

An Approach to Generating Diverse Personas for Children and the Elderly for Software Development

Tanjila Kanij*, Xiaojiao Du[†], John Grundy[‡], Anu Madugalla[§] and Devi Karolita[¶]
Department of Software Systems and Cybersecurity, Monash University, Melbourne Australia
*tanjila.kanij@monash.edu, [†]lilyxiaoiaodu@gmail.com, [‡]john.grundy@monash.edu,
[§]anu.madugalla@monash.edu, [¶]devi.karolita@monash.edu

Abstract—Children and elderly users typically interact very differently with the same software interfaces. These should be taken into consideration while designing and developing software that will be used by these users. In order to better understand the characteristics of children and elderly users of software, we systematically reviewed the relevant literature. We identified different facets of children and the elderly that are relevant to their interaction with the software. The facets for children are- Special needs children, Interaction with technology and General characteristics. Facets for elderly users are- Technical proficiency, Interaction with technology, Technology expectations and General characteristics. We developed a tool with different descriptions of those facets collected from our review. We collected feedback on the tool from experts and refined the tool accordingly. The personas generated using the tool can be used as is or can be extended by adding more context-specific information to the personas. The tool will help designers and developers of software interfaces to better understand the requirements of these user groups and to incorporate their specific needs during design and development. This will result in reducing biases arising from age-related facets and help to create more inclusive software.

Index Terms—Persona, Children, Elderly users

I. INTRODUCTION

Users of different ages commonly interact with software differently [1]. For example, the way children react/interact to/with video-based games is very different to how elderly people react/interact to/with those games [2]. Perception of technology, motor skills and cognitive behaviour are just some of the key factors that differ between people of different ages [3]. These factors have a great influence on how one interacts with and uses technology. There have been numerous research projects investigating the facets of different age groups that influence peoples' behaviour while interacting with technology. The difference in visual acuity, perception of colour, and different level of sound and noise can all influence how older people interact with technology [4]. Jastrzembski et al. considered adult parameters for modelling a mobile phone-related task and found the model predicted better for older adult performance [5]. This indicates the importance of incorporating age-related facets in modelling and development.

Software is often developed with young to middle age users in mind. There are suggestions in the literature that elderly people as well as children interact quite differently with technology/software than other age groups [6]–[9]. This should be kept in mind in order to develop more inclusive software. Existing research on children and elderly users can

be a good resource for this information. We wanted to review the literature to find key *age-related facets* that are reported to have a significant influence on technology/software usage. As a starting point, we review literature documenting *personas* for children and elderly people in software engineering.

A “Persona” is an archetype that is intended to represent characteristics of actual users of the software. A persona should have an accurate and complete description of the users (i.e. behaviours, attitudes, goals) [10], [11]. Typically a persona contains some basic demographic information of the fictitious user along with some behavioural characteristics that are going to be influential in the usage of the software. The creation of a persona usually takes place during the requirements or design phase of software development. The aim of using a persona is to represent different targeted users of the proposed software. Moreover, personas can also be used as the primary source to elicit information about the users' needs. In addition, personas likely can overcome the challenges that may occur due to unclear communication during the elicitation process, especially when dealing with specific groups of users, such as children and the elderly [12]. Personas can help a software development team to better understand their target users [13], [14]. By better understanding their users, the potential to have a bias against some user groups can be reduced. Personas are also helpful in addressing issues related to the direct participation of particular groups of targeted users, such as the elderly and disabled individuals [15].

A better understanding of the characteristics/facets related to age will benefit the software engineering community to realise age-specific requirements and incorporate those in software development. This can benefit customised software development for the users of those age groups as well as can help include their requirements in general software development. We conducted a systematic literature review of the use of personas to model children and the elderly during software engineering. Our aim was to collect a variety of personas for these age demographics and to better understand what key characteristics, or *facets*, of children and the elderly have been described to date in the software engineering literature. We collected the different facets on which those user groups differ and then developed a tool to generate personas based on the different descriptions of the facets. Our tool can be used by requirements engineers as well as designers and developers to build software interfaces suitable for children and the elderly

users. In the scenario where creating personas from direct end user research is infeasible – either due to cost or inability to reach the users – our tool will help software developers to generate persona for users of these age groups.

The rest of this paper is organised as follows: section II presents a brief review of key related work, section III contains details of research methodology, section IV presents the results and finds the answers to our research questions, section V elaborates on the results and finally, section VI concludes the paper.

