The Impact of Senior-Friendliness Guidelines on Seniors' Use of Personal Health Records

Shawn Ogunseye, Sherrie X.Y. Komiak, Paul Komiak
Faculty of Business Administration
Memorial University of Newfoundland
St. John's, NL, CANADA
{osogunseye, skomiak, pkomiak}@mun.ca

Abstract— Usability is a key determinant of the adoption and use of Personal Health Record (PHR) by seniors. Usability principles exist to guide developers in the creation of senior-friendly PHRs. The purpose of this study is to understand why seniors still perceive the usability of PHRs as low in spite of these publicly available guidelines. 16 PHRs were evaluated with a senior-focused website usability guideline to assess developers' level of compliance. We found that though there are usability issues that need to be improved upon by PHR developers, some of the PHRs should be usable and senior-friendly. To understand the discrepancy between results of heuristic or guideline-based evaluation and reports from actual use, we contend that a need to assess existing usability standards for their suitability in guiding the creation of senior-friendly PHRs exists.

Keywords— Senior-Friendliness; Personal Health Records; Adoption; Usability; Continuous use

I. INTRODUCTION

The population of seniors (people aged 65 and above) is constantly increasing as seniors now live longer than was common decades ago. Apparently, this increase in life expectancy has not come without a cost as seniors currently constitute 80% of hospital bed occupancy, 83% of prescription drug use and 55% of emergency room visits recorded for people with chronic disease conditions [2]. Even when seniors are not chronically ill, they can be susceptible to chronic diseases such as arthritis, asthma, diabetes, heart conditions, hearing impairment, hypertension, ulcer, vision impairment, etc. [34] which informs their need for constant care. Besides the commensurate increase in pressure on the healthcare system and the financial challenge this current system imposes on government [44], the inconvenience seniors face in having to spend time away from the comfort of their homes and in hospital beds is also worth considering. Due to these inherent challenges, pundits have clamored for a decentralization of the current healthcare service provision model from a "mainframe-like" system where care services are provided per patient per time, to an information technology driven distributed service model which will allow seniors "age-in-place" while keeping track of their health and coordinating with their care providers [43].

Consumer health informatics (CHI) applications refer to a plethora of information technology artifacts which support the remote provision of care to patients and are the bedrock of the vision of a distributed care system. The Personal Health Record (PHR) is a key player in this ecosystem. It is an information system that enables patients (or their caregivers) to personally keep track of their health using parameters such as their temperature, blood sugar level, blood pressure, weight, etc. in the convenience of their homes. PHR provides patients with the facilities for secure communication with physicians, recording allergies, scheduling hospital visits, viewing and understanding test results and other health related documents, ample health information and other innovations that increase convenience [11, 20, 30, 38]. For seniors, the PHR has the capacity to improve their quality of life, independence and well-being [45] whether or not they suffer from chronic conditions, substantially increasing the chances of early detection of diseases and health problems [23] and reducing the cost of providing care [12].

Due to the benefits of PHR, an ample amount of research has focused on improving its adoption [44]. So far, explanations existing literature provides for the perennially low adoption rates of the PHR can be classified as either human engendered or technology engendered. A substantial amount of existing literature describes the low level of adoption of PHR as human engendered, highlighting low computer literacy levels and low health literacy levels, (termed "digital divide") as root causes [28,41,46-49]. A few others mention issues relating to the design of the technology (such as usability, perceived usefulness resulting from functionalities, security etc.) as other possible cause. As the focus has been on human engendered causes, the majority of the solutions proffered have towed the lines of improving literacy via education of seniors, providing tutorials, etc. [44, 59]. However, studies have shown that seniors are not averse to using technology, and those lacking computer literacy skills are receptive to learning [52]. Moreover, publicly available PHR systems, like other open information systems, should be easy to use by domain experts and lay people [60] i.e. the level of health knowledge should not be a limiting factor.

