. A few (12%) participants mentioned the need to use telemedicine for birth control counselling. Eight (10%) participants chose "other".

D. Actions to Improve a Telemedicine Platform

All participants were asked about their needs, views and suggestions to improve a telemedicine platform (see Figure 3). The majority (49%) indicated the importance of creating a user-friendly telemedicine program. Twenty-four (29%) participants suggested to provide telemedicine in higher number of hospitals and be for all, while 21 (25%) participants requested to make the service available at any time "24 hours a day, and 7 days a week". Twenty (24%) participants indicated the necessity to offer many value-added programs to telemedicine patients as a part of their wellness programs, while 18 (21%) participants requested to make the services easy to access without having Internet connection problems. About 17 (20%) participants responded that telemedicine must consider desires and needs by age demographic. Ten participants (12%) chose "other", such as recommended that telemedicine be held to the same standards of in-person care, and establish unique patient engagement strategy that focuses on creating greater awareness of telemedicine's potential and its usage.

E. Usability in a Telemedicine Meeting

Regarding the most suitable and trustful healthcare delivery model (see Figure 4), the survey results revealed that the majority (74%) of participants preferred home-based telemedicine, while 12 (14%) participants chose mobile medical clinic, and a few (12%) participants selected the hospital-based telemedicine. Regarding the better mode for communication, we found that the majority (73%) of participants preferred video call, while 17 (20%) participants chose voice call, and a few (7%) participants selected "other". About the most adequate device for a telemedicine visit, the majority (38%) preferred smartphone "using a video call service", while 30 (36%) participants chose PC/tablet, about 24% of participants preferred smartphone "a voice call only", and a few (2%) of them chose "other".

IV. DISCUSSION

Telemedicine services have the advantage of ensuring the health of inaccessible local residents and increasing convenience [7] [8]. Studies have shown that remote monitoring approaches are as effective as – and in some cases better than – in-person care for many chronic conditions [9] [10]. However, all participants were not telemedicine users, even in a state of public health emergency due to the SARS-CoV-2 outbreak.

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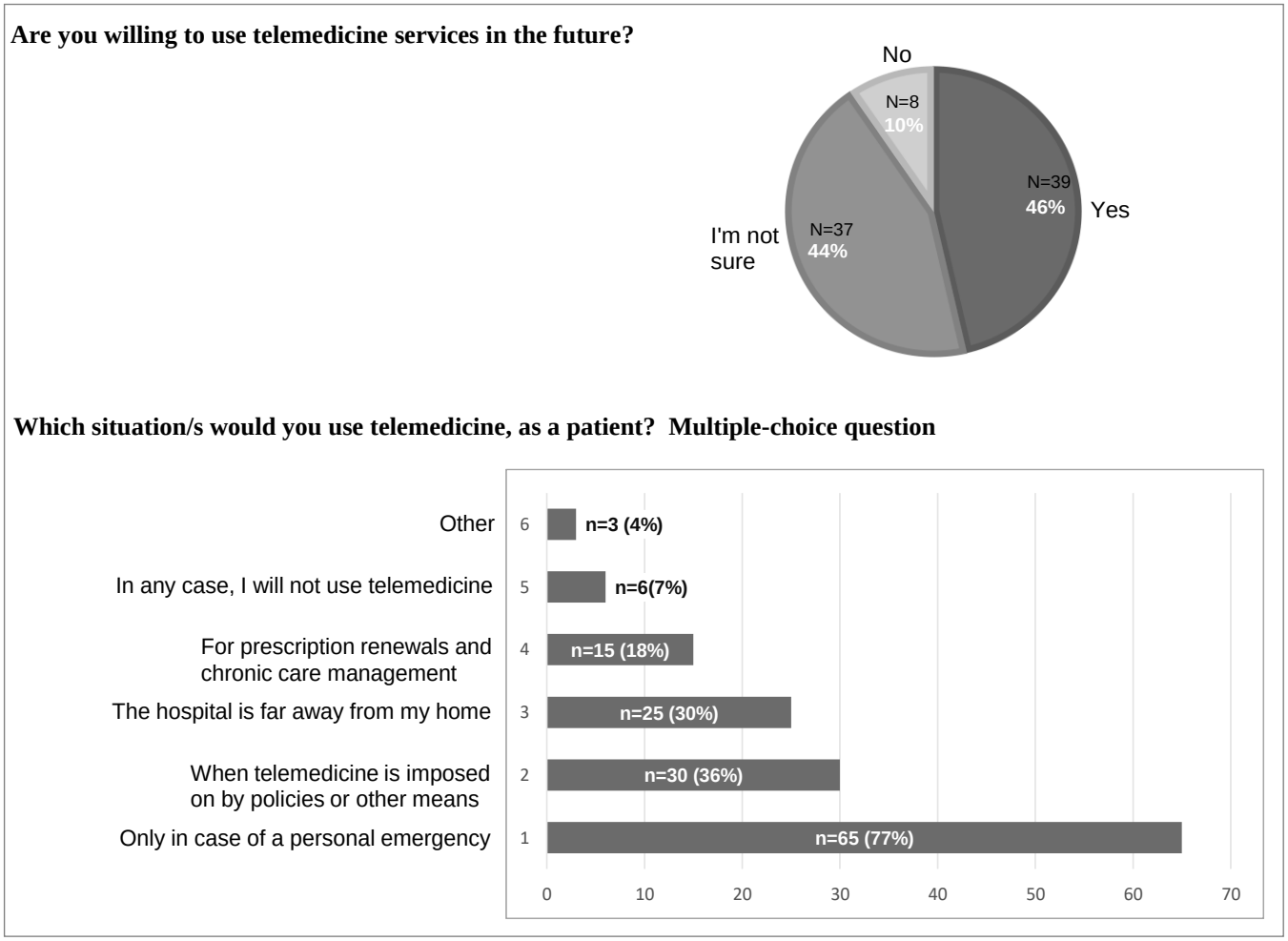

Figure 1. Telemedicine utilization in Japan (N=84)

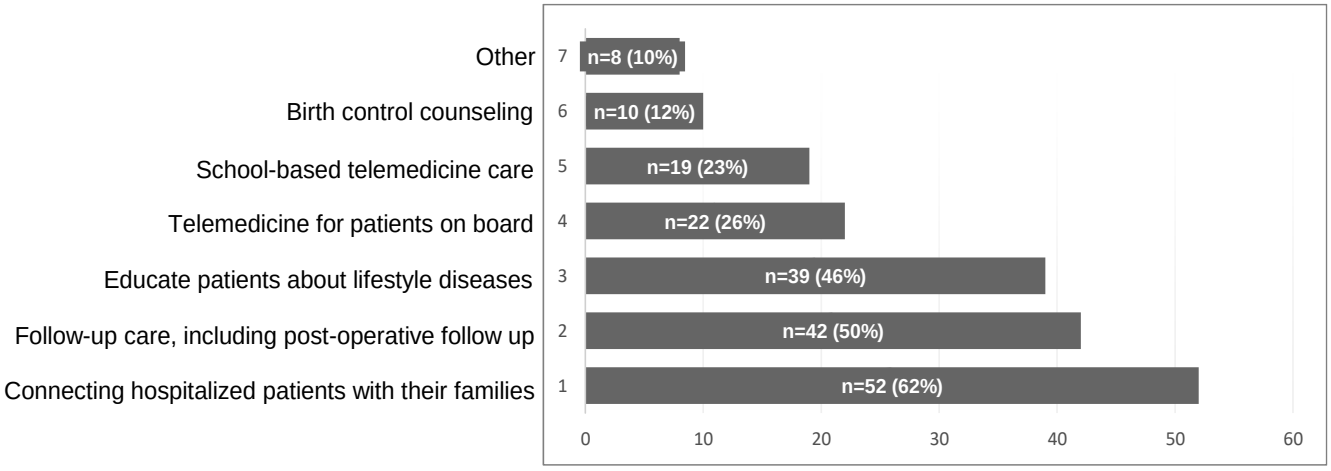

Figure 2. Issues that require telemedicine utilization (N=84) - multiple-choice question

