

# Use of Personas in Requirements Engineering: A Systematic Mapping Study

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## Abstract

**Context:** Requirements Engineering (RE) is one of the crucial activities in software development that requires a high involvement of humans (i.e., stakeholders). The aim of RE-related tasks is to develop the scope of the target software products to ensure they will fulfil its stakeholder needs. In RE, the requirements engineers have to deeply understand the software stakeholders including their needs, motivations, and goals. Attaining this information directly from stakeholders requires regular interaction which needs considerable effort. The persona, as a user representation, is a useful tool that can reduce effort amount by modelling the software users and being the primary source of information.

**Objective:** The aim of this work is to systematically review relevant studies that have investigated the use of personas in RE, the benefits of personas, and challenges during the implementation of personas in RE.

**Method:** We conduct a systematic mapping study (SMS) using a formal protocol based on an established guideline. The systematic search result in a total of 904 publications from six databases. After filtering, we select 78 relevant studies for critical appraisal, analysis, synthesis, and reporting.

**Results:** We identify methods to create and validate personas (mostly qualitative), map the benefits of using personas in RE (to ensure stakeholders' satisfaction, support a human-centric RE, and support requirements engineers' tasks and roles in RE), identify methods used with personas, discover challenges during persona incorporation in RE and their respective mitigation strategies, and recommend potential strategies for unaddressed challenges. We also make rec-

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ommendations for future research directions.

**Conclusion:** The findings of this SMS will help RE researchers and practitioners better understand the use of personas in RE and highlights key research gaps for future research.

*Keywords:* Systematic Mapping Study, Personas, Requirements Engineering

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## 1. Introduction

During software development process, RE-related tasks demand regular human interaction, especially with the proposed product’s end-users. This is in part to reduce the possibility to have personal assumptions about what the end-users might need rather than putting the end-users at the centre of the development process. However, regular access to people during the software development process can be challenging for many reasons: finding a representative set of users to work with the team throughout development; only having access to a subset of users providing a limited sample of end user viewpoints; ensuring interactions with the variety end-users is effective; and having timely access to these users to ensure the design and development of software is not delayed. The concept of the ‘persona’ was introduced in Human-Computer Interaction and Design practice by Alan Cooper as a hypothetical archetype and descriptive model of real users as a complement for real human participation in software engineering (SE) [1].

There are three key RE-related tasks: requirements elicitation and analysis, requirements specification, and requirements validation [2]. By definition, RE-related tasks involve end-users in the process, and the more users participate in RE-related tasks, the greater the likelihood that the requirements specifications will satisfy the users. Personas are versatile tools and can be used in all RE-related tasks. During the requirements elicitation and analysis stage, personas are useful to gather information about the end-users’ key requirements by identifying the beneficiaries of the proposed products and articulating their perspectives [3]. In the requirements elicitation, personas are useful for identifying user requirements [4] and helping to discover previously unidentified requirements [5], [6], [7]. Furthermore, personas can identify potential requirements issues [5] and solve conflicts among developers [6]. During the requirements specification, personas can be used to help define the proposed product requirements [8] as a foundation to create a requirements specification document [9], and to support functional and non-functional requirements specifications [10]. Finally, during the requirements validation, personas can help requirements engineers identify issues [11], [12], [13] including redundancy of specific requirements [8], refining the outcome to relevant requirements only [14].

In this review, we aim to find, analyse, and map the published evidence regarding the incorporation of personas in RE-related tasks. The focus of our review is RE in general without any intention to subscribe to any particular contexts of RE (e.g., plan-driven, agile). The reason is because we embrace the

idea that personas are versatile tools that can be incorporated cross-context in RE. We also aim to identify key areas for future research to develop state-of-the-art methods for using personas in RE. We identify relevant studies that investigated the incorporation of personas in RE-related tasks, including the utilisation of personas in each RE-related key tasks, and how the requirements engineers create and validate personas. We also synthesise the evidence for using personas in the RE-related tasks, including the benefits and challenges of using personas and mitigation strategies for the identified challenges.

Key contributions of this SMS include:

- We identify a number of ways personas have been used in RE, including identifying potential user groups and their needs, conveying possible users-proposed product interaction, uncovering system vulnerabilities, and discovering potential issues.
- We identify methods used to construct personas which we categorised into three methodological groups (qualitative, quantitative, and mixed-methods [15], [16], [17]). We identify the measures to perform persona validation and the people involved in the process.
- We collate challenges and respective mitigation strategies to incorporating personas in RE from the literature.
- We identify research gaps to inform future research opportunities in the area of persona creation and validation, more human-centred methods for developing personas, and methods for addressing the challenges of using personas in RE.

This paper is organised as follows: Section 2 describes key related work in the area of personas in RE; Section 3 presents the research methods used in our SMS; Section 4 discusses the key findings from the analysis; Section 5 presents the recommendations for future research based on the findings; and finally, section 6 concludes the paper.

## 2. Background and related work

### 2.1. Personas

Personas, according to Alan Cooper, are representations of actual users which are defined by their goals [1]. [18] defines personas as a synthesis of individuals with similar goals, motivations, and behaviours. The idea of personas is to show a clear distinction between developers and the actual users [19]. This clear boundary therefore avoids assumption bias in the SE process by defining the requirements based on “what users want” rather than on “what software engineers think users might want”.

There is no one definitive persona template; personas are perceived as composite user archetypes, which consist of users’ ways of thinking, behaviour, goals, and motivations for a specific context [20]. Based on [21], persona attributes

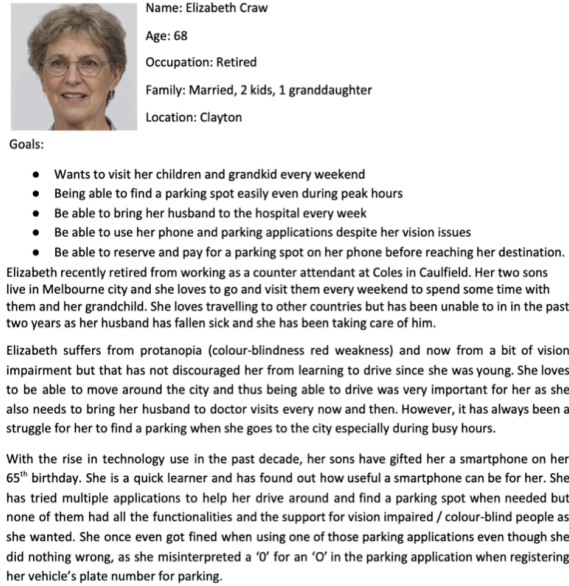


Figure 1: Example of a requirements persona (from [25], (c) IEEE)

can be categorised into three groups: identical attributes (characteristics that will remain the same for each user group - age, gender, location); aggregated attributes (aggregation of the user attributes - technological proficiency of a particular age group); and cosmetic attributes (characteristics used to identify the persona - name, photograph). Personas are not only able to represent humans, but they also can be used to represent other objects (i.e., a town) [22].

Personas are mostly represented in a textual description (often accompanied by a photograph or picture). [23] argues that narrative personas are able to present users' contextual needs with respect to the proposed product. A strength of text-based personas is that their narrative can cater to multidisciplinary perspectives [24]. On the other hand, personas also can be presented as a visual representation [12] to highlight certain human aspects (e.g., emotional feelings, mental well-being), and can include photographs or pictures [13]. For example, in [25], personas are used to represent diverse user groups for the development of a human-centric smart parking application. An example of one of the personas developed and then used in the study is shown in Figure 1.

## 2.2. Personas in Human-Computer Interaction (HCI)

Personas can help software engineers to build empathy for the actual users [6]. Ferreira et al. introduced the PATHY 1.0 [26] and PATHY 2.0 [27] techniques to create personas by providing questions that help the engineers empathise with the users, ultimately enhancing the end-users experience with the final product. In addition to this technique, persona stories – stories inspired

by personas - are also argued to be able to raise empathy for the end users [28]. Lopez-Lorca et al. argued that personas with visual representation - such as adding a photo to a persona's narrative - could have a significant impact on building an emotional bridge between stakeholders of the proposed product [12] and help boost empathy [29].

Another role of personas in HCI is to improve understanding about real end-users [30]. A context-specific description of the actual users enables the software engineers to focus more easily on the users' needs [31]. Personas also help developers understand users' behaviour [32] and support a framework for human behaviour interventions [33], users' cultural aspects [34], their knowledge and skills [14], their needs, and age specific differences [35]. Furthermore, personas are beneficial to discover more about how the users and the software will interact [36], [37]. Empathy and a comprehensive understanding of the users' needs can support decision-making in the software design process [38], [39], [40]. Given software applications are mostly designed for people with a multitude of different human aspects, personas provide an opportunity to integrate human aspects into the development process.

### *2.3. Personas in Requirements Engineering (RE)*

There are three major RE-related tasks: requirements elicitation and analysis, requirements specification, and requirements validation [1]. Performing the first tasks requires interacting with the stakeholders of the proposed product. The outcome of this task is used as the basis for the second task (i.e. specifying the requirements in a standard format). The third task involves evaluating stakeholders' satisfaction with the specified requirements. Involvement of humans (i.e. stakeholders) in RE is imperative for a successful outcome in the process, but access to people (e.g. through interviews, observations, group discussions) consumes considerable time and budget which can be prohibitive. Personas can bypass human involvement in RE, making it an efficient but still valid method for producing valid requirements.

Personas can be more than a standalone tool. Personas can mutually support other human-centred tools in RE for example, a persona can be used with scenarios [12], [41] and viewpoints [8], [42] to understand how the persona behaves in different situations. [43] proposes using human stories, a combination of personas along with user roles. Personas can also be used with user stories to portray users' emotional feelings [44]. Furthermore, to convey users' goals, personas can be combined with goal models [45], [46] and experiential goals [47].