II. BACKGROUND AND REVIEW

Elderly users: The term “elderly” conventionally refers to people above 50–60 years of age, though this depends on societal and cultural contexts. According to The Australian Bureau of Statistics (ABS), elderly/seniors are people aged 65 and above [16]. By 2050, the world elderly population is expected to reach 2.1 billion, resulting in more older people aged 60 or over than children, adolescents, and youth at age below 24 [17]. This rapidly increasing population has become an important focus in most industries. However, most of the products adopt the assumption that all seniors possess age-related disabilities and that their needs are homogeneous and constant [18]. Whereas in reality, while they often have some common age-related decreased physical and mental performance, they also have unique advanced skills, knowledge, life skills and wisdom acquired over many years. Due to these differences, technology is accepted by some more than others.

Due to increasing elderly user adoption and usage of technology, a new field of ‘Gerontechnology’ was born. This field concentrates on technological solutions that improve elderly life conditions by focusing on their particular abilities and need at social, health and cognitive levels [19]. The increased use of technology among the elderly can be attributed to technology’s ability to connect families and friends, ensure more safety at home, assisting in monitoring health, self-esteem as well as social interaction [20]. A common technology used by the elderly is ‘assistive technology’, such as an electric wheelchair for movement support, health monitoring applications, smart devices, etc. [21]. However, the acceptance of these technologies among elderly users varies from person to person. Technology acceptance models have attributed these variances to factors such as perceived usefulness, perceived ease of use, attitudes towards use, behavioural intention and actual use. According to Wouters et al. [22] the level of technology use among the elderly is influenced by six themes: challenges in the domain of independent living, behavioural options; personal thoughts on technology use, influence of the social network, influence of organisations and the role of the physical environment. Based on these factors some technological solutions might get accepted by elderly while others are rejected.

The best way to incorporate these information is to involve elderly users while collecting requirements and designing software for them. However, this is not always practical. Apart from access to elderly users there are other challenges as well.

Baez and Casati [23] realized that even though having access to the senior residents of a residential care, it was difficult to get them heavily involved in agile development process. This was due to the iteration processes being very similar and due to errors in earlier iterations, making residents more reluctant to participate in following iterations.

This paper focuses on understanding elderly users and their interaction with technology via personas to better understand elderly users’ specific software interface usage needs.

Children users: Young children users, our other focus in this paper, have their own personal preferences, needs and interests that are very different from their parents and teachers. They are not ‘just short adults’ but an entirely different user population with their own culture, norms, and complexities [24]. For example, this group of users typically has much more difficulty in verbalizing their thoughts, especially when it concerns abstract concepts and actions [25], [26]. Therefore, in designing solutions aiming for young children, they need to be understood as a separate user group. However, children are also fast becoming tomorrow’s power-users of everything from the Internet to multimedia authoring tools [27]. They are a group of users who have mostly naturally grown up with technology due to the advances in technology in the 21st century. They may use technology for enjoyment, learning or social interaction [28]. Many studies have also explored methods to better utilize technology to improve their learning, to support disabled children and to increase social awareness. Similar to elderly users, the level of technology acceptance may vary from child to child. Therefore, in this paper, we try to understand their characteristics as well as facets that impact their interaction with technology.

III. METHOD

In order to create a tool that can generate different personas based on important facets for children and elderly users, we divided our research method into two parts. In the first part, we conducted a systematic literature review to collect information about the key facets and their descriptions for these two user groups. In the second part, we developed a web based tool where designers and developers can select different descriptions of the facets and generate different personas for children and elderly users.

A. Systematic Literature Review

We conducted a systematic literature review (SLR) of the relevant literature to identify the facets of different age groups that influence peoples’ interaction with technology. We listed all the facets of our two target age groups that are identified in the literature. We applied content analysis to group those attributes and identify the facets of different age groups. Our SLR study was designed and conducted based on secondary study guidelines proposed by Kitchenham et al. [29]. As proposed by Kitchenham, the review was conducted in three stages: planning the review, conducting the review and reporting the findings.

1) *Planning the review*: In the planning phase we developed a review protocol - set up our research questions, decided on inclusion and exclusions criteria and finalised the search process. Our research Questions were:

RQ 1: What are the key characteristics/facets illustrated in children personas?