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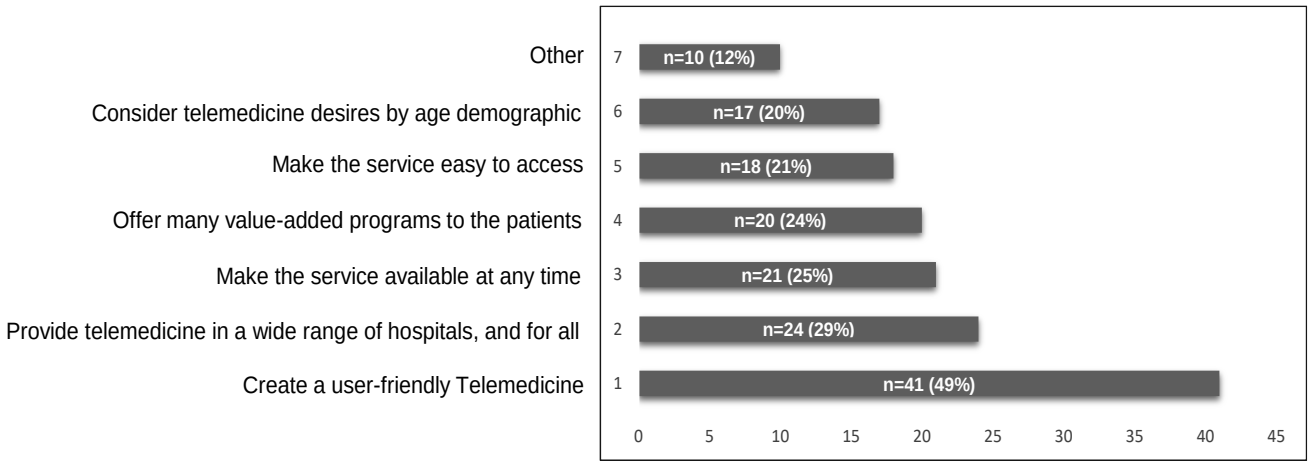

Figure 3. Key actions to improve current telemedicine program (N=84) - Multiple-choice question

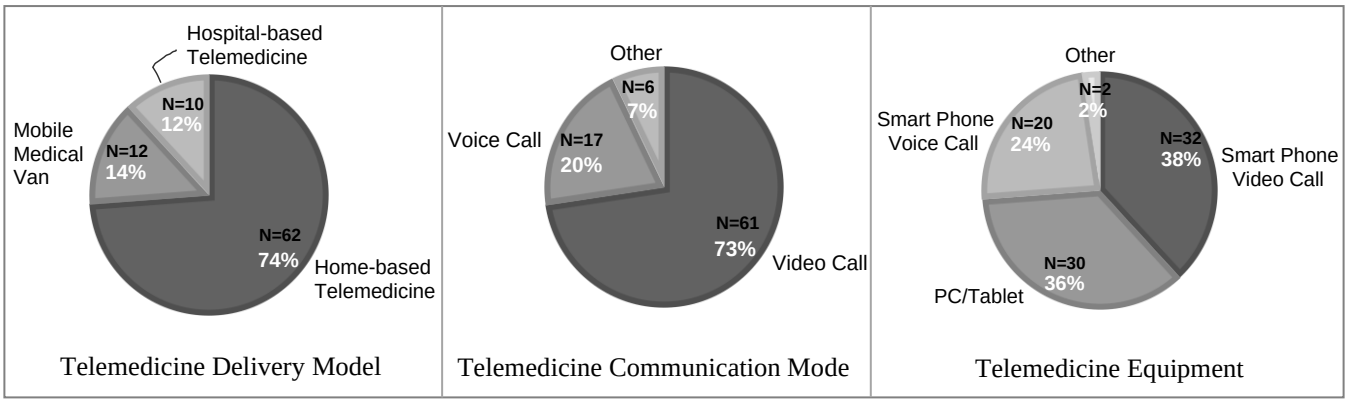

Figure 4. Best model of telemedicine usage (N=84)

Further, less than half (46%) of them stated their willingness to use the telemedicine service. In Japan there is a strong cultural bias towards face-to-face consultation, but the servicing rural and remote areas by doctors is increasingly difficult so there is an urgent need to increase the uptake of telemedicine [2]. In terms of telemedicine growth and development, studies reported that the service should deliver care that respects the patients' preferences and values - responds to needs in a person-centered manner [11] [12]. Based on the participants' responses, there are two approaches to potentially increase the use of telemedicine in Japan. First one aims to expand telemedicine capabilities. This is by identifying community issues and concerns that can be addressed through online care services. In other words, it is better going beyond traditional home diagnostic and monitoring activities to include further medical care forms where the individuals' abilities are restricted. The survey results revealed that most (62%) participants indicated that telemedicine is a good tool for virtual visits to inpatients by their loved ones and/or conducting remote follow-up meetings with the family members who are unable to be with their patients at hospitals. In our previous study the same suggestion had been stated by the majority of Japanese physicians [13]. The second approach is about understanding people's requirements, preferences and views to improve a telemedicine platform. From the participants' responses, there are 6 key actions suggested to higher use of a telemedicine program. Regarding the first action, the majority (49%) stated the importance of creating telemedicine equipment as user- friendly as possible. The usability issue is one of the seven core principles that underlie the development of successful telemedicine systems [14]. Furthermore, to make a telemedicine easier and safer, be mindful of the importance of site in which virtual encounters occur [11]. The survey results indicated that most participants preferred to conduct a telemedicine appointment at home by using video call over the smartphone. Similar findings showed in another survey that the majority of Japanese participants preferred video call with supplementary text message as a communication tool used for telemedicine [15]. On the other hand, studies pointed out that home-based telemedicine system via video

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conference can be of great benefit to patients in terms of convenience, reliability, health care availability, and cost savings. However, there are some issues affecting the efficiency of this system and should be well considered and addressed, such as privacy and security concerns, patient age, patient and healthcare professional's capabilities to use digital technology, Internet speed, network signal, audio quality, and technological compatibility [16] [17] [18]. In addition, a recent study indicated the necessity of the apps being easy to use for patients and staff, providing smooth access to important functions [19]. Regarding this point, further study stated that a user-friendly device which is easy to use by patients with low digital literacy is helpful, and a system allows medical personnel to remotely control the equipment could be an option [10]. Second action, 24 (29%) participants suggested providing the telemedicine services in the greater number of hospitals/clinics. In Japan, there is a slow spread of telemedicine in the hospitals. A high percentage of hospitals are not offering the service due to many issues, such as the lack of infrastructure and uncertainty about reimbursement [20]. A study reported that among the 110,898 medical institutions that exist, the number of medical institutions implementing telemedicine increased slightly from 10,812 (9.7%) in April 2020 to 16,202 (14.6%) in June. Of this number, only 6,801 (6.1%) medical institutions implement telemedicine for a patient's first visit [21]. The third action is about the service availability seven days a week. The current study findings showed that twenty-one (25%) participants requested to offer telemedicine services for patients at any time, day or night. This might be because there are sometimes difficulties to find an appropriate major hospital/clinic to visit in case of an emergency in Japan [22] [23]. Confirmation on that, 65 (77%) participants would prefer to use telemedicine services in a state of a personal emergency. Regarding the fourth action, 20 (24%) participants recommended offering many value-added programs to the telemedicine patients as a part of their wellness programs. The fifth action, 18 (21%) participants clarified the importance of fast Internet speed for transmitting patients' files, records, pictures, and videos. A study reported that 18 factors inhibit the dissemination of telemedicine service in Japan, including network speed [24]. Most of the telemedicine applications require a high speed and reliable Internet bandwidth to run smoothly. Unreliable and low wideband Internet pose barriers in smooth delivery of telemedicine service [25]. Last action, 17 (20%) participants stated the necessity of considering telemedicine desires by age demographic because not all generations have same requirements towards telemedicine. A study reported that age plays a large role in consumer healthcare trends and telemedicine usage. Understanding consumer telemedicine trends by age group may be the key to increasing awareness and the use of telemedicine [26]. Based on the mentioned above, it can be said that telemedicine success and growth begin with the individuals' satisfaction. Patients will start demanding more use of telemedicine that is when the service satisfies their needs and expectations.