Personas are developed as user representations to provide a comprehensive understanding of the user, and promote empathy [6], [39]. Personas not only bridge the gap between the developers and the 'non-developer' population, but they can also facilitate communication with marginal users, such as users from specific age groups [4], [35], [48], [49], those from particular cultural backgrounds [34], [50], and/or people with specific health conditions [31], [51], [52], [53]. Utilising personas helps the developers to share a common understanding of the users [54] so that even if disagreements emerge among the team, personas enable the developers to have a unified vision about who the end users are [55].

Incorporating personas in RE-related tasks aims to ensure users' satisfaction by making them the main focus of product development.

A systematic review included in this report described personas as one of the artefacts of agile RE [56]. Few studies in the review were found to use personas in agile RE, some used methods involving personas including scenarios and user stories, but there was no in-depth review of persona construction and utilisation in agile RE. In a larger systematic mapping study, the integration of personas in agile development was described [57] which included challenges and key limitations of integrating personas into the integration process. These limitations included: determining sufficient information to be presented in persona descriptions, the representativeness of a persona for a particular context, and possible interaction between personas that share common requirements.

Salminen et al. conducted an SLR about quantitative persona construction [58]. This SLR highlighted the benefits of using quantitative methods, and included a synthesis of the popular quantitative methods used for constructing personas. Despite the endorsement of quantitative methods and criticism of qualitative methods for creating personas, the SLR supported the use of qualitative methods for validating personas. A survey for creating personas in a quantitative manner was also presented in [59] with a focus on data-driven persona development (DDPD). This study reported the evolution of DDPD research, showing how the research evolved over three different time periods. The development of DDPD research can be seen from the objectives for creating personas, data sources used in the creation process, the methods used in DPDD, and persona representation. These studies investigated quantitative persona development, how the methods evolved, and how they might evolve further.

The studies in this SLR do not specifically focus on the use of the personas in RE tasks demonstrating a gap in exploring the use of personas in RE-related tasks. This provides an opportunity for a systematic meta-synthesis to provide important information for RE researchers and practitioners, particularly with respect to human-centred RE.

### 3. Research method

We conduct this Systematic Literature Review (SMS) to evaluate and synthesise existing research studies related to the usage of personas in RE. For initial step, we develop the SMS's protocol based on the guidelines proposed by Kitchenham et al [60]. Next, we evaluate positive findings for the analysis of existing information on personas, including their construction and applicability both in academia and industry. Then we identify research gaps for key areas for further work related to persona utilisation in RE-related tasks.

The first author develop the protocol for the SMS, define search terms as well as inclusion and exclusion criteria, conduct the literature searches, filter the studies, and conduct data extraction and analysis. These activities are conducted under the close supervision of the second, third, and fourth authors, who are experienced in conducting SMSs in software engineering. During the first phase, we define research questions and elaborate on them, and select

search terms and literature databases. Then we perform database searching and select relevant papers in a broad and inclusive manner. Next, we filter the resultant papers based on the inclusion and exclusion criteria, followed by a quality appraisal and data extraction. The third phase of the SMS involves reporting the findings from the synthesis of the data extracted from the papers.

### 3.1. Research Questions

We formulate the Research Questions (RQs) of this SMS by following the methods developed by Petticrew and Roberts [56]: defining the intervention, the population, outcomes of interest, and the context within which the intervention was delivered. Kitchenham et al. [60] describe this approach as PICOC (population, interventions, comparison, outcomes, and context). Table 1 shows the PICOC used in developing the following RQs.

**RQ1** *What is state-of-the-art of using personas in RE?* This research question focuses on how the requirements engineers commonly present, create, and validate persona. We also want to identify RE-related tasks personas have been used to date as well as identifying the methods or techniques have been used with personas for use in RE.

**RQ2** *What are the benefits of using personas in requirements engineering?* We want to investigate the reported aims and objectives of incorporating personas in those tasks, as well as the reported beneficial results coming from the incorporation.

**RQ3** *What are the challenges of using personas in requirements engineering?* In this research questions, we want to identify reported challenges of incorporating personas in the RE-related tasks. Moreover, we want to report the identified recommendations mitigate those challenges from the selected studies and discover other potential mitigation strategies.

Table 1: PICOC for research questions

<b>Population</b>	Requirements Engineers/Software Practitioners involved in RE
<b>Intervention</b>	Personas incorporation in RE
<b>Comparison</b>	N/A
<b>Outcomes</b>	Personas' construction and applicability in RE
<b>Context</b>	Requirements Engineering/Requirements Elicitation/Requirements Analysis/Requirements Specification/Requirements Validation

### 3.2. Identifying the relevant literature

We select major search terms from our PICOC (see Table 1 and Table 2), followed by exploring some new terms as the alternative search terms (Table 3) for this SMS.

Table 2: Major search terms

<b>Intervention</b>	Persona/s
<b>Outcomes</b>	Persona incorporation in RE
<b>Context</b>	Requirements Engineering

Table 3: Alternative search terms

<b>Personas</b>	N/A
<b>Requirements Engineering</b>	Requirements Engineering Process, Requirements Elicitation, Requirements Specification, Requirements Analysis, Requirements Gathering, Requirements Identification, Requirements Validation

### 3.2.1. Search strategy for primary studies

We define the key search terms (Table 2) based on PICOC (Table 1). In order to obtain more relevant primary studies, we also use alternative search terms relevant to the main concept (Table 3). The alternative terms consisted of the terms commonly used in relevant studies to describe personas and terms related to phases in RE. The major and alternative search terms were linked with Boolean ‘AND’ and ‘OR’ operators when relevant, resulting in the final search strategy (Table 5). Six online databases were searched using the search terms, which was performed using stemming and wildcard depending on the database (see Table 4).

### 3.2.2. Literature resources

In this SMS, we use six electronic databases : ACM Digital Library (ACM), SpringerLink, IEEE Xplore (IEEE), Engineering Village, Wiley Online Library, and Taylor & Francis Online. We include journal papers, conference proceedings, workshops, and symposiums in the searches.

### 3.2.3. Search process

At the initial search of six databases, we receive in a total of 904 publications related to personas in RE. We flag relevant papers based on the titles and the abstracts; being broadly inclusive. Next, we remove duplicates if any.

Table 4: Literature databases

<b>Electronic databases</b>	<b>No. of publications</b>
SpringerLink	360
ACM Digital Library (ACM)	256
Engineering Village	128
Wiley Online Library	72
IEEE Xplore (IEEE)	49
Taylor & Francis Online	39



Table 5: Final search string

personas	AND	“Requirements Engineering” OR “Requirements Engineering Process” OR “Requirements Elicitation” OR “Requirements Specification” OR “Requirements Analysis” OR “Requirements Gathering” OR “Requirements Identification” and “Requirements Validation”
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### 3.3. Study selection

We select the papers in two stages. Firstly, we apply a set of inclusion and exclusion criteria to filter the studies resulting from the search process. For each selected paper, we include or remove it after assessing their relevance to the research questions based on their titles and abstracts. If the title and abstract are insufficient for us to make a decision, then we check the paper’s full text eliminating duplicate and irrelevant studies. Consequently, we include 271 relevant publications in the final selection. During the study selection process, we apply inclusion and exclusion criteria. We use the criteria to filter to decide the included papers and remove irrelevant papers. We also conduct one iteration of ‘*backward snowballing*’ to scrutinise the reference lists of selected papers to identify relevant studies that might have been missed during the initial search processes. From this process, we identify five additional studies.

#### 3.3.1. Inclusion and exclusion criteria

We apply the following inclusion and exclusion to select the studies, as follows:

##### *Inclusion Criteria*

- Publications written in English only.
- Publications published between January 2000 (adoption of persona in software engineering [1]) and March 2023.
- Publications that included information about personas (i.e. persona creation, validation, and applicability).
- Publications that focussed on personas and user-centred design in RE-related tasks.

##### *Exclusion Criteria*

- Publications that were not written in English
- Incomplete and/or short papers (less than five pages)
- Book chapters, prefaces, interviews, reviews, posters, panel discussions, tutorial summaries, and article summaries.
- Duplicate papers (only the most complete, recent and improved one was included if there was more than one).

- Papers without bibliographic information such as publication date/type, volume and issue numbers.
- Studies with inadequate information regarding utilisation of personas in various RE activities.

### 3.3.2. Quality assessment

In order to assess the quality of the collected publications, we formulate a number of quality assessment questions (see Table 6). After conducting the quality review, we remove 198 publications resulting in 78 publications to be reviewed (referred to as P1 to P78).

Table 6: Quality assessment questions

No.	Questions
QA1	Is the paper highly applicable to the research?
QA2	Is there a clear statement of the aim of the research?
QA3	Is there a clear methodology for the research which aligns with the research questions or objectives of the research?
QA4	Does the paper provide adequate information regarding the data collection and data analysis of the research?
QA5	Are the methods used to collect the data aligned with the research methodology?
QA6	Is data representation and analysis aligned with the research methodology?
QA7	Are the findings of the research clearly stated and supported the research questions or objectives?
QA8	Does the paper provide information about how the personas are defined or described?
QA9	Does the paper provide the methods or techniques that have been done to enhance the effectiveness of personas in RE?
QA10	Does the paper provide information about how the personas have been evaluated?
QA11	Does the paper provide limitations, a summary, and recommendations for future research?
QA12	Is the paper published in a scientifically reputable venue?