As theorized by Davis [7], a consumer's perception of the "usefulness" and "ease of use" of a technology determines their propensity for adoption and sustained use of the technology. Accordingly, as evidenced by existing research on the adoption of PHRs (and technology in general) users' perception of PHRs' usefulness is determined by its usability [7, 24, 45, 50, and 51]. Usability (which encompasses users' perception of

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ease of use, effectiveness, efficiency, and error tolerance levels of a system) is especially important to seniors who are prone to judging technology's usefulness by their ability to easily use it and generally avoid systems they can't figure out [6].

As the influx of technology savvy adults from the "baby boomers" generation into the senior age-group increases, the erstwhile digital divide will continue to close and eventually become very low in significance. However, even as the number of technology savvy seniors has continued to increase, a congruent increase in adoption of PHR has not been noticed. To address this problem, a need to first understand the extent to which current PHRs are suitable for use by seniors thus exist.

II. USABILITY

An information system (IS) is only useful to all of its stakeholders if targeted users consider it usable. This is why a substantial amount of HCI research has focused on proposing techniques, methods and guidelines for improving it [1, 6]. Although there is no widely agreed upon definition of usability, in this paper, we adopt the ISO definition given as: "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [21].

A. Seniors & Usability of Technology

As people age, physiological changes lead to loss or decline in visual acuity, motor skills, cognitive abilities and physical abilities which militate against their ability to use technology [24, 35, 42]. Ample studies on the effect of age on the use of technology exist. Examples include the research by Vigdor and his colleagues [40] on how seniors fared with technology-based instruction. Their work depicts user interfaces (UI) as a key factor that affects the usability of learning technologies by senior citizens. Likewise, research on the usability of mobile phones as it pertains to seniors showed that there is a significant age-related difference in UI expectations between the senior citizens and younger adults which affects adoption [32]. Leung and his colleagues [25] considered the effect of the characteristics of UI icons in mobile phones on how usable the device is for senior citizens. Their research showed that senior citizens had problems using common UI icons in mobile devices, reiterating the effect of usability on the tendency to adopt and continue using technology. Consequently, prior research enjoined technology designers to increase their consideration of seniors in their designs arguing that it can mitigate the age-related digital divide, improving the lives of seniors [6, 27].

B. Seniors & Usability of PHRs

Unlike normal websites, PHRs are by nature supposed to demand attention from users as they enable users or their caregivers to participate in tracking their health, and using the information they garner for decision making. PHRs require high levels of accuracy when records are inputted and their outputs require adequate comprehension to be of benefit. The primary difference between health websites and PHR is that for the former, seniors are primarily information consumers of health information but in the latter, they are play a more tasking role as *information contributors,* generating content.

While the challenges of integrating electronic health records ensues, a handy PHR can help seniors in transitioning from one provider to another and can prevent fatality in cases of emergency. Seniors find the use of PHRs challenging [6, 36, 57]. This may explain why several researchers have found PHR adoption by seniors to be unexpectedly low, and even lower when continuous use is measured [3, 44, 55, 56].

C. Usability Guidelines

Usability guidelines aid designers in ensuring that their websites are accessible [24]. Scapin and colleagues [53] define Web Usability Guideline (WUG) as "statement[s] ensuring some adequacy of a particular user interface of a website with respect to a particular context of use where a given user population has to fulfill interactive tasks with a given system". WUGs have been used extensively, in the evaluation of health websites and some PHR both for seniors and younger adults [56, 57]. A Popular WUG is the Web Accessibility Initiative (WAI) Guideline also called the Web Content Accessibility Guideline (WCAG). It is a universal guideline aimed at ensuring that web content is accessible to people with disability (age related or not). A more senior-specific guideline is the checklist from the National Institute of Aging and National Library of Medicine. Its principles are quite similar to the WCAG except for a few exclusions.