Regarding the limitation of this study, the survey was conducted with limited number of Japanese participants. The results cannot be generalized beyond the participants of a study. The participants expressed their own perspectives to develop the current telemedicine platform, and these may not express views of the majority of Japanese people.

V. CONCLUSION

At present, telemedicine plays an important role to help individuals avoid direct physical contact and thus reduces the risk of COVID transmission. This study discussed public willingness to use a telemedicine program, and in what situations/cases it is preferable to use for. It also identified two approaches to promote the use of telemedicine program in Japan. The first approach aims to expand the scope of telemedicine, so as to address many issues which concern the society. Regarding the second approach, it focuses on developing a telemedicine program by understanding the public's views and needs. Based on the participants' feedback, this study pointed out that 6 actions can improve a telemedicine platform, and possibly raise the rate of its usage. The key actions are concerning telemedicine usability, availability, value, and accessibility.

Overall, the growth of telemedicine requires fully understanding of the individuals' needs. Therefore, additional studies are needed to explore the demands and perspectives of different groups of people, including elderly and people with disabilities.

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Integrating Wellness in Digital Interaction

Case Studies on Digital Talents and Youth Gamers

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***Abstract*-The outbreak of the COVID-19 pandemic has resulted in many users actively working and learning from their homes with long hours of sitting and screen time. Health and wellness are the two concepts that require digital users to be aware of and self-managed towards social, physical, emotional, and spiritual well-being. There are multitude of digital interactions available now. Due to movement controls, there are various ideas and opportunities that have surfaced for users to interact for health and wellness, especially on using applications for contact tracing and vaccination management. This paper reviewed literature and survey reports on two user groups, namely the digital talents who serve the digital industries and youth gamers who are attending school online. Their digital interaction experiences with work-life balance were revealed and discussed. The paper ends by proposing how wellness concepts can be integrated into digital interactions for maintaining a balance of life and its quality.**

Keywords- Health and wellness; digital interaction; digital game; digital talents; youth.

I. INTRODUCTION

Health and well-being are vital in our daily lives, and they are now more important than ever following the global outbreak of the COVID-19 pandemic. The emergence of the new virus variants of COVID-19, and the surge in daily positive COVID-19 cases in Malaysia have caused most people to stay at home due to their fear of contracting it. This abrupt shift in lifestyle has caused a big impact to an individual's physical and mental wellness. The awareness of health and wellness should be of paramount importance.

The new definition of health by [1] as "the ability to adapt and self-manage in the face of social, physical, and emotional challenges" (p. 1) is highly applicable in this paper. Meanwhile, the concept of wellness is multi-dimensional that encompasses our lifestyle, mental health or mental wellness, and spiritual well-being [2]. Wellness is considered as "an active process through which people become aware of, and make choices toward, a more successful existence" [3]. Both health and wellness concepts are the foundation of the current discussions of heavy and active digital users on how they can choose their lifestyle or type of activities in performing their interaction with the digital world or virtual spaces. This paper aims to explore the current situations of two heavy user groups namely, the digital talents and the youth gamers, of their digital interaction experience while working/studying from homes.

In this paper, Section II states the objectives and the research questions. Section III presents a framework of eHealth and some examples of eHealth apps or interaction platforms. Section IV highlights theories related to adopting new technology or desire in taking actions for better health. Sections V, VI and VII present the review methods of the case studies of two user groups of digital interaction. Section VIII discusses the key findings by integrating the wellness concept. The last section concludes the review and provides future research work in this area.

II. OBJECTIVES AND THE RESEARCH QUESTIONS

Since the outbreak of the pandemic, the digital talents and the youth gamers have been working or schooling from home with flexible working arrangements.

The main objective is to investigate how these two types of users, namely digital talents, and youth gamers, are coping in their current home-based environments. These research questions are asked to meet the objective of this paper: 1) To what extent do digital talents perform their work-life balance while working from home? 2) To what extent do youth gamers perform their daily and social life balance while studying from home?

III. INTERACTING FOR HEALTH AND WELLNESS

The primary goal of digital interaction for health can be explained through the eHealth concept. eHealth, telehealth, and digital health are proposed to be an important agenda for the development and innovation in the health system for all countries. The current healthcare system is also facing challenges due to restrictions of movement and patients' fear of stepping out from their homes. Healthcare services have been reduced, with non-core clinical services temporarily ceased, including the postponement or limitations of medical appointments via face-to-face consultations [33]. This situation necessitates the establishment of an efficient strategy for delivering healthcare while maintaining service quality. With the emergence of digital health / eHealth,

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patients and healthcare providers can now interact digitally and communicate virtually; patients can continue to receive healthcare-related support without having to travel by utilizing various communication technologies such as teleconsultation, which is also cost-effective [33].

eHealth functions by integrating mobile technologies that serve as a great tool to promote health and wellness. Health-related mobile apps, such as fitness apps, diet tracker apps, and mindfulness/relaxation apps are widely available and can be used by anyone, anywhere and anytime. In general, eHealth is a useful tool for bridging the gap in these difficult times caused by the pandemic, by offering venues for everyone to engage in digital contacts, virtual healthcare, and self-health management. Various communication tools are being applied to conduct virtual fitness classes and act as a platform for digital interactions with other users which also serves as a great source of motivation. Although mobile and online health tools that can be used to manage health are widely available, the interest in using these interventions is still low. There is a higher preference for face-to-face consultations over online programs for stress management purposes [4]. eHealth applied in digital interactions for health purposes is more acceptable by potential users who were among the digital workers [5]. They felt more connected to have someone to talk to regarding health topics. Because of these findings, digital interactions are an important feature to be integrated into any digital health / eHealth interventions to ensure higher acceptance by users.

According to [6], eHealth consists of three dominant domains which are, health in our hands, interacting for health and data enabling health (Refer to Figure 1, the three circles); any eHealth initiatives with the application of three domains in combination (Refer to Figure 1, Star area) is believed to be the most impactful one. Figure 1 also shows various examples of eHealth applications explained in the text and visually. Digital interactions aided by digital health/eHealth tools are the way forward in providing better solutions to users / patients in healthcare during this unprecedented pandemic time.

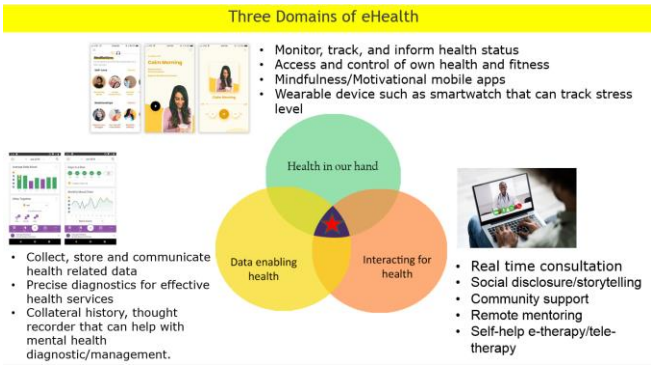

Figure 1. Overview of three domains of eHealth [6].

A. *MySejahtera – Malaysia's Contact Tracing App for Mitigating the Pandemic Outbreak*

The Government of Malaysia has developed MySejahtera in 2020 (Refer to Figure 2). "It is a smartphone application that was created to aid in the monitoring of the COVID-19 outbreak in the country by allowing users to estimate their COVID-19 risk. This software also gives the Ministry of Health (MOH) the information it needs to plan for prompt and effective countermeasures." [7]. The MySejahtera website listed the following functions of the app: "... it assists the Government in managing and mitigating the COVID-19 outbreak; help users in monitoring their health throughout the COVID-19 outbreak; assist users in getting treatment if they are infected with COVID-19; locate nearest hospitals and clinics for COVID-19 screening and treatment".