### 3.4. Data extraction and synthesis strategies

The purpose of data synthesis includes a critical appraisal of the selected papers. To extract the detailed information from the 78 selected studies, we create a Google form with four major sections: publication details, domain and motivation of the study, personas usage in RE/SE, and the study results. Then we elaborate these sections into 31 questions (listed in Appendix Appendix A) that consist of 23 long answer questions, six short answer questions, one multiple-choice question, and one check-box. Each of the co-authors was given several publications to conduct independent data extraction. Next, we compare and discuss the results of the extraction. After reaching a consensus, the first author carry out the data extraction under close supervision from the rest of the authors.

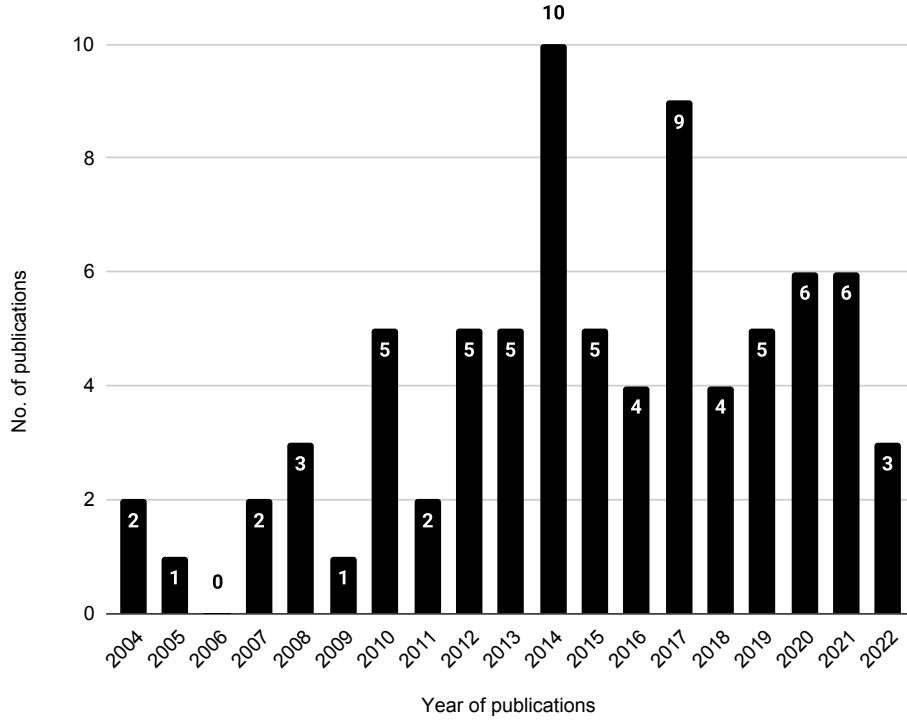


Figure 2: Number of publications by year

## 4. Findings

### 4.1. Overview of selected studies

In this SMS, we include 78 studies: 54 conference papers, 12 journal papers, eight workshop papers, and four symposium papers. Figure 2 shows the year of publication for all the selected studies. We identify that 71 studies were conducted in an academic setting, five studies were conducted in an industry setting, and two studies were conducted in both settings. Appendix B contains the full list of references for the selected studies.

### 4.2. RQ1: Incorporation of personas in RE

The first research question in this SMS investigates state-of-the-art use of persona in RE, including persona presentations, persona creation and validation process, and RE-related tasks in which personas used to be incorporated. We also look at the methods or techniques commonly used with personas to support RE-related tasks.

#### 4.2.1. Persona presentations

In this SMS, we also investigate how personas presentation in the selected studies

and categorised them into three groups: text-based representations (65 publications), model representations (four publications), and visual representations (two publications). Table 7 lists the publications associated with each persona representation group.

Table 7: Persona representations

Persona representations	Publications	Total
Text-based	P1, P3, P5, P6, P8, P9, P10, P11, P13, P14, P15, P16, P17, P18, P21, P22, P24, P25, P26, P27, P28, P29, P30, P31, P32, P33, P34, P35, P36, P37, P38, P39, P40, P41, P42, P43, P44, P45, P47, P48, P51, P52, P54, P56, P57, P58, P60, P63, P65, P66, P68, P70, P71, P73, P74, P76, P77, P78	58
	Template	10
	Table	2
Model	P20, P53, P55, P67	4
Visual	P3, P46	2

Further to this, based on our discovery, we group text-based personas into three more categories: narrative form (58 publications), template (ten publications), and table (two publications). **Narrative** form is the most common way to present personas as this approach of presentation is able to explain the aspects of actual end users (e.g., needs, motivations, goals, and pain points) according to the context of the proposed product [23]. This type of text-based persona uses a story-telling approach that does not follow any particular structure or layout. As an example of this, [P30] introduces ‘cultural personas’ - aiming to enhance developers’ understanding of the cultural aspects of their end users (see Figure 3). The authors refer to a definition of ‘culture’ established by [61] that describes culture as intellectual programming of people’s minds. The study looks at UX-related cultural differences in four countries (Australia, China, Germany, and Vietnam) and have those differences reflected in cultural personas. In order to provide a better culture-related comprehension, cultural personas have three dimensions: the first dimension conveys a general description of the culture, the second provides specific characteristics of the culture, and the third dimension involves personas representing culture. The personas later on can help the engineers to consider cultural UX preferences of each targeted user group throughout the software development process. In order to be able to narrate the persona easily, some studies provided **persona templates**. Persona template is a persona presentation that follows a particular structure or layout. The persona is divided into sections such as demographic information, motivation, goal, concern, and so on. For example, [P56] and [P60] propose a Persona Definition Document for profiling personas. This document consist of three major components: a demographic profile (e.g., name, education, language proficiency, interests, abilities), a knowledge and skills profile (e.g., computer skills, domain skills), and an interaction profile (roles, goals, concerns, usability preferences). In addition to the document, these studies also introduce a Viewpoint Document that described the roles of each persona in a particular environment. This document also present the persona’s goals, concerns, and tasks in a given



Figure 3: Example of *Cultural Persona* (from [34], (c) Springer Nature, reproduced with permission)

environment on which both functional and non-functional requirements specifications were based.

Another way of presenting personas is by using a model. This structured manner of presenting personas can also be considered an augmentation of narrative personas. [P20], which introduces **Assumption Personas**, adopts **Toulmin's Argument Model** [62] to present the reasoning of assumptions used to narrate the personas (see Figure 7). The model has six elements, which are Claim, Grounds, Warrant, Backing, Modal Qualifier, and Rebuttal. The persona characteristics are considered as a Claim with their associated Modal Qualifier, a qualifying phrase to enhance the Claim's believability. Claim also has its associated sources of information which justify the specified characteristics, which are called Reference. Reference represents either Grounds (i.e., evidence justifying the Claim), Warrant (i.e., Grounds' contribution level to

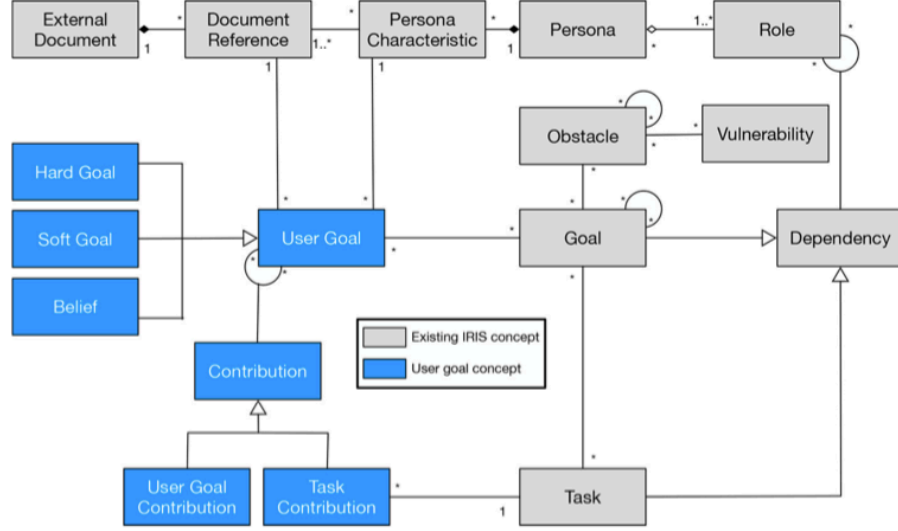


Figure 4: Goal model for visualising personas (from [64], (c) the authors)

Claim) along with the Backing - the knowledge supporting the Warrant, or Rebuttal (i.e., propositions challenging the Claim). Personas can be modelled using a **UML class diagram** as studied in three publications [P53, P55, P67]. In [P55], the UML class diagram is utilised to present their **Persona Ontology**. In the diagram, there is a class representing a persona along with general characteristics such as class attributes. There are also other classes to represent the role played by the persona, concerns, the environment the persona engaged in, and many more. A class instance is then created using a **UML instance diagram** by adding appropriate values to the declared class attributes.

[P53] presents a **context-based persona story metamodel** for agile requirements. The key entities of the model are User Story, Persona, and Navigation Relationships. The model also has other additional compulsory entities to enhance the understanding of the modelled requirements. [P67] visualises personas as a **goal model** that integrates personas and goal-oriented security RE (see Figure 4). The model adopts Integrating Requirements and Information Security (IRIS) and user goals concept. User goals represent the desire of personas which then are elaborated to hard goals, soft goals and beliefs (adopted from *i\** Strategic Rationale model [63]).