Other guidelines with claims of a capacity for evaluating seniors-friendliness exist. This led Kurniawan and Zaphiris [24] to harmonize available guidelines and research on senior-friendliness to a single consolidated whole. Their harmonized guideline for website usability for seniors was tested and validated by actual seniors and found to cover the pertinent principles of all other guidelines leading to better assessments of websites. We adapt the harmonized guideline presented in [24] for this study.

III. METHODOLOGY (DESCRIPTION OF PRELIMINARY STUDY)

To understand the relevance of WUG to usability, adoption and use of PHRs by seniors, we selected from myphr – a free resource for health information from the American Health Information Management Association (AHIMA) available at (www.myphr.com) and informationweek – an IT website (www.informationweek.com), 10 PHRs from their list of PHRs. Another 6 was randomly selected via a Google search for the phrase "personal health record". These 16 were chosen for the following reasons:

- They are freely available to the public requiring only registration
- They are web-based

PHRs are different from health website primarily because PHRs focuses on user generated contents while health websites provide information for users to consume. The WUG were primarily developed to evaluate websites even though they have been used for PHRs. We "weeded out" health websites, completely closed PHRs requiring some kind of access code

and other non-PHR platforms initially arriving at a list of 21. However, after several rounds of review of the PHRs, we found 16 to be usable for our evaluation (contact the authors for the list of PHRs evaluated).

A. Evaluating the PHRs

Usability principles or standards are meant to guide designers in the development of PHRS. They also serve as a form of heuristics used by experts to assess existing systems to identify areas to be improved [10, 18, 37]. It is perceived to be more objective and easier to conduct than experiments with test users [29, 39] as the latter can be biased, for instance, from the choice of the sample population. Using the harmonized guideline from Kurniawan [24]

There was an initial validation of the metrics involving all the authors to ensure objectivity and agreement about its semantics and scope. On the pretest stage, a second set of test was conducted which focused on evaluating the assessors understanding of the guidelines using a sample website from the National Institute of Aging (NIA) that was built following NIA guidelines. A final assessment of the PHRs was then conducted by one of the authors. An external assessor independently carried out a second set of assessment in order to improve the validity of the results. The external assessor was an academic at another university with the requisite theoretical and practical knowledge (providing computer-mediated health policy interactions with seniors who are retirees of a Fortune 500 company). The external assessor was adequately briefed on the focus of the research. She was given a copy of the assessment instrument, and like the internal assessor, was allowed to carry out practice runs on the NIA sample site.

B. Measuring Senior-Friendliness

The assessors score a PHR's compliance to a principle in the guideline (from [24]) on a scale of 0 to 5 where 0 implies a total non-compliance and a score of 5 implies a complete compliance to the dictates of the guideline. The use of a range allowed a scaled judgment of compliance as against a rigid black and white assessment strategy.

IV. Result

After collating the results from the two assessors, the Cohen's Kappa coefficient was calculated to check the level of inter-rater agreement between the assessors in their evaluation [13]. The Kappa coefficient was evaluated based on the Landis and Koch and was found to be above the threshold value of 0.7 recommended by [15]. We estimate the "degree of compliance" to a usability principle as the percentage of the average score from both assessors. However, for the sake of clarity, we inverted the degree of compliance to show a percentage estimate of the degree of non-compliance as follows:

degree of non-compliance = 100 - degree of compliance

We will discuss only the most severe problems noticed from our evaluation (We judged severity by how common the problem is including only issues with non-compliance scores of 40% and above as shown in Fig. 1).

A. User Feedback & Support

For feedback and support, the assessment of the PHRs gave a compliance rating of about 30%. This implies that most of the PHRs evaluated did not provide a site map which is supposed to offer navigational support to seniors if they lose track of where they are on the PHR [56] and give them a sense of understanding of the overall organization of the PHR.

Many of the PHRs also lacked a tutorial or help section. Help and tutorial features are pertinent in senior friendly designs as they give seniors instructions on how to perform tasks [24, 56].