The app has a check-in function for users to register point of entry into any business premises, while the data collected is to ease the identification of any individual who had casual contact with a positive COVID-19 patient within the same premise; data such as positive COVID-19 cases are also collected and analysed into useful information to identify COVID-19 hotspot locations, so that people may avoid going to that location; it has virtual health advisory feature to provide health-related support such as virtual consultation with a health practitioner. The MySejahtera app also integrates an online clinic appointment system in Malaysia such as BookDoc [7] and Encoremed [7] to allow appointment bookings with clinics.

Generally, the MySejahtera app incorporates all three domains of eHealth (Figure 1), and it has been a very effective eHealth tool to assist the Malaysian government in handling the pandemic situation and the national vaccination programme. Its usage is widespread and it has become an essential app for all those who reside in Malaysia.

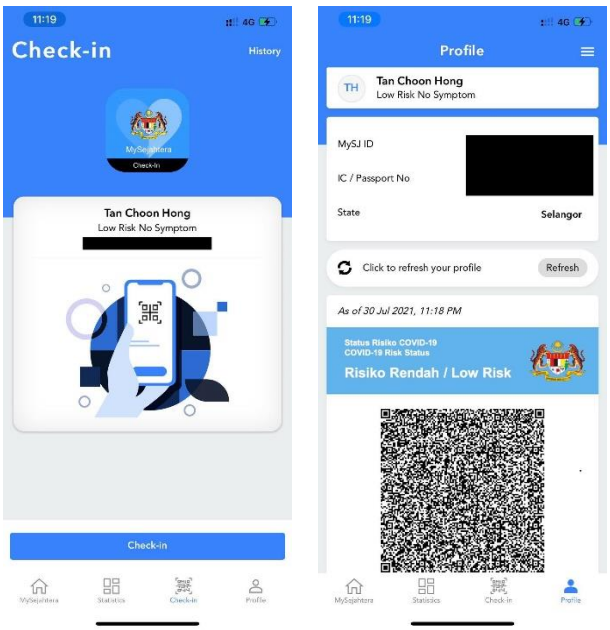

Figure 2. Various key screens of MySejahtera apps used in Malaysia to combat COVID-19.

B. *Other forms of lifestyle applications and interactions*

Exergame applications, such as Zwift Cycling [41], provide services that can change the future of our lifestyle. These will be the new way of digital interactions for promoting healthy lifestyles. Exergames can be performed at home and get connected with the community nearby or at the global stage. Another lifestyle application is a virtual run programme. For example, E-Bee Virtual Run programme was organized at Multimedia University (MMU), Cyberjaya, Malaysia [38]. Alumni from MMU and the public participated in virtual run. There were badges and goody bags provided upon meeting the minimum requirement of the race via some selected running apps and after the participant posted screenshots as evidence of completion. These kinds of virtual race games give space and opportunity for users to enjoy a healthy social life during the pandemic time.

IV. THEORIES OF ADAPTING DIGITAL INTERACTION TOOLS

eHealth innovations tend to diffuse relatively slow. The uptake was modest despite the effectiveness of eHealth interventions [4][8][9]. The understanding of the uptake facilitation of eHealth is very limited, and not many studies focus on the acceptability of eHealth consumers [4][10]. Low acceptability of eHealth is a key barrier to the diffusion of eHealth innovation [8]. Hence some understanding of the technology acceptance or diffusion theories are discussed in the following section.

A. *Unified Theory of Acceptance and Use of Technology (UTAUT)*

UTAUT is a well-known and commonly utilized theory to study technology acceptance. UTAUT has been adopted by previous research to examine the acceptance of eHealth, and to identify key barriers to the acceptance of eHealth. Performance expectancy, effort expectancy, social influence and facilitating conditions are four constructs proposed by UTAUT as direct predictors of users' propensity to use technology. Performance expectancy is described as “the degree to which an individual believes that adopting the system will assist him or her in improving job performance”. Effort expectancy is described as “the degree of ease of usage of the system”. Social influence is described as “the degree to which an individual perceives that important other believe he or she should use the new system”. Facilitating conditions is described as “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system” [9]. Overall, UTAUT provides a deeper understanding of the key facilitating and impeding factors of technology acceptance and usage, which is useful for planning the adoption of technology for health purposes.

B. *Behavioural intentions to adopt innovations*

“The Health Belief Model (HBM) was proposed through social, psychological, and behavioural theories to better understand actions or behaviours related to health” [10]. This theory mentioned that any health-related actions will be taken by individuals if they perceived the activities that could prevent illness or risk to their health. Perceived vulnerability to a negative health condition, perceived severity of a prospective negative health condition, perceived advantages of a specific preventive action on health, and perceived barriers that hinder engagement in a preventive health action make up the core foundation of the health belief of a person. According to this theory, an individual will engage in preventive health behaviour based on their motivation, which is impacted by overcoming perceived hazards and believing that positive outcomes may be achieved at a reasonable cost by doing some actions or measures [9][10]. Protection Motivation Theory (PMT) also establishes perceived severity and vulnerability of health issues as factors that influence individual actions on preventive interventions and health promotion. Perceived stress on related harm contributes to the intentions to seek health-related support to reduce the harm [4]. Both theories can be used to gain a deeper understanding of the acceptance factor of any health intervention by identifying the intrinsic motivation and barriers that influence an individual's decision to participate in a specific activity. This can help future developers to identify the needs of users and deliver interventions that are credible, safe, and well-accepted by most users. One example to explain using these theories is the recent adoption of MySejahtera app, which is currently highly and widely used in the country. The data of December 2020 showed “24.5 million users with up to 30,000

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daily downloads despite misconceptions" on the use of the app for the public and this number is 70% of the population of the country [40]. HBM and PMT's conceptions on the perceived severity and vulnerability of COVID-19 health implications to all adults have influenced a strong reaction and beliefs of people to use it. Moreover, the concepts from UTAUT are relevant in explaining the adoptions of MySejahtera app, due to the factors such as Performance expectancy (usefulness), effort expectancy (ease of use), social influence and facilitating conditions (enforcement conditions by the government, surrounding environment of the community or society) will have a significant impact on users' acceptance and use of the health management app.

V. METHODOLOGY

Digital lifestyles and interaction have had a significant impact on two groups of users: 1) digital talents and 2) youth gamers. Hence, the focus groups are targeted to these two user groups. Their daily tasks are affected and profoundly influenced by how they work and study, while still staying digitally connected to the world.

The current study reviews existing documents reported in the literature, which include media reports, to explore the digital lifestyle of digital talents and youth gamers. The steps taken were to identify survey reports or official publications. Keywords used were digital talents, digital industry, or digital workers. As for the second user group, the keyword searched were gamers, youth, young gamers. All these were concurrently searched with the main keywords, i.e., COVID-19 or pandemic, work, or study from home. These articles were reviewed by extracting the survey findings and key observations in this paper.

VI. CASE STUDY 1: DIGITAL TALENTS AND THEIR WORK-LIFE BALANCE

A. *Digital Talents: To what extent do they perform their work-life balance while working from home?*

This section summarizes how digital talents are playing their roles in digital industries. Digital talents are those who have the technical skills and soft skills that serve digital industries.

B. *Digital talents drive the industries in need of technical and soft skills*

According to [39], digital industries are related to work areas in Software development, Creative Multimedia, Enterprise Resource Planning, Big Data & Analytics, e-Commerce, Networking and Network Security, Artificial Intelligence, Automation, IoT, telecommunications, and others. The skilled workers in these industries are called digital talents who are the assets for the digital industry. Digital talents play a 'frontliner' role for digital innovations, particularly for the healthcare system. Industries that provide telehealth and digital health solutions have been in great demand [11]. [11] proposed that "monitoring, detection, prevention, and mitigation of the impact of COVID-19 could be aided by the use of four interconnected digital technologies: IoT, big-data analytics, AI, and blockchain".