Furthermore, visual representation is another way to present personas. This type of persona presentation integrates a picture representing a narrative persona. We identify a similarity in two studies that visually present their personas. These studies embed a scenario into persona representations in order to provide a rich background story. The first study ([P32]) emphasise the emotional aspect of the end users with health situations (either physical or mental). The study uses **poster-like representations** to depict the emotional feelings of the end

users that the personas represent. The second study ([P46]) uses visual representation in a health-related domain. The study presents personas in a set of **rich pictures** (Figure 5) that convey patient journeys, including the processes the patients have to go through, the challenges they come across throughout the process, and the people they are involved with.

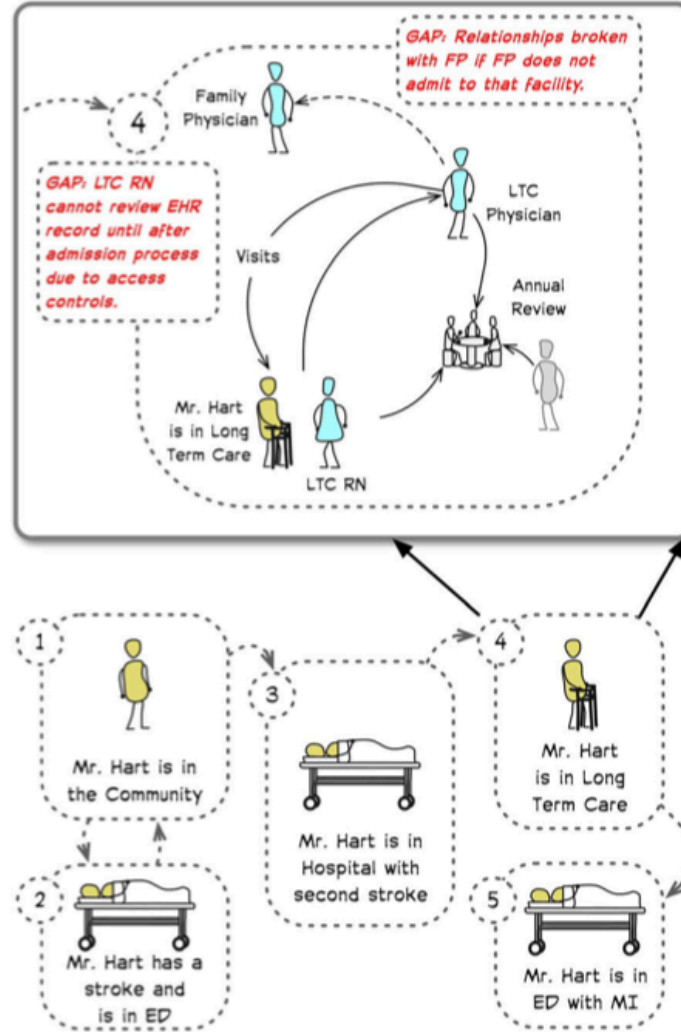


Figure 5: Example of persona as a rich picture (from [63], Open Access CCA 4.0 IL)

#### 4.2.2. Construction of personas

There are three main techniques to create personas: qualitative, quantitative,

and mixed techniques, as argued in [15], [16], [17]. Therefore, we categorise the identified persona creation techniques into those three groups.

Figure 6 shows the summary of the reviewed studies and how they generate personas. Most of the studies use qualitative techniques (46 publications) to create personas for use in RE, followed by ten publications that generate personas using a mixed approach, and six publications that construct personas using quantitative methods. There are also ten publications that do not specifically mention how personas are created in the studies.

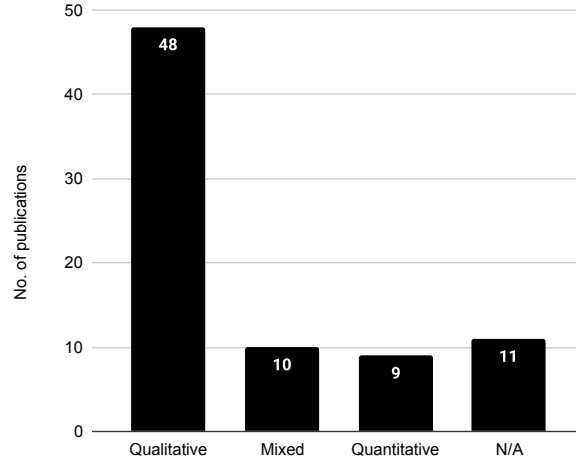


Figure 6: Persona’s generation technique

Based on our analysis, the commonly used technique to create personas for use in RE is the qualitative techniques (48 publications). Generating personas in this way, the most popular approach used is participatory design, involving stakeholders to communicate their needs [25]. Activities involved in this approach including **interviews** [P1, P2, P31-P33, P35, P45, P47], **focus group discussions** [P31-P33, P44, P46], **brainstorming** [P16], and **workshops** [P19]; typically involve stakeholders within the activities. [P76] combines literature study, user research (interview and focus group discussion), and inductive research method to generate personas. The researchers perform a literature research to identify potential user groups and to further investigate it, they conduct user research. The aim of the user research is to collect information related to users’ work routines, how existing solutions support them to do their tasks, and challenges that come across their way in their work setting. Next, interdisciplinary experts analyse the result using grounded theory and code it into several concepts. Finally, the researchers use the findings to develop four personas.

Furthermore, some studies use a particular qualitative method or framework to create the personas. [P21] uses two **existing frameworks** during the persona generation process. The study uses *Riegels-bergers’s* framework [65]



to elicit and define trustworthy persona behaviour. The behaviour was based on two trust-warranting properties: contextual properties (i.e., context-specific driving factors that motivate personas to do trustworthy actions), and intrinsic properties (i.e., the ability to do the actions which are either norms-accepted or out of benevolent intentions). The outcome of this stage is then used to formulate propositions for use in the *Persona Case* framework [66], a technique driven by the Grounded Theory model. The model showcases how the formulated propositions are used to justify (either support or negate) the potential persona characteristics from which persona characteristics are derived.

Another approach to create persona is using **modified techniques**. [P9] adds six more steps to Lene Nielsen’s 10 Steps to Personas method [60]. The study modifies two steps of the method (i.e., Constructing Personas and Creating Scenarios), adding activities in persona construction including: (1) globalisation (considering a wider users population), (2) involving end users to validate personas, and (3) prioritising the personas for requirements trade-off (if needed). In scenario creation, the study also adds three more activities. The first activity is to set common terminology and definitions to avoid misinterpretation of the scenarios. This activity must be done prior to writing the scenarios. The second activity (conducted after the scenario writing) is identifying critical scenarios to use as the basis of the proposed product’s key requirements. The third activity is identifying safety-related situations to be considered in the risk assessments. In addition, PATHY 2.0 (Personas empATHY) technique, as proposed in [P24], tries to adapt Empathy Map – a personas’ creation method for business model design, to be able to be used in a software development context. The template of PATHY 2.0 consists of six fields (*Who*, *Context*, *Technology experiences*, *Problems*, *Needs*, and *Existing solution*) that describe the persona’s characteristics, the environment they engaged in, their technical proficiency, the problems they are facing and how they want to solve them, and current problem-solving options.

Ten studies create personas using mixed methods-based approaches, i.e. using both qualitative and quantitative methods. [P3] introduces the Persona-based method for Adaptive Feedback Acquisition (PAFA), which is claimed as a modified version of Mulder and Yaar’s guideline. The first stage of the method uses a qualitative to conduct activities including user **interviews**, **observations**, and **field studies**. Next stage is to quantitatively analyse the outcome of the first stage by conducting a **statistical cluster analysis** to group the users based on their similarities. Last stage is to create personas as representations of each user group. [P38] also uses a mixed method to create personas. This study interviews the users to ascertain their possible actions in a particular environment, taking into consideration of their goals and motivations. Next, clusters the extracted information along with user log data was, resulting in several groups of users for which each a persona was created.

[P40] uses a qualitative approach to observe the user behaviours by utilising several probes material, such as a set of instructions, cards, diaries, collages, and disposable cameras. First, the study categorises user behavioural variables based on their similarity using a **cluster analysis** technique. Second, creates

personas representing each cluster, enriched by collected qualitative data (i.e. probing material). [P54] uses empirical studies (both quantitative and qualitative) to generate personas for use in a software-based motivation study. The study conducts interviews and a survey to obtain expert views about aspects of software-based motivation. In order to clarify the views, the study then interviews the users. Next, the study uses collected data to develop personas. [P37] uses a qualitative approach by conducting a crowd-sourcing study (i.e., involving a large number of participants) to create multiple preliminary *Personas non Grataes* (PnGs). Cleland-Huang introduces this concept for supporting the identification security requirements of the proposed system [19]. PnGs help software developers to identify users who have the potential to threaten the system. The study uses a **machine learning** technique to discover and group context-specific facets based on the resultant PnGs' descriptions. At the final stage, the study creates a set of final PnGs based on the facets and PnGs' descriptions. Moreover, [P4] uses a crowd-sourcing technique to create a pool of user profiles. The pool also stores previously generated personas. In order to create personas for a proposed product, software developers utilise a computer-aided tool, namely Persona Builder, and choose the persona characteristics from the pool or reused the existing personas. The tool automatically aggregates the chosen characteristics and generated personas accordingly. [P23] aims to address the critics over persona trustworthiness by integrating a qualitative analysis to CAIRIS (Computer Aided Integration of Requirements and Information Security) - a user characteristics integration software [33]. Next, the study then defines persona characteristics using a qualitative analysis, aligned with Toulmin's argumentation model [34] to justify the associated characteristics. Based on the analysis, the study then generates new persona characteristics. CAIRIS was used as a supporting tool to refine existing personas for a particular project based on the new characteristics.