Another crucial issue noticed was that the error messages from failed tasks were not clear or easy to understand. It would be expected that PHRs should assist in correcting errors either automatically or providing very clear feedback to allow users achieve the correction.

Finally, most of the PHR did not have any adaptive features. The font sizes for many of them could not be changed, and they were generally designed without the capacity for seniors to adjust or control them as they may desire.

B. Search Engine Accommodation:

Even though the guideline for search engine design was just one, some of the PHRs did not follow it. The guideline encourages that search engines should correct errors and misspelled words rather than return empty results or error pages. For seniors, this can be frustrating.

C. Component Complexity (Text Design)

Component complexity describes the visual density of information elements in a website [61]. However, this subsection discusses principles focused on the textual contents of the PHRs alone. Texts used as links did not comply highly with the principles in many of the PHRs evaluated. Also, when they are used as links, many of the PHRs did not give a visible feedback to seniors confirming focus or target capture. Some PHRs also used links that required double clicking. The flouting of this guideline will negatively affect usability for seniors with motor or visual impairments as they need to know when they have arrived on a link, and when they have clicked it. Although these issues were not as rampant as the issues concerning user feedback and support, they are the third most observed issue in the PHRs evaluated.

D. Others

For the other principles evaluated, most of the PHRs were rated highly (scored above 60%). A summary of the results for the most critical cases are presented in TABLE I.

V. Discussion

The result of the heuristic evaluation is in consonance with past research on general e-health platforms which report a lack of compliance of some PHRs to Usability guidelines for seniors-friendliness [56]. However, it is worth noting that the assessors agree that about 20% of the PHRs evaluated showed a high degree of compliance (80% and above) to the

guidelines and less that 10% scoring below 50% in compliance. Principle H3.3 that requires pages to show their current location was adhered to by all the PHRs evaluated therefore it was exempted from our results. The average compliance score was slightly above 72% for all the PHRs evaluated.

The results showed that for developers and designers, there is still room for improvement in their compliance to WUGs, especially in the areas of user support, text design and the ease of use of search engines. [50, 57] discussed several possible reasons why designers of web-based systems do not abide to WUGs. They include issues like a lack of knowledge or understanding of guidelines by management which results in a lack of policy to support it. Also, implementing guidelines might lead to financial costs, making policymakers wary of adopting it. The lack of legal action against non-compliance was another reason given for non-compliance. Some designers were also reported to have complained that some guidelines are difficult to implement. These issues and a few others may discourage complete implementation of WUGs.

As the PHRs showed 72% compliance to the seniors' WUG, We can infer that while seniors might face challenges using some PHRs or some features in their PHR, generally, over 50% of these publicly available PHRs should be usable. However, seniors and other stakeholders still complain about the usability of PHRs describing concerns that are outside current guidelines. This was observed in a preliminary content analysis study of an online discussion forum (from a reputable blog) between geriatricians, patients (seniors & their caregivers), representatives from PHRs companies, and PHR developers show that stakeholders doubt the capacity of WUG to lead to truly senior-friendly PHRs. A geriatrician argued that WUG does not lead to the creation of usable PHR instead "[the system] meets … technical requirements but provides no value for the doctor and patient in improving their communication, and thus remains unused". Apparently, meeting WUGs does not infer usability in the case of PHRs. This raises a question about the usefulness of seniors' WUGs for PHRs. Are there peculiar features of PHR (or seniors) that the current WUGs do not capture? For instance, WUGs do not consider the information quality in their guides (beyond format or presentation). [58] argues that an attribute of information quality (called contextual information quality) is its ability to support the tasks of consumer. In the case of health information systems, the quality of information presented in publicly available platforms for seniors to consume should be verifiable high. The importance of information quality is therefore overlooked in current WUGs as there are no principles to ensure that designers meet strict accuracy, currency, completeness demands that quality health information should possess.