A survey was reported in response to the COVID-19 situation by [12] of 266 digital workers (workforce) recruited from different companies. Sixty per cent (60%) of the company expressed the need for training in various digital skills such as digital marketing (74 out of 179 respondents), skills on office automation / remote working skills, digital productivity tools and technical skills. Skills required in digital industries are constantly changed in reaction to the demand of the industry.

Apart from the above technical skills, talents with soft skills are also high in demand. The World Economic Forum (2020) reported that the top three soft skills for Malaysia are 1) emotional intelligence (EQ), 2) creativity, originality, initiative, and 3) skills in analytical thinking and innovation. According to [13], EQ is a skill that requires a sense of self, social awareness, a good attitude, emotional self-control, and a focus on people relationships and how to manage the relationships including with themselves.

C. *Work From Home (WFH)*

The future of jobs is emerging and requires timely delivery from anywhere and anytime. The survey conducted by [12] reported many digital workforces had shifted to Work From Home (WFH) through technology and digital platforms (Figure 3). Apart from that, many digital workforce companies are concerned about their salary payment and cash flow due to the pandemic and movement control orders in Malaysia. They are also concerned about adapting to how to WFH effectively such as the need to pay attention to the element of wellness, health, and productivity.

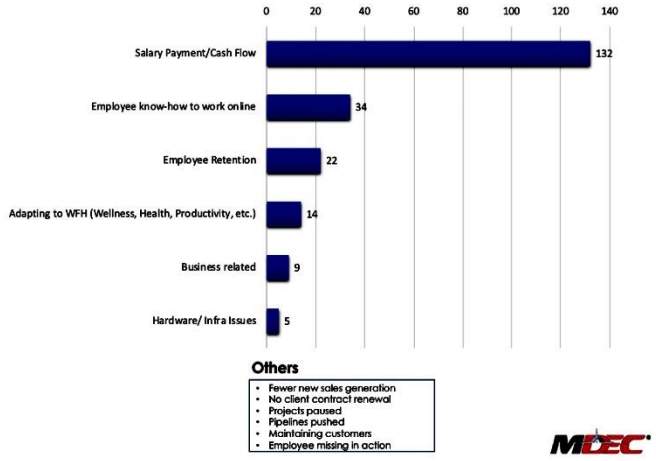

Figure 3. Digital Workforce's immediate concern by talents in COVID-19 situation [12].

The pandemic has also forced the need for social distancing and remote working at a global scale [12][14]. Out of 55% of workers who were surveyed by PwC, a combination of face-to-face and remote work is preferable, with 28% preferring largely virtual work with some face-to-face interaction.

D. WFH: A precursor of burnout?

The trend of the digital industry essentially focuses on digital collaboration, along with the virtual presence and clear communication, especially in the gig economy and future of work for digital industries. According to a job expert, the Employee Provident Fund's CEO, Alizakri Alias [15] emphasized that the nation requires digital talents who are agile, flexible, and adaptable [15]. Multitasking is also a common working style for digital talents. Working digitally from home tends to involve long sitting hours and long screen time. Before COVID-19, Malaysian digital workers were also living a sedentary lifestyle with limited time to spend for more physical activities and a lack of knowledge on health priorities [41]. A study by [17] reported a high percentage (50% of 105 workers) who experienced high stress and pressure in terms of WFH during movement control orders. Cities in ASEAN like Kuala Lumpur, Bangkok, and Singapore respectively were ranked at the bottom 10 out of 50 cities of the 2020 Work-Life-Balance Index [18]. Moreover, the statistics also depict that generally Malaysian are not so healthy as there are high cases of adults in Malaysia who are overweight or obese [16]. In Malaysia, the incidence of Non-Communicable Diseases (NCD) is also very high. The incidence of diabetes among adults in Malaysia is one in five, hypertension is three in 10, and high cholesterol is four in 10 [16].

COVID-19 has made most workers, especially digital workers who performs WFH, struggle to draw the line between work and life at home [18]. According to the same report, employees, especially digital talents, easily slip into an imbalance of 'working' and 'home' hours. People are unable to disconnect [19], as there is an unclear boundary between the two environments - workspace time and personal space-time. Workers may overwork and exceed 48 hours per week. At times, they experience loneliness due to having little interactions with others.

A survey conducted by PricewaterhouseCoopers (PwC) has reported that only 28% of their employees can detach from work outside of working hours, and only 25% believe their boss helps them manage stress and focus on mental and emotional well-being. Only 22% of employees are encouraged to take brief breaks during the workday [19]. In some research, employees stated that they feel pressured to be "always-on" [14].

With long working hours, talents may develop burnout symptoms. The three things that define burnout are being exhausted, cynical, and discouraged [20]. Pandemic burnout is also the most talked about topic in the media and research. Intervention and evaluation research for alleviating or preventing burnout continue to be scarce in the literature [20].

Burnout is not caused by mental illness; it is caused by problems in an employee's relationship with the workplace [21]. By spreading the awareness of unclear work and personal time boundaries and encouraging time off , digital talents can upskill or re-skill to strengthen their organizational resilience and agility. A more empathetic employer with health-promoting workplaces is much needed. Hopefully, strategies can be implemented such as training and awareness campaigns about burnout issues and promoting wellness in digital working space by introducing many thriving and resilience concepts at workplace in collective manners. There are also some discussions at the global and local level on better policies and working terms for protecting the rights and well-being of digital workers.

VII. CASE STUDY 2: YOUTH GAMERS AND THEIR PLAY AT HOME

A. Youth gamers: To what extent do youth gamers perform their daily and social life balance while studying from home?

Countries around the world have instituted various forms of lockdowns to curb the spread of the COVID-19 pandemic. In 2020, this action has led to a significant increase in the amount of time spent on video gaming as a form of entertainment by 39% globally [22].

B. The rise of online gaming - The case of Roblox

Roblox is a free online gaming platform where gamers can build and share their creations [23]. Gamers create avatars of themselves and interact with like-minded others from around the globe by sharing experiences in their virtual worlds through the built-in chat function. Roblox is the most popular game among 5- to 12-year-olds in the US, and as of the first quarter of 2021, is one of the highest played games in the world due to the pandemic. There are on average 42.1 million daily active users of Roblox worldwide [24].

C. Gaming trends among adolescent youth gamers

According to a survey conducted by gaming accessories firm HyperX, playing video games was the primary method of socializing with friends among 13- to 18-year-olds with more than half doing so. 77% of their parents believed that gaming during the lockdown had helped with their child's mental health as they could stay in touch with their friends [34]. In another survey conducted by HyperX, 55% of 13- to 18-year-olds thought that gaming should be incorporated into their school curriculums as they believed that gaming was a path to a future career, which was also supported by 40% of the parents surveyed [35].

Although these statistics are viewed very positively for the online gaming industry, nevertheless, are there any effects

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or consequences of such an increase in gaming, particularly on youth gamers?

D. Is Internet gaming addiction a disorder?

In 2018, the World Health Organization (WHO) included gaming disorder in the 11th Revision of the International Classification of Diseases (ICD) [25]. Video gaming had already been recognized as a disorder in South Korea and China by then. Subsequent treatment programs had been established [26]. To meet the criteria for diagnosis, the behaviour pattern must be of "sufficient severity to result in significant impairment in personal, family, social, educational, occupational or other important areas of functioning" and would have been evident for at least 12 months [25].

In contrast, the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-5) took the position that there was insufficient evidence to determine if Internet gaming was a disorder but did recommend further research [27].