The least commonly used approach for generating personas is a purely quantitative technique was the (nine publications). [P48] uses a **secondary source** (i.e., forum posts). The study **clusters** the posts to identify the main topics and group the stakeholders with which they associated using **association rule mining**. Later on, the study uses a **classifier** (proposed by Cleland-Huang et al. [67]) to identify the quality-related concerns (i.e. security, performance, and usability). The outcomes of these activities are used as the base to create personas. [P51] used **questionnaires** to collect user data. The study clusters the survey results based on variables related to users' preferred technology devices and their technology usage. The clusters were then analysed to identify the most relevant characteristics to be elaborated into personas. [P6] and [P7] use **cluster analysis** to group the users and the features. Firstly, the study cluster the students with Mathematics, Engineering, and Policy Studies backgrounds to group them based on their field of study and gender. Secondly, the study cluster the most commonly used mobile phone services into three major groups (communication, multimedia, and commerce). The next step is to identify the preferred services of each user group using a **simultaneous conjoint analysis** [68]. The analysis is later used to identify the primary personas.

#### 4.2.3. Persona validation

A validation activity aims to check the believability and the precision of the personas and refine it accordingly to add to the trustworthiness of the created personas. From 78 selected studies, we identify several methods undertaken to validate the created personas which are shown in Table 8.

Table 8: Persona validation methods

Methods	Publications	Total
Focus group discussion	P16, P35, P42, P44, P46, P66, P68, P77	8
Workshop	P9, P18, P19, P20, P51	5
Interview	P3, P32, P38, P72	4
Validation document	P1, P11	2
Scenarios	P18	1
Others	P38, P43, P45, P48, P58, P62, P67	6

Among the validation approaches presented in the primary studies, **focus group discussion** is the most common method (eight publications). The second most used method is a workshop (five publications). The idea to conduct these methods is to confirm the resultant personas and find any possible missing characteristics or inconsistencies in the personas. In addition, three publications validate the resulting personas by conducting **interviews** with experts (both from industry and academia) [P3], end users [P32, P38, P74], and other stakeholders who are going to benefit from the proposed product [P32]. Two studies ([P1], [P12]) use a **validation document** to evaluate the created personas. The document consists of a number of questions to ensure that the personas are different and complete. The validation document also has a section to determine whether new personas should be created. [P18] incorporates **scenarios** in the persona validation process. The study evaluates personas against multiple scenarios to understand how the personas behave under specific contexts. This activity helps to identify personas' unsuitable and missing characteristics.

[P58] validates personas by utilising the information gathered from **usability testing**. The study also checks the personas against the updated **user feedback**. Furthermore, the study performs **user research** based on user interviews. The results from those three measures are helpful to evaluate and refine the created personas. [P62] incorporates **experts' reviews** to validate personas. The main reason for performing the review is because this measure is arguably more affordable than involving end users during the validation process. The experts can use their knowledge to learn the gap between user needs and product requirements on which the personas' refinement will be based. [P45] conducts a **calibration** process to validate the created personas. In this process, the end users undergo a set of tasks in given scenarios and give their feedback with respect to the willingness to complete the tasks. Statistical analysis was then conducted to process the collected calibration data. [P38] also conducts a statistical analysis (i.e. ANOVA) to demonstrate whether the created personas are meaningfully different one from another. In [P48], the researchers perform

a manual comparison between the created personas and the sample from the secondary data used to create the personas. The inspection aims to check the relevance between the sample data and the characteristics of the personas.

Furthermore, we find from the selected studies that the personas validation activity most commonly involved human participation. Table 9 shows the groups of people involved in the personas’ validation.

Table 9: Group of people involved in persona validation

Group of people	Publications	Total
End users	P5, P9, P23, P32, P35, P38, P44, P58, P62, P67, P68, P72	12
Project team	P20, P32, P35, P44, P66, P77	6
Experts	P3, P42, P48, P51, P62	5
Other stakeholders	P14, P19, P32, P48	4

Persona validation activity commonly involves **end-users**, as mentioned in twelve publications. Those studies select relevant end-user representatives to evaluate whether the personas sufficiently represented them. For instance, [P5] involves children to validate the created personas since the study develops *Child-personas*. The study recruits 20 children (between 9 and 11 years old) and conducts a workshop to understand their needs, developmental abilities, and limitations. Next, the study involves the same group of children in the persona validation process. Interestingly, the children do not directly validate the personas, instead, they give their feedback on the product’s design from the personas’ point of view. The developers use the feedback to refine both the design and the personas. Persona validation can also consider the participation of **experts** (five publications). Domain experts can assess the effectiveness and efficiency of resultant personas. These experts can evaluate the personas based on their expertise [P62].

Six studies involve the **project team** member when validating personas. In [P20], the project team conduct a half-day workshop to evaluate the characteristics of the resulting personas. The team elicit new assumptions during the workshop and refined the personas accordingly. Other publications describe the project team working with the end users [P35, P38, P44] in one case, with case users’ immediate families [P32] to evaluate and refine the personas. [P77] validates the personas by having a project consortium to develop a common understanding of the end users and ensure that the resultant personas align with that understanding. Persona validation activities also involve experts. Commonly the experts come from the same knowledge domain of the studies. However, an interdisciplinary panel of experts [P51] also can validate the personas to gain insight from other perspectives. Since the study targets older adults with health situations, the panel comprises of people with expertise in medicine, psychology, and sociology. They evaluate the created personas in a workshop with computer science and engineering experts.

#### 4.2.4. RE-related tasks personas have been used in

There are three key RE-related tasks in software development: (1) requirements elicitation and analysis - to discover and analyse the stakeholders' requirements; (2) requirements specification - to specify the requirements in some form; and (3) requirements validation - to validate these requirements by analysing the captured requirements for completeness, consistency and correctness and with stakeholder feedback [2]. These activities are usually undertaken in iterative fashion.

Based on review of our selected studies, we find that personas can be used in one or multiple RE-related tasks. Table 10 summarises the identified key-related tasks personas are used in. Moreover, we also identify some interesting persona uses in each key RE-related tasks (see Table 11)

Table 10: Key RE-related tasks personas are used as identified by the selected studies

No. of task(s)	RE-related task(s)	Publications	Total
One RE-related task	Elicitation and Analysis	P2, P3, P4, P6, P7, P8, P10, P11, P16, P24, P26, P27, P34, P37, P39, P40, P41, P43, P45, P46, P49, P53, P55, P58, P59, P61, P63, P64, P69, P70, P72, P73, P74, P75, 76, 77, 78	37
	Specification	P9, P25, P50	3
	Validation	P14, P71	2
Two RE-related tasks	Elicitation-Analysis and Specification	P15, P18, P20, P21, P22, P31, P32, P42, P44, P47, P60, P62, P65	13
	Elicitation-Analysis and Validation	P19, P28, P33, P35	4
Three RE-related tasks	Elicitation and Analysis, Specification, and Validation	P1, P12, P13, P29, P36, P38, P52, P56, P57, P68	10
Unclear		P5, P17, P23, P30, P48, P51, P54, P66, P67	9

Our analysis shows that requirements elicitation and analysis is the task in where personas are commonly used (64 publications). We discover that personas are helpful to **convey user needs** (34 publications). A study about after-care system [P64] claims that personas portray the consideration of multiple points-of-view of demographic-diverse patients. [P70], a study that develops a system for providing technology-based living assistance for older adults, argues that personas can identify the end-users needs (i.e. the elderly and their caregivers) with respect to their health and daily living situation. Personas are also helpful to enable the requirements engineers to **better understand user characteristics** (13 publications). Creating personas to represent special user groups helps overcome barriers to interacting with vulnerable groups in RE-related tasks. For instance, for a game development, [P40] creates three child personas to help understand children's gaming-related behaviour without directly involving children (minors). Personas can be a good **foundation to create scenarios** (4 publications). [P6] and [P7] utilise persona as the starting point to create user scenarios. After identifying and creating primary personas, the studies conduct scenario analysis to depict how the personas might interact with the proposed product.

During requirements elicitation and analysis task, personas can **encourage stakeholders engagement** throughout software development process (2 pub-

Table 11: Reported use of persona in RE

RE-related task	Use of persona	Publications	Total
Req. elicitation and analysis	Convey user needs	P2, P13, P15, P16, P19, P20, P22, P24, P27, P28, P32, P34, P42, P44, P45, P47, P49, P52, P53, P55, P56, P57, P59, P60, P61, P62, P64, P68, P69, P72, P73, P76, P77, P78	34
	Understand user characteristics	P1, P21, P26, P29, P39, P40, P56, P58, P62, P65, P74, P75, P78	13
	Foundation to build scenario	P3, P6, P7, P41	4
	Identify user-system interaction	P10, P37, P52	3
	Engage stakeholders in software development	P18, P33	2
	Identify potential issues	P13	1
	Solve conflicts	P31	1
Req. specification	Specify expected requirements	P1, P12, P13, P18, P20, P21, P22, P25, P29, P31, P32, P35, P42, P43, P44, P47, P50, P52, P56, P57, P60, P62, P64	23
	Establish common understanding of the requirements	P9, P36	2
Req. validation	Evaluate mock-ups	P12, P13, P28, P35, P57, P68	6
	Check requirements redundancy and completeness	P1, P12, P36, P52, P56	5
	Suggest improvements of the requirements	P14, P36	2
	Check requirements quality	P29, P71	2

lications). [P18] argues limited access to the real stakeholders may result in lack of stakeholders engagement. The study then overcomes the challenge by incorporating personas. Personas, which are data-driven user archetypes, to some extent can help requirements engineers to engage with the stakeholders represented by the personas. Furthermore, personas can help requirements engineers to **identify potential user-system interaction** (3 publications). [P37] introduces *Personae non Gratae* (PnGs) to convey the concept of ‘corrupt behaviours’ from potential disruptive users on which a threat model can be constructed. Such personas contain negative uses and interactions of the target software, in contrast to most uses of personas, including positive or expected behaviours. [P10] uses personas to **convey possible interaction** between real users and the proposed product. The study depicts the interaction using UML use case diagrams where ‘actors’ symbolises the personas and ‘use cases’ represents the actions undertaken by the personas. Moreover, using personas in requirements elicitation and analysis task can help the requirements engineers to **discover potential issues** (1 publication). In a study about architectural requirements, [P13] presents *Architecturally-Savvy Personas* (ASP-Lite) to represent a group of users who were highly technologically proficient and concerned about the quality of the proposed product (e.g., performance, reliability, portability). The personas are helpful in identifying potential architectural issues in the proposed product. In addition, one publication ([P31]) mentioned that persona can help to **solve conflicts** among requirements engineers. The study states that having personas as user representations help the requirements engineers to be familiar with their end-users. Therefore, anytime different opinions related to user requirements emerge, the requirements engineers would resolve it using personas’ perspectives instead of using their own assumptions.