RQ 2: What are the key characteristics/facets illustrated in elderly personas?

a) *Inclusion and exclusion: Inclusion criteria*:

- Included a specification of persona for elderly or children
- Peer-reviewed publications
- Personas are used and presented in the paper
- Personas used and presented in the paper are detailed enough and of good quality
- If there is no persona presented in the paper, they described significant differences in characteristics for elderly and children

Exclusion criteria:

- Described persona however not specific to any age group
- Different language other than English
- Duplicate- reporting same data
- Short papers, posters, or abstracts

b) *The search process*: In order to achieve good coverage of research articles, we consulted with a librarian and selected IEEE Explore, ACM Digital Library, Compendex, SpringerLink and Inspec. In order to design a search string, we followed the general format: *A:(specifying user group) + B:(persona)*

Our expected user groups included elderly people and children. We nominated different words/phrases representing the user groups. We used logical operator “OR” for the different words representing the user groups and used the logical operator “AND” for connecting strings A and B. The terms that were used in the searches were decided based on an agreement of all researchers. Phrases used for part A were “children”, “kids”, “young user”, “elderly”, “old user” and for part B were “persona”.

2) *Conducting the Review*: There were a total of 360 articles returned from all databases. We read the title and abstracts of all those articles and selected 181. We filtered out the duplicates from our selected sets. We found 151 articles for full-text reading. While reading the full text of the articles, we applied our inclusion and exclusion criteria and performed data extraction on the included papers.

a) *Data extraction and synthesis*: We selected 57 articles for data extraction and analysis. The major reason for excluding papers during full-text read was due to unavailability of the personas. We also found that some papers were not specific about elderly or children personas. We extracted three broad categories of data from these articles - demographics data of the article, characteristics/ facets described in the article and details about the reported research. If a persona was available we also collected the persona for further analysis. A close scrutiny of the 57 papers revealed that some results were very similar. Three papers were removed due to reporting the

same results at multiple venues or using the same persona for different purposes. In those cases, we kept one paper that reported the research study in the most comprehensive way and used/presented the most number of personas. We ended up with 54 papers after data extraction.

b) *Quality Review*: We conducted a quality check on the set of included papers. Three of the authors reviewed each of the included papers and assigned a response to three quality criteria: “Overall is it relevant to our research questions?”, “Does the paper report a good quality research?” and “Is the research reporting of a good quality?”. We used a five-point Likert scale to assign a review - “yes”, “somewhat yes”, “neutral”, “somewhat no” and “no”. After conducting the quality review for each paper we removed a further 15 papers due to being low quality according to our quality checklist.

B. Tool Development

We reviewed the personas that we collected from the primary studies. Based on the facets identified for children and the elderly from the personas and the included papers, we developed a tool where designers and developers can combine different facets to generate some personas. The key steps we followed for developing our tool were:

- 1) *Identifying unit themes*: We read the persona descriptions as well as the qualitative data extracted from the included papers, many times and identified the different themes of descriptions within those.
- 2) *Calculating frequency*: We calculated the frequency of occurrence of each unit theme identified in the previous step.
- 3) *Ordering the themes*: We prepared a list of the identified themes in order of their frequency of occurrence.
- 4) *Grouping the themes*: We group similar themes together to make broader categories. We later referred to those as facets in the persona.
- 5) *Preparing facet descriptions*: We reviewed the descriptions from the personas for the facets to prepare description to be used in the tool

IV. RESULTS

A. Systematic Literature Review

Our final set of primary studies contained 39 papers. 25 of those were on elderly personas, 12 focused on children personas, and 2 papers contained both elderly and children personas. We refer to the papers on elderly personas as E1, E2...E27 and the papers on children personas as C1, C2...C14. Papers C13 and E26, and C12 and E27 are the same papers that contain both child and elderly user personas. In total we found 59 elderly personas and 22 children personas from the selected articles. We denote the elderly personas as EP1, EP2...EP59 and the children personas as CP1, CP2...CP22. The final inclusion set is shown in Figure 1. The included papers were published between 2008 to 2020. Around 80% of the papers were published in conferences and the rest were published in journals.

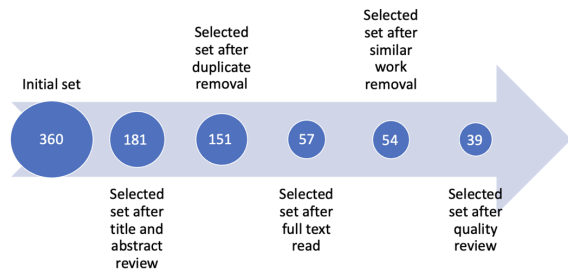


Fig. 1. Inclusion set after each stage

TABLE I
CHILDREN FACETS

Facets	Articles	Personas	Frequency
Special needs children (SNC)	C2, C5, C7, C9, C10, C5	CP1, CP2, CP9, CP12, CP20, CP3, CP22	26
Interaction with technology	C4, C6, C12	CP11	9
General characteristics	C3, C4, C8, C11, C12, C13, C14	CP4, CP8, CP7, CP10, CP21	14