E. Why have youth gamers embraced Internet gaming during the pandemic?

Despite these differing perspectives, online gaming has increased significantly, hence it is important to explore the reasons for this increase and the associated experiences through the lens of the COVID-19 pandemic. [28] conducted an online survey (N = 781) that focused on gameplay habits and effects on players' well-being. It must be noted though that the data was derived from those who were 16 years of age and older with 47.4% of respondents falling into the 16–24 age range. Nevertheless, the findings are important to gain an insight into the understanding of youth gamers behaviour during the pandemic. They found that 71% of respondents had increased the amount of time spent playing games, while 58% of respondents reported that playing games had positively impacted their well-being by providing cognitive stimulation and opportunities to socialize, along with reducing anxiety and stress.

F. The effects of video gaming on well-being

[28] explained how video gaming on personal computers, gaming consoles and smartphones had affected the well-being of gamers. A central theme across their research findings was related to escaping from reality. Respondents played video games to cope with and even escape from the realities of the pandemic. By escaping into an alternate reality of the virtual world, respondents could shift their attention away from their current situation.

There were also key elements mentioned about how gaming had positively impacted their mental health. The data included many references to how gameplay improved their mood and reduced their anxiety which was likely due to experiencing flow [29], whereby gamers find optimal experiences balancing the challenges in the game with their need for achievement. The flow experience was also associated with cognitive stimulation as an effective method to combat boredom during the lockdown.

Agency, or having a feeling of control within the game environment was also another important theme. Gamers could experience feelings of competence and achievement, as well as a sense of purpose as the games were found to address such basic needs that could not be satisfied under pandemic lockdowns. This agency was also found when the gamers specifically chose more relaxing type games that acted as stress relievers to calm down or de-stress.

The last two themes of normalization and socialization are particularly significant. Respondents shared that playing video games provided them with a sense of continuity and normality in their lives, as well as providing them with an enjoyable experience too. This sense of normality is compounded by the added component of socialization, which has helped them keep in touch with friends. Playing online multiplayer games with friends kept respondents from feeling isolated at home which helps to combat loneliness and isolation. The gamers also felt connected to a community to whom they could talk to. Some respondents also shared that their family cohesion was also enhanced as playing online games with family improved family relationships. This study demonstrated that playing online games managed to provide both online as well as offline social support, thereby providing positive effects, particularly in the uncertainty of continued lockdowns.

G. What are the effects of gaming on academic performance?

Playing games can be engaging with some advantages on users' well-being and collectively among the virtual team of gamers or families. The psychological impact of playing games can be obvious to youth gamers but at times unmanaged by them. A study conducted in China involved almost 10,000 students (average age 13.5 years old) were surveyed on their recreational use of the Internet, social media or on playing video games. The researchers found that students who spent more than an hour each day on these activities during the school week scored significantly lower grades [35]. The excessive technology use was a distraction from learning activities and recommended that students spend no more than an hour or four hours daily on school days and weekends respectively [35]. This finding suggests that incorporating time limits on youth's usage of interactive technology is necessary to maintain a balance between online and offline worlds, such as on their studies or learning activities.

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VIII. DISCUSSION

Health is cultivation via a healthy lifestyle; it is not an outcome through medication or supplements. Generally, studies showed a high percentage of high stress and pressure among those who WFH [17].

A. Integration of wellness in the virtual and physical workplace for digital talents

One can practice healthy lifestyles while being "immersed" in the digital interaction world for work, social connection, play and learn. The study of a healthy environment for work, be it physical or virtual space, is an emerging topic of discussion. Many scholars remind the public that a healthy lifestyle is vital for digital workers or youth gamers. However, are they aware of the principle of balance of work arrangement, play and personal life while WFH? All these are related to the wellness concept, which can be described as multi-dimensional in choosing a better lifestyle, social relationships, mental & emotional wellness, and spiritual well-being [2][3].

[30] has provided some key guides of beating burnout among digital workers by identifying the priority of tasks, being able to communicate with family effectively at home, and being able to set better boundaries and mindset (attitude) between work and personal life. [30] stresses about collective well-being by organizing a workplace team to manage better their "collective time" or arrangement for connectivity and collaborations.

B. The well-being of youth gamers

There are some guides for youth gamers when dealing with their digital interactions, especially on time management. Their awareness of moderation in spending time on games and the selection of the type of games and activities are crucial. The following are some other guides to ensure safety and privacy for the young users:

(1) Never share any of their personal information online, even with friends. This includes passwords, telling people where they live, or how old they are [31]. Be aware of how to deal with online issues by showing them how to report and mute others. It is also vital to keep the channels of communication open and encourage them to talk to older adults such as their parents if they see something that makes them uncomfortable [31].

(2) Most websites or gaming platforms have Parental Controls features. Parents can and should customize the safety and privacy settings. This entails turning off the chat function entirely or limiting interactions to only friends, as well as using the most restrictive contact settings to prevent anyone from reaching them [32].

(3) Parents need to control in-game purchases by ensuring that any credit cards are password-protected in the computer systems so that no unanticipated purchases are made. Many games work on the freemium model whereby they are free to play but gamers are incentivized to make purchases in the game with real money to customize their avatar or gain competitive advantages within the game [32].

C. eHealth interaction and acceptance

The beginning of the paper, as presented in [6], has highlighted how digital interactions have been directly involved with health and wellness. The second domain, "Interacting for health" has higher acceptability by digital talents [5]. The use of digital interaction for wellness is inevitable during a pandemic. However, its adoption is also heavily influenced by individuals' perceptions and beliefs. According to HBM, an individual's desire to engage in a specific health-related action is heavily influenced by their desire to avoid illness and their perception of benefits. According to UTAUT, the acceptance and use of technology are heavily influenced by perceptions of usefulness, ease of use, surrounding and facilitating conditions.

IX. CONCLUSION AND FUTURE WORK

We cannot deny that the digital virtual worlds have 'invaded' our living spaces in the cognitive, social, and affective domains. Some studies have reported more users experienced burnout or always "on" from working at home. Life has not been easy for many people during pandemic time. Hence, the discussions of integrating wellness concept in digital interaction at homes is important. The paper presents the challenges and opportunities for the future of digital adoption for health in works at home settings.

The setting of boundaries and the ability to manage EQ are some crucial steps to overcome the burnout issue at work. For youth gamers, the playtime should be in moderation. Addiction or long hour gaming is still a phenomenon that should be controlled through self-management from the youth and guidance from the adults. Some organizations or non-governmental organizations are promoting telehealth or therapy for those who need help from homes. There should be more discussions on how to promote positive mindset and interaction through improved communications and "collective wellness" through digital interactions. Future research will be exploring wellness concept for each of the user groups, especially on the young minors. The research can be expanded to include students who are studying at home; what are the changes and challenges faced by them? Another question asked would be on the factors that motivate or deter user groups from using certain technologies for their health benefits.

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Person-centred Health Care Resting on Digitization and Systematic Processes

A position paper

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***Abstract*—This position paper argues for further research within person-centered healthcare using digitization and systematic process within the fields of information systems and quality management. The included state of art shows the existence of both digital applications and innovation, whereas there is lack of knowledge on how to engage users, especially when it comes to older citizens. Besides the digital application, we should focus on developing related systematic processes to increase both organizational value and patient value. Understanding user-design and development are necessary prerequisites to engage in digitalization and is also key to transformation in health care.**

Keywords-e-health; person-centred healthcare;quality management; information systems; position paper.

I. INTRODUCTION

The world-wide paradigm shift to a Person-Centered model of health Care (PCC) is stimulating innovation in the organization, delivery, and management of services and changing the relationship between patient and healthcare worker by increasing collaboration [1], [2]. As healthcare workers work more closely with patients to ensure PCC, the assembly line disease-oriented model of care is replaced. In PCC, the importance of involving the patient and their family is emphasized while planning and delivering care.

As part of the Swedish national vision, "In 2025, Sweden will be the best in the world at using opportunities offered by digitalization and e-health to make it easier for people to achieve good and equal health and welfare." [3]. Through technology, innovations can emerge to bridge the gap between the pragmatic and the value-based and help to engage patients more autonomously in their own care, as well as provide greater possibilities to meet their needs. The key areas of innovation relate to communication, operational support, and access to services, with an emphasis on tailored-made solutions to the individual, reinforcing the shift to a more patient-centered approach to health care.