Incorporating personas in requirements specification task is the second most common use found for personas in RE. From the selected studies we find that personas are helpful in **specifying proposed product requirements** (23 publications). For example, [P56] presents an approach to document system requirements called *Personas-Viewpoints-Requirements Matrix*. The matrix provides a summary of personas and their associated requirements in a given environment. [P22] constructs an assumption model for personas, based on Toulmin’s argumentation model to depict actions undertaken by the persona and assumptions as the rationale for the action [62]. As an example, there is an assumption that a persona can delegate a security decision to other team members. This assumption is supported by an argument that managers do not deal with security issues, along with supporting knowledge to ground the argument (see Figure 7). This model then serve as a basis to generate a requirements specification document. [P43] integrates personas and the Contextual Goal Model (CGM) to specify functional and non-functional requirements. In this integration, each persona attribute is modelled as a contextual condition, which then serve as contextual facts for logic predicates. Another identified use of persona in requirements specification task is to **establish common understanding of the requirements** (2 publications). Personas uphold common vision among requirements engineers which enables easier requirements specification [P9]. [P36] mentions

that personas provide additional information which help requirements engineers to have a deeper understanding of the requirements.

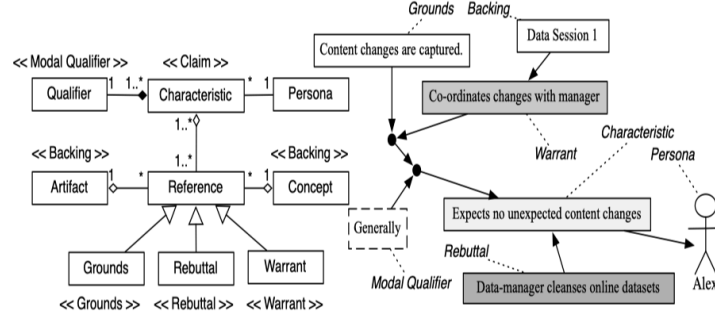


Figure 7: Conceptual model of *Assumption Persona* (from [69], (c) Springer Nature, reproduced with permission)

Based on the selected studies, requirements validation is the task where personas are least used. We find 6 publications that mention personas are beneficial to **evaluate mock-ups**. [P68], a study that develops mobile application to help with anxiety-related issues, uses personas to evaluate the prototype of the application. The study takes into account the personas' perspective while performing usability evaluation against the prototype. Personas also endorse the **checking of requirements redundancy and completeness** (5 publications). [P56] introduces a *Scenarios-Tasks-Requirements Evaluation* (STRE) matrix to help requirements engineers summarise whether the scenarios (created based on the personas) have fulfilled a particular requirement or not. In addition, the study presents *Conflict Requirements Resolution* (CRR) activity - aiming to resolve the identified requirements conflicts by taking personas' needs into consideration. Incorporating personas in requirements validation can give requirements engineers some ideas on how to **improve the requirements** (2 publications). Normally, after performing usability evaluation, the requirements may change. Personas are helpful to ensure the changes are still relevant to end-users' perspective [P36]. Moreover, personas can be useful to **check the requirements quality**. [P29] creates a requirement quality checklist in order to validate the specified requirements. The study visit each criteria from the personas' perspectives to measure the quality of the requirements.

#### 4.2.5. Methods used with personas

Personas are not a stand-alone human-centred method in RE. From the selected studies, we find that several other methods are commonly used together with personas to better capture the targeted users' requirements. The methods either complement the use of the personas or the other way around. Figure 8 summarises the methods or techniques used together with personas in the reviewed studies. We divided those methods into two groups; methods used



to complement personas and methods that are complemented by personas (see Table 12).

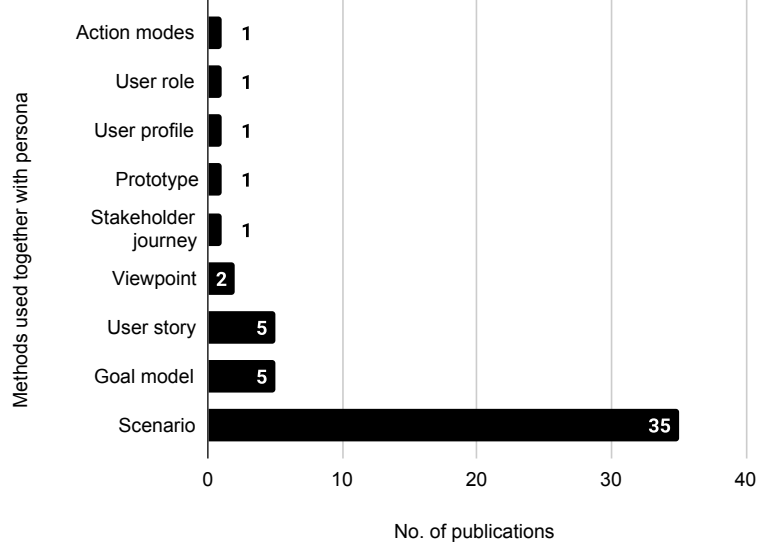


Figure 8: Methods used in conjunction with personas in RE

From our selected studies, 45 publications mention methods that are used to **complement personas** in RE. The most common method to support personas is **scenarios** (33 publications). [P32] introduces emotional scenarios to help developers empathise with the created personas. The scenarios help to better illustrate emotional-related issues experienced while using the product. The study gives an example of a scenario to depict the persona’s emotional feelings toward a wearable alarm device. Emotional scenarios enriched the created personas by conveying emotional aspects. In order to write the scenarios, the researchers of the study interview the product’s beneficiaries. The interviews focus on understanding the users’ impression of the product. [P64], a study focusing on capturing users’ emotional aspects, uses **user stories** in addition to personas and emotional goal modelling to develop an aftercare system for patients with heart failure. The study utilises user stories in requirements elicitation to show how the users used a particular feature of the system. In addition, the emotional goal expresses users’ emotional-related goals after they use the system’s features. The user stories are later used to conduct persona-based interviews with the health workers. The health workers then have to answer interview questions from the persona’s perspective. The findings show that user stories enable the engineers to better understand the system’s important functional requirements. [P3] combines personas with scenarios and **goal models** in a feedback acquisition study. The motive of using goal models is to have a clearer picture of users’ goals that rationales their behaviours. Before creating

Table 12: Role of the methods to be combined with personas

Role in the project	Methods	Publications	Total
Complement personas	Scenarios	P3, P6, P7, P9, P12, P16, P18, P20, P21, P22, P23, P28, P32, P35, P36, P41, P47, P50, P52, P54, P55, P57, P59, P60, P61, P62, P67, P68, P71, P72, P75 P76, P77	33
	User stories	P25, P48, P64, P66, P78	5
	Goal models	P3, P7, P55, P67	4
	Viewpoints	P55, P56	2
	Stakeholder journeys	P69	1
	Prototypes	P35	1
Complemented by personas	Scenarios	P24, P 73	2
	Goal models	P43	1
	User profiles	P31	1
	User roles	P29	1
	Experiential goals and action modes	P35	1

the goal models, the researchers derive multiple scenarios to portray the personas’ behaviour in particular circumstances. The engineers then extract and identify the users’ goals from each scenario and the relationships between the identified goals, which are then illustrated in goal models. Later, the engineers are able to better understand each persona’s goals and the measures to achieve them from the models.

Furthermore, we identify other methods that can complement personas in RE. In [P56], each persona has multiple roles (i.e., role as a student and a part-time employee) at the same time. The study incorporates **viewpoints** to showcase how each persona role behaved in a particular environment (e.g., using a mobile phone in a coffee shop to do online shopping). The viewpoints of a persona are presented in a format called Viewpoint Document. The document consists of environment-specific information about the persona’s goals, scenarios, tasks, concerns, and requirements (both functional and non-functional). The study argues that the benefit of using viewpoints to complement the created personas is to rationalise the users’ requirements. The **stakeholder journey framework** (SJF) is another complementary method to personas introduced in [P69]. This method is an extension of the customer journey framework (CJF) [70], a framework to model users’ interaction with technology. The stakeholder journey broadens the scope of CJF by also considering the beneficiaries of the proposed product. The first step in designing SJF is stakeholder mapping, where brainstorming with the actual stakeholders of the proposed product is conducted. This activity aims to identify the prominent stakeholders, which are then elaborated into personas in the following step. The next step is to illustrate each persona’s stakeholder journey, and the last step is consolidating the illustrated stakeholder journeys. The study shows that using SJF to portray dependencies between stakeholders helps identify potential conflicts in stakeholders’ requirements. In [P35], **prototypes** are used to complement personas.