1) *RQ 1: What are the characteristics/facets illustrated in children persona?*: Seven of the 22 children personas and five of the 14 papers analysed were focused on **Special Needs Children (SNC)**. Articles C2, C5 and C7 were developing persona and/or technology for children with Autism Spectrum Disorder. The other descriptions were grouped under two facets **Interaction with Technology** and **General characteristics**. C12 described childrens' game playing habits and C6 described childrens' interaction with agents. We grouped those under interaction with technology. Under the general characteristics we found different personalities such as extrovert, cheery, active, quiet, calm and so on. Table I summarises the findings to answer RQ1. The first column lists the facets, the second and third column lists the papers and persona respectively, and the final column indicated the number of times this was found amongst the unit themes.

2) *RQ 2 What are the characteristics/facets illustrated in the elderly persona?*: We found a total of 102 unit themes describing elderly people from the personas and the selected papers. Applying content analysis on those unit themes we derived four broad facets. Those are **Technical proficiency**, **Interaction with technology**, **Technology expectation** and **General Characteristics**.

a) *Technical Proficiency*: The most prominent theme under this facet was "Usage/Literacy". The unit themes related to "Usage/Literacy" were what technologies elderly people use, how often they use those and their views on using those. Based on the descriptions we divided "Usage/Literacy" further into three categories; "Low", "Moderate" and "Advanced". Most of the elderly personas and some of the descriptions fall within the moderate category (12).

The second prominent theme under this facet was "Interests" in using technology, further subdivided into "minimal" and "welcoming" categories.

TABLE II
TECHNICAL PROFICIENCY (ELDERLY)

Theme	Articles	Personas	Frequency
Usage/Literacy			
- Low	E1, E9, E12, E20, E22, E23, E27, E10	EP17, EP59, EP12, EP11, EP26, EP23, EP53	9
- Moderate	E1, E5, E19, E20, E25, E2, E10, E4, E22	EP18, EP20, EP19, EP1, EP2, EP42, EP43, EP44, EP45, EP46, EP54, EP24, EP36, EP50, EP51	12
- Advanced	E12, E18, E19, E3	EP58, EP1, EP34	5
Interests			
-minimal	E1, E6, E22	EP17, EP55	3
-Welcoming	E19, E27	EP3, EP27	2
Assumptions	E18, E25		3
Views	E2, E25	EP54, EP4	2

Two other themes under the "Usage/literacy" facet were "assumptions" (3) and "views" (2). "Assumptions" reflected some assumptions found about elderly people such as: "*there are social assumptions that older people are incapable of using technologies*", Stereotypes depict older adults as reluctant users of digital technologies. However, recent research suggests that new technologies are being embraced by a growing proportion of older adults.

b) *Interaction with Technology*: This facet contained descriptions related to elderly peoples' interaction with different interfaces and technologies. The most prominent theme under this facet was elderly peoples' difficulty in using technology and interfaces. This was the most frequent theme across all facets. A compilation of the difficulties resulted in the following list: uncommon functionalities, complex interface design, unintentional/accidental taps on screen, difficulty understanding menu hierarchies and instructions, unfamiliarity, small font and buttons, colour contrast, multiple characters per button, selection on touch screen and unhelpful feedback.

c) *Technology Expectation*: This facet included elderly peoples' expectations about technology. There were some indications about the nature of the technology they expect and the interface they require. In E23, the personas expected robotics to be "comfortable", "interesting" and "be familiar with elderly". In E3 persona expected TV interface navigation to be targeted and historical records to be easier to find.

d) *General Characteristics*: Under this facet the most prominent theme was "physical challenges" (9), this theme included all the challenges elderly people face due to physical conditions such as hearing loss, poor eyesight and so on. Another theme was "actions" - actions performed by elderly people such as going for walk everyday, taking regular medicines, using health monitoring devices and so on. The other themes indicated elderly peoples' likes, desires, enjoyments, attractions and so on.

B. Tool Development

Combining the different facet descriptions found in our SLR we prepared a custom web based tool where users can select

different facets for children and elderly users. Based on the selections made by the users, the descriptions of the facets will be populated in the persona. Users can download the persona for further usage. For example, if a user selects to generate children personas using our tool, the facets “general characteristics”, “interaction with technology” and “special needs children (SNC)” will be displayed. They can then select different descriptions for each of the facets. The descriptions of the facets were taken from the personas we collected.