While it is recognized in Sweden that welfare technology holds promise to transform the health care system to a PCC model, existing challenges are also acknowledged [4]. Among them are questions of personal integrity, data management, work processes and routines that enhance both the healthcare workers' procedures [5] and foster collaboration with patients to strike a balance between technological solutions and social interaction. Ahlin et al. [6] argue that digitalization is complex and often technological challenges become barriers to human connection. In their study, they found a need to develop social presence to achieve a complete transformation and quality in health care through welfare technology.

The World Health Organization (WHO) [7] suggests the need for a categorical framework for examining and developing e-health based on two categories: Digital Health Interventions and Digital Applications. Within the framework, six primary areas of development are identified including: client-to-provider telemedicine, provider-to-provider telemedicine, targeted client communication, health worker decision support, digital tracking of patient status, provision of educational training. While this model is helpful in making visible the complexities underlying the system of health care, it also invites critical reflection about how research can be designed to examine the interconnectedness of the components to achieve greater understanding about designing PCC. Much of the research to date focuses on single dimensions in the application and use of digital solutions in health care. Fewer focus on the interconnectedness of the elements to arrive at understanding how health care systems can achieve a balance between the pragmatic and the value co-creation [8].

In the field of information systems, studies in human communication online reinforce the complexity of participation in a digitally supported environment [9]. Use of digital technologies requires knowledge and competence to achieve the intended high quality of collaboration [10], [11]. In the field of quality management, innovations are taking place through service design and value co-creation, which involve the end-user in the needs assessment and design of services.

We suggest that an interdisciplinary approach, combining perspectives from Information Systems and Quality Management will contribute valuable new insights about how health care systems can transform to a PCC designed to

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balance the pragmatic and the social value-based. Therefore, the aim of this position paper is to highlight central elements from both theoretical perspectives to contribute with insights about how welfare technology can be used as a driving force to transform and innovate health care system. The foundation for our argumentation will come from two research fields, quality management and information systems.

We base our position paper on interventions and innovations within home-care for older persons. In Sweden, Home Health Care is provided within a system of care, in which collaboration among all actors is central [3]. The health care plans serve as the bridge to enable participation and collaboration of all parties in the planning and follow-up of individual plans for a patient. This provides an important context in which to study how digital solutions can innovate to foster collaboration and co-creation. The population of older persons is selected based on studies showing persons in the older generation require a different kind of support when using technology, and also have different kinds of expectations about being actively engaged in their health services. Statistics reports that almost 50% of respondents in a study experience they lack competencies for using digital tools and services. A second motivation to focus on older populations is stimulated by the current pandemic in which digital solutions may help to combat challenges in providing care to persons in high-risk groups [12].

We present state of the art in Section II and conclusion in Section III.

II. STATE OF THE ART

Research and development in the transformation to a patient-centered approach to health care supported by digital solutions is broad. The research reflects an evolution beyond the mere application of digital solutions for management systems into the human dimension, under a variety of terms including e-health, mhealth, and telemedicine for example. In this state of the art, we present research on the application of digital technologies in health care as part of the paradigm shift to Patient-Centered Care. The research illustrates the need for a broader approach to developing PCC, which we suggest can be addressed by drawing on the knowledge, processes and tools from information systems and quality management. To better understand this argument, we also highlight key studies from these two fields. Among the factors identified as both promising and challenging are: accessibility, user-capacity, patient-involvement in co-creation and quality management systems that bridge internal efficiency with customer value.

A. Detailing Patient-Centred Care

Haglund [3] defines "people-centered health care as an approach to care that consciously adopts the perspectives of individuals, families, and communities, and sees them as participants as well as beneficiaries of trusted health systems that respond to their needs and preferences in humane and holistic ways" ([3], pp. 1). Shaller [13] has identified eight dimensions of patient-centered care: "1) Respect for patients' values, preferences and expressed need; 2) Coordination on and integration on of care; 3) Information, communication and education; 4) Physical comfort; 5) Emotional support and alleviation of fear and anxiety; 6) Involvement of family and friends; 7) Transition and continuity 8) Access to care". ([13], pp. V). Epstein and Street [14] argue that achieving a patient-centered approach to health care necessarily transforms the system of care from an assembly line model to a model of care, but putting people at the heart of health services. Moreover, it alters the relationship between patients and care-givers inviting the patient to be actively engaged at all levels of their own health care, shifting focus to people rather than disease [2].

Transformation to a PCC approach is supported by digital technologies, which are guided by both a pragmatic and value-based intent. Pragmatically, digital solutions aim to develop tools and services supporting reduced healthcare costs, improved diagnostic procedures, management of health, communication and collaboration between patient and caregiver, independent living [15], and access to services [1]. Value is added through the use of digital solutions to make services more accessible, to collaborate, and to provide individuals with tools and services to support independent living, thereby enhancing quality of life [14]. At the same time, [7] cautions the need to strike a balance between technological solutions and human social connections. They argue that digital solutions," should complement and enhance health system functions through mechanisms such as accelerated exchange of information...An understanding of which health system challenges can realistically be addressed by digital technologies, along with an assessment of the ecosystem's ability to absorb such digital interventions, is thus needed to inform investments in digital health." ([7], pp. iii).

The move to PCC in Sweden is supported by national and regional policy to develop PCC [3], [16]. Under the Swedish healthcare reform Nära vård ("Accessible Health Care") [16] regional governments are redesigning health care systems to provide greater accessibility to care, and stimulate patient co-involvement. Value is placed on the individual, and recognizes co-creation as an important ingredient to better understanding of the needs of the individual. Included in the reform is a recognition that health care services can and should also aim to promote greater equality and the possibility for individuals to live more independently, taking charge of their health [16]. An active agent in the new model is digitalization, under the terms e-health and "welfare technology", which reflect a comprehensive approach to e-health with the intent to both deliver equal care to all persons, as well as strengthen resources in the delivery and quality of services, and create systems to engage the individual in their own care by enhancing both independence and participation [17].

Research and development in the transformation to a patient-centered approach to health care supported by digital

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solutions is broad. The research reflects an evolution beyond the mere application of digital solutions for management systems into the human dimension, under a variety of terms including e-health, mhealth, and telemedicine for example. In some countries, the term Connected Health [1] is used to reflect an overarching model that incorporates the myriad of perspectives, reflecting a "distinct balance of technology use for information sharing and connectedness together with proactive care and integrated healthcare services. Moreover, it has opened up a new vista in healthcare by digitally connecting clinicians to clinicians, patients to clinicians and patients to other patients" ([1], pp. 3). The WHO [2], cautions the need to strike a balance between technological solutions and human social connection. They state, "Digital health interventions should complement and enhance health system functions through mechanisms such as accelerated exchange of information, but will not replace the fundamental components needed by health systems such as the health workforce, financing, leadership and governance, and access to essential medicines. An understanding of which health system challenges can realistically be addressed by digital technologies, along with an assessment of the ecosystem's ability to absorb such digital interventions, is thus needed to inform investments in digital health. " ([2], pp. iii).

B. Digitalization and Value Co-creation in Health Care

In the area of patient-centered health care, value co-creation and service design methods have been explored to foster patient-involvement [5], [16], [18], [19], [20]. Yet as [5] found, the rhetoric still outweighs the practice. They found that patients have the ability to contribute to development of their care, but that systematic processes, methods and tools to enable patient co-creation were often lacking. [19] found similarly, that there is an awareness about the value of patient knowledge, but few practical examples exist in which patients are included in the development processes. In a more recent study, [18] identified knowledge gaps in how organisations navigate and bridge knowledge from different perspectives, suggesting the need for continued research to bridge the gap. These studies illustrate the need to better understand and develop systematic approaches that foster co-creation to enhance quality in health care toward a PCC.