After creating personas, the study develops a respective prototype for each created persona. Stakeholders' representatives of the project involved in persona creation also contribute to the website's prototype development. The graphical designers develop the prototype with the participants' inputs regarding the preferred design, and information should be provided on the website.

Persona is also a helpful complimentary tool to other methods in RE. [P73] shows that personas can complement **scenarios** in order to identify the customers who will likely file lawsuits and develop a chatbot to engage with the potential litigants. The study creates scenarios by discovering the main reasons for lawsuits from complaints' logs, and the company then offered solutions to overcome the situation. The scenarios show the actions flow in two ways: receiving customer information and using a chatbot to establish communication with customers. The study then creates several personas to complement the scenarios. Each of the personas has concerns that are related to major reasons identified for filing complaints.

From the selected studies, we also find that personas can be a supportive tool for **goal models**. The Contextual Goal Model (CGM) introduced in [P43] integrates personas to consider users' perspectives. CGM contains the goals of the proposed products and the measures to achieve those goals. The context determines which goals should be activated and their respective actions. The study then compares these goals with the created personas' goals. The comparison allows a better requirements specification and helps to prioritise the requirements according to the users' needs. [P31] uses personas as an addition to **user profiles**. User profiles aim to categorise and characterise user groups and typically contain information about users' skills, physical traits, cognitive abilities, environments the users engaged in, and their major requirements. The study then uses the profiles to scaffold the personas representing each user group. The result of the study shows that using user profiles and personas helped the developers to understand the targeted users. The developers also keep these profiles and personas in mind throughout the decision-making process.

Persona can also support **user role**. [P29] explains that the user role is part of user stories which describes one's activities and responsibilities. However, the study argues that the downside of user profiles is the lack of empathy towards the users. Therefore, the researchers of the study create personas to highlight the user roles. The personas enable the developers to better understand the end users and empathise with them. In [P5], personas serve as a complimentary to **experiential goals**; the experience people have using the proposed product. The study then uses **action modes** to present how the product can support the users to have the experience. Later on, the study uses these aforementioned to frame the questions to be asked for data collection (e.g., interview, observation), followed by information synthesis. Finally, the study uses the synthesised information as the foundation to narrate personas.

**Answer to RQ1:** In RE, we find that text-based is the most preferred persona presentation. The main reason is because this type of presentation able to convey end users’ demographic information and personal aspects (i.e., goal, motivation, behaviour, concerns). In persona creation process, we figure out that qualitative techniques are the most commonly used to create personas. The most obvious technique is participatory design technique, by engaging stakeholders in activities such as interviews, brainstorming, workshop, and focus group discussions. Qualitative techniques are also the most preferred approach to validate and evaluate personas. The techniques commonly involve end-users. In addition, some studies also use a statistical analysis to validate personas by checking the distinction between the created personas. Given the small number of selected studies that mentioned personas’ validation, we recommend to study persona evaluation and validation to make the personas more reliable. Most of the studies incorporate personas in requirements elicitation and analysis tasks. In this task, personas serve as the source to elicit requirements, user possible interaction with the proposed products, and discover potential conflicts. Acknowledging personas are not stand-alone tools, we identify some methods that can complement personas (e.g., scenarios, user stories, goal models). We also discover that personas can serve as a complimentary to other human-centred methods, such as scenarios, goal models, and user profiles.

#### 4.3. RQ2: Benefits of using personas in RE

This research question looks at the reported benefits of incorporating personas in RE. We find 56 publications reporting the benefits of using personas in RE. From those reported benefits, we identify several positive outcomes regarding bringing humans to the centre of RE. Table 13 summarises our findings.

Table 13: Reported benefits of personas in RE

Reported benefits	Publications	Total	Positive Outcomes
Support better understanding of the end users	P1, P4, P11, P13, P14, P15, P26, P27, P30, P31, P37, P40, P42, P43, P46, P50, P51, P54, P55, P57, P58, P60, P63	23	Ensure users’ and stakeholders’ satisfaction
Provide proper user representation	P1, P5, P6, P35, P36	5	
Help developers empathise with the stakeholders	P2, P12, P24, P25, P32	5	Human-centric RE
Identify user requirements	P2, P7, P8, P12, P18, P20, P24, P28, P31, P32, P36, P44, P47, P51, P52, P56, P57, P59, P60, P63	20	
Complement other methods used in RE	P23, P29, P36, P52, P53, P56, P61, P63	8	
Validate the requirements	P36, P41, P56	3	
Communication tool between stakeholders and developers and also between developers	P9, P35, P36, P52, P63	5	
Used to help evaluate the design/model/prototype	P10, P13, P18, P32, P42	5	Support tasks and roles of developers in the RE/SE process
Facilitate risk mitigations	P22, P26, P37, P48	4	
Improve developers’ engagement throughout the development process	P3, P18, P21	3	
Reusable	P30, P45	2	
Support the tracing of user requirements	P32, P36	2	

We identify several benefits related to how personas ensure users’ and stakeholders’ satisfaction in RE. The first reported benefit is that personas can serve as a **proper tool that can represent actual users**. [P1] argues that personas as user models are able to synthesise relevant knowledge about the users. The study proposes a set of activities to collect data about the targeted users. The activities start by establishing hypotheses about possible users, conducting ethnographic interviews with the users, and analysing the interviews. The study uses the findings from the interviews to specify the behavioural attributes and possible values that can be assigned to the attributes, and to identify meaningful behaviour patterns. Next, the study synthesises the outcomes of previous activities and present the result as personas. From the selected studies, we also find that 31 publications argue that using personas in RE **supports a better understanding of the targeted users** of the proposed product. In a case study, [P60] uses personas to represent the end users (i.e., students) and to demonstrate how the users use the system. The finding of the study shows that personas help the developers to gain a better understanding of users’ needs. The study describes the user characteristics (using Persona Profile Document) and complements each created persona with a Viewpoint Document (describing how the persona interacts with the system in different environments). In addition, to provide a unified understanding, the study introduces Persona Ontology which shows the relationship between personas’ characteristics and the environment in which they are engaged. The findings of [P73] show that personas enable the developers to **empathise with the end users**. The study utilises personas to identify the potential complaints given by the users and the underlying reasons based on the developers’ empathy towards users’ pains, expectations, and dissatisfaction outlined in the personas.

Personas also contribute to bringing humans closer to the centre of RE. We find personas’ usefulness in **identifying user requirements** for the proposed product. For example, [P70] creates personas to represent special users (i.e., older adults and their caregivers) in South East Asia. The study derives the targeted users’ requirements from the created personas. Moreover, still in a specific culture-related study, [P64] introduces an emotion-informed requirements elicitation technique. The study uses personas including their emotional goals to elicit requirements from users with a specific health situation. In addition, [P50] uses personas to identify specific requirements (in this instance are privacy requirements). The study uses the identified requirements to facilitate users’ control over their personal information. [P41] also emphasises that it is necessary to identify the stakeholders’ business requirements. The study proposes a Business Context matrix to show the relationship between the business process (i.e., recruit, employment, salary) and properties of the business context (i.e., operator, organisation, product environment). The study also creates test scenarios from personas’ business perspectives to complement the matrix. Moreover, personas are able to capture tacit characteristics of the users, such as pain and emotional feelings.

From the selected studies, we identify that personas are helpful to **validate the requirements of the proposed product**. [P19], a study about secure

requirements engineering, uses personas to check the requirements’ usability by evaluating the persona’s efficiency in finding the task, observing the effectiveness of the task in fulfilling the persona’s goal, and persona’s satisfaction with the task. [P71] incorporates personas in a cognitive walkthrough to validate the requirements. The study uses personas to understand how two user groups (i.e., elderly users and general users) complete a set of identical tasks. The findings of this study are particularly beneficial to understand how the proposed product should cater for the needs of the special user groups (e.g., the older population).

Furthermore, we discover that personas are beneficial to support tasks and roles of the developers in the RE/SE process. Personas can be useful as a **communication tool during the software development process**. [P9] argues that personas contribute to building a common vision for the targeted users among the project team members. The study unifies different understandings from each project sub-team through discussion about personas used within the project. The study also mentions that having the personas described using non-technical language makes it easier to share a common understanding with the stakeholders of the developed product. Personas also **improve the developers’ engagement** during the development process. [P3] underpins this benefit when conducting a study about feedback acquisition. One of the findings demonstrates that personas help the developers to be more engaged with the development process. The experts (both from academia and industry) who assess the implementation of four created personas in the project stated that the engagement was improved by the way the personas were presented. Presenting personas in a rich fictional narrative makes the developers feel like they are working with real people. Moreover, we find that personas can be useful for **risk management**. As an example, [P37] utilises *Personae non Grata* (PnGs) to portray potential attackers of a system, including their actions, motivation for these actions, and their ability to perform the actions. PnGs present the frustrations that motivate the personas’ disruptive behaviour as well as the skills that enabled them to do the misconduct activity. This can help developers to predict system vulnerabilities and specify appropriate mitigation strategies. Another benefit of using personas in RE lies in their **reusability**. Personas are reusable to some extent regardless the criticism on being too context-dependent. [P45] introduces Sentire, a persona-based framework for RE in which calibrated personas are utilised. Calibrated personas are the previously created personas being reused in other projects. However, to make those personas relevant to the project, they must be calibrated. The calibration process involves end users and asks them to act as the personas to do a set of tasks. A statistical analysis of the users’ feedback on the given tasks is then conducted based on a hypothesis of new personas. Moreover, personas also help the developers **trace the decision-making process** regarding specifying user requirements. [P32] mentions that personas are used to justify the specified requirements. In addition, having scenarios to complement the personas make it easier for the developers to rationalise the discussion for the requirements based on persona characteristics instead of their assumptions.