To evaluate our prototype tool we interviewed six (5 male and 1 female) experts from the software industry and academia who have experience working with personas and collected their feedback on our tool. The participants are from 30 to more than 70 years of age. Three of them are University Lecturers or tutors, two of them are partners of a company, and the remaining participant is a UX consultant. Their work experience ranged from 3 to 49 years. The application domain they worked in included cyber-physical systems, fitness, education, consultancy, mining and many other fields.

Feedback on our tool: We asked our participants whether they thought the facets for children and elderly users were sufficient to describe these users. For the elderly facets, two participants thought those were sufficient to describe the elderly users, three were neutral and 1 participant thought they were insufficient. For the children facets one participant thought those were sufficient and another participant thought those were somewhat sufficient to describe children users, three were neutral and one participant thought the facets were insufficient. We also asked them the reason behind their response. The most prominent reason behind their response for both children and elderly persona was that the personas generated based on those facets are very generic and not context-specific. They thought elderly personas can give developers some idea about the “pain points” of this group of users. However, they said that more information is needed while designing particular technology solutions for them.

We also collected feedback on the clarity of the facet descriptions. For both personas three participants found the descriptions to be clear, one found somewhat clear. One was neutral and one participant found the description was not clear. Two suggestions we received in response to this were (1) developers like dot/bullet points (2 participants) and (2) we could break down the children by age groups (1 participant).

We asked our participants if they found the personas generated using our tool for children and elderly users would be suitable for all application domains. All participants said for the elderly persona the template is useful to give a generic view. However, they said that application specific information should be added. For children personas, two participants said they were not sure about this, two participants said application specific information should be added to the persona.

V. DISCUSSION AND IMPLICATIONS

We received detailed feedback on different aspects of our tool. Some of the key comments on the tool included that the personas were very generic and lacked context-specific

TABLE III
TOOL VALIDATION AND IMPROVEMENT

Findings	Actions taken
The generated personas using the tool was very generic, context/project specific information was missing	We have added free form text fields for motivation, pain points and goals where users can add information
Text is very detailed, could be presented in dot point	We have revised the text and used different colours to highlight information
More graphics would be better	We have added photos of the personas
More age group division among elderly and children	The tool is based on persona and information found from SLR, unfortunately there is not enough evidence to break down the age groups further. We plan to conduct future research on each of these user groups to identify difference within each age groups.

information, the text could be presented in dot points, text should be customizable, the tool could have more graphics, and it would be useful to divide the children and elderly user groups further into more sub-groups. Table III summarizes the findings of evaluation interviews and our actions to address those.

Basic persona with external layering: Our tool evaluators stated that our tool generates a generic persona that lacks context-specific information. To address this feedback we improved our tool by adding open space to add more context-specific information about the users. Marcengo et al [30] referred to the persona containing durable aspects as basic personas and those containing context-specific information as persona with external layers. The persona generated using our tool can be enhanced via additional layers added to create more context-specific personas.

Highlighting information: The request to present information with dot points reinforces the findings of Nielsen et al. [31] that companies find it difficult to use when persona descriptions are presented more like a human description narratives to create more empathy. We have dot points and different colours to highlight information in our tool.

Educational tool: Participants noted that our tool could be used for software developer education purposes. Using elderly persona for education purpose has been investigated by Wouters et al. [22]. The authors created four elderly persona based on interviews and incorporated those with scenarios to present as learning materials to teach the context of the use of technology for ageing-in-place.

Application for children: We found some information about children’s interaction with technology and their personalities. We also found the characteristics of special needs children. All these can be helpful for designing applications.

Minimum effort: Some elderly users are welcoming to new technologies and happy to learn those, however, a lot of the elderly people were reluctant about those. We also found that one persona mentioned that they want to enjoy the benefits of technology with minimum effort and to spend less time learning those. These are important insights designers need to keep in mind while designing technologies for the elderly.

UX challenges: A lot of difficulties elderly people face using technology relate to using touch screens and/or small screens. There were clear issues noted regarding font size, background colour, button size, multiple characters per button, selection on the touch screen, tapping on the touch screen and so on. These are very important considerations while designing interfaces for them.

VI. SUMMARY

We described a preliminary investigation to identify the key characteristics/facets of elderly and children and used these to develop a tool that can help developers to generate diverse personas for these users. The tool can be used to generate and compare different basic persona for children and the elderly. Developers can also add more context specific information to the persona. In future work, a closer examination of the interaction with technology facet is necessary. A number of research were found for children with special needs and a number of important information was found about elderly users physical challenges. However, other human aspects such as gender, culture, emotions, personality, socio economic aspects may have a strong influence on these age groups, which needs to be investigated further. We plan to extend our review to include grey literature on children and the elderly to enhance our understanding of the facets and come up with more age groups within children and elderly users.

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