Other studies of innovation health among the elderly draw similar conclusions about the lack of patient involvement. In a Swedish study, [8] provide a critical reflection on the promises and realities of digital care among the elderly, in particular in rural communities. Through an examination of innovations in the "Virtual Health Care Room", they note that digital health services are not always accessible for everyone, and that they can also lack a patient-centered perspective (ibid). They highlight the need for continued research, in particular in Sweden among the elderly, that examines health care and not just the technology. As they point out, there is little to no research on the way in which digital solutions are advancing health care among the elderly in Sweden.

In a study of digital solution to support adherence to daily medication intake among the elderly (over 65 years of age), Crawford et al. [20] found that participants were open to technology. However, factors that need to be improved upon include access, patient-specific solutions and designs. As well, gender and educational background affected patient experience. Their findings also demonstrated a positive relationship between autonomy and digital solutions. The greater the use and reliance on digital solutions the less autonomous patients felt. Among some of the respondents, technical solutions threatened self-determination and sense of self-reliance. This study indicates both the potential for continued development in the use of digital medicine, as well as the need for further research to better understand how to secure an effective and successful application among the elderly.

Other related studies, where access to services was examined, reveals complexities in the challenges that are both person specific and organizational. Wildenbos et al. [22] found that although access to technology was made available, rates of usage and adoption were low and inconsistent. Among the barriers they identified through a systematic literature review were, cognition, physical ability, perception and motivation. Suslo et al. [23] suggest that digital solutions hold promise for meeting the unique needs of the elderly, which is often complex and requires both healing and support. Yet the challenge, they suggest, is to secure digital literacy among the elderly, sufficient to benefit from the digital solutions.

A Danish study of digital service delivery among older adults [24] found that age was not a primary factor in the lack of use of e-health services, nor was accessibility. Rather, the primary reasons for "digital disengagement was lack of computer skills and lack of interest or confidence in using the internet." ([24[, pp. 48). Based on their findings, they propose that policy and programming should focus on ways to bridge the gap, targeting skills and attitudes related to technology. More significantly, they found that use of the digital technology among older populations did not necessarily result in improved communication. In fact, many respondents indicated concern that they were less understood by their caregivers. This has direct bearing on the national and international policies that aim to improve communication for patients.

In an extensive review of the research on mHealth (digital healthcare solutions) for the elderly, [25] concluded that numerous studies focus on the development of mobile applications, with particular emphasis on providing service to the end users. They suggest an exciting area of future studies exists around delivery of health care at a distance and the coordination of emergency response. Among the challenges that they highlight for future innovation are quality assurance in the use and application of mHealth, data

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privacy and security, data mining and machine learning, and finally, user acceptance.

C. *Model of prerequisites for participating in the digital society*

Digital technologies like social media have fundamentally changed the way we communicate, consume, and create [26], and not least how we collaborate. Using digital technologies for collaborative purposes is simply becoming the new normal [27], [28], solving challenges with information shortages [11], but also facilitating communication [29], enabling knowledge sharing and development [30], [31], and are used for negotiating, building awareness, sense making, and learning [32]. Digital technology as a facilitator of collaboration has been theorized in, for example, the boundary object theory [11] and the distance framework [10]. In these theories, it has been illustrated how digital technology can be applied and configured for collaborative purposes, but also the importance of support of and competence in using the technology, as well as the configuration of processes supposed to be supported by technology. At the same time research on, for example, digital technologies as a boundary object has been criticized for focusing too much on the technological properties [33], [34], missing out on the "hows" and "whys" related to technology use [34]. Of course, digital technology and access to it are critical aspects of the ongoing digitalization and impact our possibilities to collaborate. But health-care workers and patients must have support to actively engage in digitalized collaboration, as is indicated above as well as by the model of different prerequisites for participation in the digital society developed by [9] (see Fig. 1). Digitalization is more than just a matter of technology.

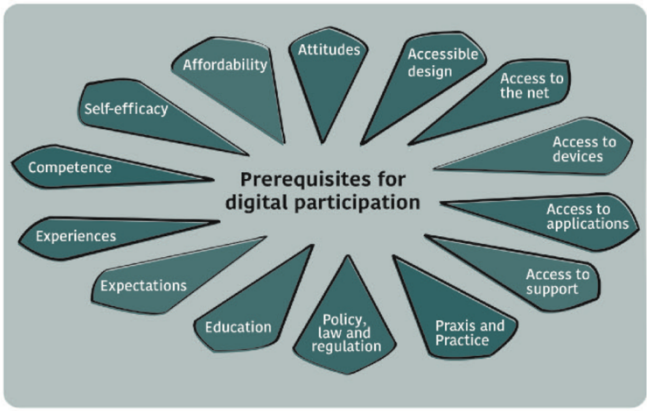

Fig. 1. Prerequisites for Digital Participation [9]

Johansson's [9] model summarizes a wide variety of prerequisites affecting individuals' possibility to participate in the digital society. For example, individuals need access to digital technology, support, and competence to use the technology. Even though the model is developed focusing on people with different disabilities or people being homeless, it can also be viewed as an illustration of the complexity of digitalization as a transformative process and aspects that must be considered to span distance with digital technologies. It illustrates that it is not enough to just make technology accessible or enact laws. There are several other prerequisites that also need to be in place for a digital transformation to take place and succeed. This complexity is what makes effective digitalization very challenging.

D. *Quality Management and Value Co-Creation*

Quality management is a systems approach to organizational, service and product development with the primary intent to meet and exceed customer needs [35], [36]. In recent years, traditional approaches to customer satisfaction have been expanded by digitalization and service design to focus on value co-creation [37]. Rather than designing services to meet the needs of customers, service design aims to engage the customer in the process of identifying needs and designing service solutions that best fit their needs [38]. Galvagno and Dalli [39] define co-creation as the "joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically." (p. 644). Creating conditions for collaborative innovation, is according to [40] "the new imperative" emphasizing among other things value co-creation and the importance of engaging people as active collaborators.

In a recent study of digitalization and quality management, [5] argue the need for research to go beyond focus on technological innovations to the impact on business models, and organizational systems that support value co-creation. Seen within a system view, digital solutions impact both internal structures, systems and processes as well as interactions between external factors. Referring to [41] they include the following levels of interaction: process level, organizational level, business domain and societal level. Further, [5] propose an analytic framework for understanding how quality management can develop to foster value co-creation in digitalization initiatives. The framework examines value creation from a variety of roles including the customer/patient and the provider/organization, postulating the need for organizational flexibility to foster adaptability and innovation. Findings from their study recommend levels and forms of digitalization that need to be further examined and developed to achieve the balance between organizational efficiency and creating customer value.

III. CONCLUSION

The Resolution on Digitalization suggests the need for a comprehensive framework to better understand how to develop an effective PCC to improve health care. This position paper suggests that knowledge and practical approaches from both information systems and quality management can well serve this agenda. In particular, we

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stress the importance of development knowledge and understanding about user-involvement, co-creation, and systematic processes to support involvement as necessary components to achieve the 2025 Agenda in Sweden. While a PCC is intended for all populations, there are unique challenges to applying welfare technology in Home Health Care that both advance and challenge services and user-experience. Statistics show that almost 50% of older persons experience lack of competencies for using digital tools and services. A second motivation to focus on older populations is stimulated by the current pandemic in which digital solutions may help to combat challenges in providing care to persons in high risk groups [12]. This provides an important context to study how digital solutions can innovate to foster collaboration and co-creation.

This position paper demonstrated the need for continued research into the ways in which welfare technology can be used to achieve the E-health vision 2025, and in particular with older populations. While there is good evidence of advancement and innovation in the application of digital solutions in health care, evidence also pointed to a lack of knowledge about how to engage patients in health care planning and development. Also, systematic processes need to be further developed to balance goals of organizational efficiency with patient value. Therefore, we emphasized that understanding user-design for developing PCC is key to transformation in health care.

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