The role of service quality is also grossly underemphasized in the WUGs. [54] showed that good service quality for a web-based system can lead to user satisfaction and continued use. This holds true for seniors too who usually need help using technology [59] and should have ready assistance to prevent frustration and eventual rejection of PHRs [6]. These dimensions of quality are currently beyond the scope of available seniors' WUGs.

In agreement with [50], a mixed method approach that considers key stakeholders in PHR accessibility and evaluates usability using multiple strategies like heuristics, survey or experiments is necessary. However we contend that seniors' WUGs should also be evaluated for adequacy for PHRs.

As a practical contribution, the study highlights usability issues to be addressed by designers to improve the senior-friendliness of their PHRs. It also provides ample information to managers on the usability issues that can affect their PHRs and the possible limitations of WUGs to guide designs.

Finally, the study questions the assumption that the low rate of adoption of PHRs by seniors might be due to designers' non-compliance to relevant usability standards and encourages the use of theory to improve the capacity of current guidelines.

Key limitations of this study are its lack of a survey of actual seniors and the number of PHRs evaluated which can constrain its generalizability. Consequently, future research should survey seniors to identify usability issues of concern to them that may be limiting the usefulness of current PHRs. Also, the adequacy of current WUGs should be evaluated especially for its ability to guide the designs of truly senior-friendly PHRs.

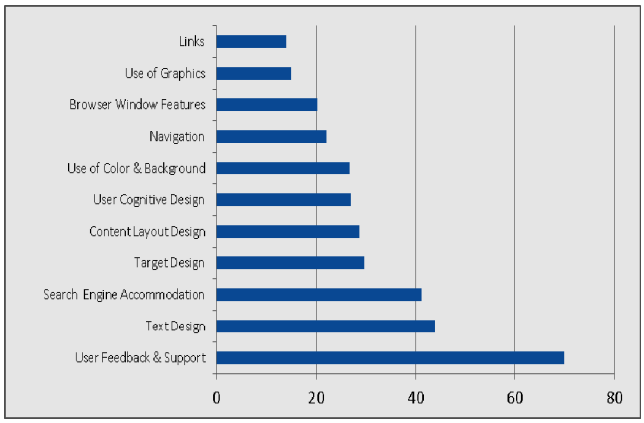

Fig. 1. The level of non-compliance of assessed PHRs to Seniors' WUG

VI. Conclusion

Understanding the low rate of adoption of PHRs by seniors will require studies that approach the issue from the human and system perspectives [50, 59]. However, many of the related issues affecting the adoption of PHR's are either been naturally reducing [2] or being circumvented by improvements in design [60]. We have focused on system related issues that might be hampering adoption of PHRs even by technology savvy seniors. The results show that designers need to re-evaluate their systems and improve on areas where they might be falling short. Generalizing from the applications evaluated, some aspects of these systems would be challenging for most seniors to use as is.

When seniors find PHRs troublesome, their desire to use or continue to use it wanes. We know that seniors need PHRs

TABLE I. SUMMARY OF EVALUATION RESULTS SHOWING THE MOST CRITICAL PROBLEMS IDENTIFIED BY ASSESSORS

Principle	Average score %
H9. Text Design	
H9.3.There should be spacing between the lines	27
H9.6.Use san serif type font i.e., Helvetica, Arial of 12-14 point size. Avoid other fancy font types.	25.5
H10. Search Engine	
H10.1.Search engines should cater for spelling errors	10
H11. User Feedback & Support	
H11.1.Provide a site map	24.2
H11.2.An online help tutorial should be provided	3.5
H11.3.Support user control and freedom	34.5
H11.4.Error messages should be simple and easy to follow	34.5

[59], barring health and computer literacy concerns; usability is the most important factor that can affect adoption for seniors [6]. Since PHRs with high levels of conformance to WUGs are still not found sufficiently usable by seniors, a need to also evaluate the guideline themselves for adequacy to guide the development of senior-friendly PHRs therefore exists.

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