**Answer to RQ2:** There are three positive outcomes from utilising personas in RE. First, personas promote stakeholders’ satisfaction with the proposed product. This outcome resulting from three reported benefits: (1) personas support better understanding of the end users; (2) personas provide proper user representation; and (3) personas help requirements engineers empathise with the stakeholders. Second, personas put humans as the focus of the software development process. Personas help requirements engineers to identify and validate user requirements. In addition, personas complement other methods used in RE. Third, personas support the developers to better do their tasks and roles in RE. This outcome resulting from the use of persona as communication tool in RE-related tasks and persona incorporation in software design evaluation. Personas also can help requirements engineers to mitigate issues occurred in RE and to trace user requirements. Furthermore, personas promote developers’ engagement throughout software development.

#### 4.4. RQ3: Challenges of incorporating personas in RE

Our third research question investigated the limitations of using personas in RE that have been reported in the literature. This included formulating a set of recommendations that can be considered to address the limitations identified.

##### 4.4.1. Identified limitations in personas’ incorporation in RE

From the selected studies, we identify 15 challenges to incorporating personas in RE (from 19 publications out of the 78 included studies). We also summarise eleven potential implications from the identified challenges (see Table 14).

One of the early activities in persona construction is getting to know the targeted users. [P30, P33, P63, P71] report that **difficulty accessing representative sample users** is a key challenge to this. Even though some studies argued that - to some extent - the sample users are sufficiently representative, it is still questionable whether they are able to represent all of the targeted population. An example of this challenge is when the personas have to represent a particular group of users, such as older mobile phone users [P33, P34] or people of a particular cultural background [P30, P63]. In addition to creating personas with diverse cultural backgrounds, [P63] identifies the challenge of writing a **concise persona description** without undermining relevant information. [P48] argues that implementing the personas in only a particular project domain and having a **small number of software developers** may also result in less coverage for the end users. [P3] reports the issue in persona validation activity. The study disregards end-users participation to validate the created personas and only relies on some experts’ point of view. As a result, there is a possibility that the personas cannot capture some aspects of the users they are representing. Furthermore, **project size** [P16, P44] and its **context** [P26, P28] can affect the flexibility of cross-domain utilisation of the created personas.

During persona construction, we also identify some key challenges in the literature. [P28] argues that there was a **lack of common standards** to construct

Table 14: Reported challenges during personas incorporation in RE

Reported challenges	Publications	Total	Negative Impacts
Difficulty accessing participants/data for a representable population	P30, P33, P34, P63, P71	5	Persona is less representative of the actual users
Difficulty creating a concise persona description	P63	1	
Small development team	P48	1	
Misalignment between persona creation and persona validation	P3	1	Not generalisable
Small scale project	P16, P44	2	
Limited context	P26, P28	2	
Existing assumptions of engineers	P2	1	Difficult to construct personas and unclear description
Lack of common standards	P28	1	
Developers have to add more steps in RE	P1, P32	2	
Expensive RE since it requires complex comparison and statistical computation	P13	1	Costly
Lack of motivation from participants	P58	1	Participants need to be incentivised to be involved in the project
Resultant personas are not memorable	P28	1	Difficult to distinguish personas during communication among the developers
Developers are not familiar with user-centric approach	P28	1	Limited to only using with developers who have familiarity with user-centric approach
Difficulty in distinguishing the role of each resultant persona	P35, P37	2	Misunderstood/Misinterpreted personas
Difficulty to elicit requirements from persona used in too broad product	P77	1	

personas. In addition, [P1] and [P32] report that utilising personas in RE implies to adding **extra activities**. Those additional activities are quite **expensive** [P13] since they require statistical analysis and comparison. Furthermore, [P58] reports that **lack of motivation** from the sample users challenges participants' recruitment. There are also identified issues in the personas' applicability in RE. [P28] reports that there is an issue in **memorising the personas**. In addition, [P35, P37] argue that **distinguishing the role of each persona** used in the project is an issue. [P28] also describes how incorporating personas in the project requires developers with **familiarity with using a user-centred approach**.

The aforementioned challenges result in some implications for the resultant personas and the construction process. We identify some influential factors contributing to the **representativeness of personas**: the selected users' insufficiency to represent the targeted population [P30, P33, P63]; the number of engineers creating the personas [P48]; the length limitation of persona description [P63]; and misunderstanding during the persona validation [P3]. Having personas implemented in a small project and a specific context can result in personas that are not **generalisable**. **Bias** and **subjectivity** during the persona construction can be an issue due to engineers' assumptions and pre-existing knowledge of the end-users [P2]. As mentioned in [P28], the lack of guidelines



also makes it difficult to **construct** and **articulate the personas**. Additionally, utilising personas inflicts a heavier workload in RE, and as a consequence, it becomes a **time-consuming** [P1, P32] and **costly** [P13] process. Furthermore, in [P58], if sample users are reluctant, there has to be motivation, usually in the form of some **incentive** for their participation in the persona construction process. The challenges during incorporating personas in RE also have consequences on implementing the personas throughout the process. For example, in [P28], the developers complain that memorising the personas is difficult, particularly when they have to **distinguish between personas** during discussions. Two studies [P35, P37] report that the developers also have difficulty distinguishing between the role of each persona used in the project and the consequence, which can lead to **misinterpretation** of the role of the personas.

#### 4.4.2. Mitigations of challenges in personas' incorporation in RE

Twelve publications of 78 selected studies mention measures to mitigate the identified challenges of using personas in RE. We identify 11 mitigation strategies to address five identified issues during personas incorporation in RE (Table 15). In addition to these identified strategies, we also identify 12 strategies from the selected studies which can potentially address five issues that occur during persona incorporation in RE. Table 16 summarises those actions.

Table 15: Reported mitigation strategies to address identified personas limitations

Issues to be addressed	Recommended mitigations	Publications
Less representative of actual users	Modify guiding questions in order to create more detail characteristics of the personas	P24
	Exploratory user research to identify the class of targeted users upon which the information will be gathered from	P28
	Recruit broader sample users	P71
	Use synthesised information to enrich the personas	P33
	Create either more specific or more generic personas	P14
Not generalisable	Keep personas dynamic by collecting further data	P51
	Create either more specific or more generic personas	P63
	Diverse research environment	P6, P30
Time consuming	Make a lighter version of personas' construction technique	P1
Persona validation	Involve users to participate on personas' validation process	P3
Lack of participants' motivation	Identify collaboration nature of the users; maintain users' privacy; and reward users' participation	P54

With regard to the issue of personas' representativeness, we find five publications [P14, P24, P28, P33, P71] suggesting several recommendations. For instance, [P24] proposes PATHY 2.0 and suggests **modifying the guiding questions** for filling information related to personal characteristics, living environment, experience with technology, problems along with existing solutions,

and needs, resulting in personas with more detailed characteristics. Moreover, to select appropriate user groups, [P28] recommends conducting **exploratory user research** in order to identify outliers (i.e., those not yet supported by existing solutions, indirect users). Six publications recommend mitigation strategies to make personas more generalisable. [P51] presents an example that emphasises the importance of **keeping the personas dynamic** by collecting further data through an upcoming survey to update the created personas. [P63], which focuses on creating personas with certain cultural backgrounds, suggests two approaches to making more general personas. One approach is **creating personas for each cultural background**, and another is **narrating the descriptions to be as general as possible** to represent multiple cultural groups. Interestingly, [P38] proposes **affordance-based personas**, which analyses the patterns of possible actions undertaken by users and uses them as the basis for the creation of personas. The study argues that this approach is able to create more generalisable personas compared to personas created using a qualitative approach. [P5], which introduces a framework to create child personas, recommends an approach that can be used in order to afford cross-domain usage of personas. The reusability of personas can be attained by **separating the personas** into context-free dimensions (i.e., data obtained from theoretical understanding) and a context-dependent one (i.e., data that is specific to the project). The context-free dimension of personas then can be reused for other contexts or domains.

Table 16: Recommendation for potential mitigation strategies

Issues to be addressed	Recommended mitigations	Publications
Not generalisable	Create personas based on users affordances	P38
	Create context-free dimension of personas	P5
Time consuming	Creating personas using a quantitative approach	P38
Not memorable	The influence of the choice of photograph	P33
	Add 'one-liner' in persona descriptions	P9
Lack of common standards/guidelines	Combination of Riegels-bergers' framework and Persona Case framework	P21
	PATHY 2.0	P24
	Modified version of Kim Goodwin's guideline	P5
	Modified version of 10 Steps to Personas	P9
	Modified version of Persona Technique	P1, P11, P12
	Persona-based method for Adaptive Feedback Acquisition	P3
Developers unfamiliarity with persona creation approach	Make use a decision diagram to select a suitable approach to create personas	P39

On the other hand, three publications recommend mitigation strategies with respect to issues occurring during persona construction. [P1] acknowledges that constructing personas can be time-consuming, hence suggesting formulating a

**lighter version for the persona construction framework.** The study indicates the possibility of scrapping two activities from their proposed framework to streamline the process. Those activities are: identifying significant behaviour patterns and implementing and evaluating prototypes. On the other hand, [P3] recommends better **involving end-users** when performing persona creation and validation activities. [P54] suggests three measures to motivate the users to participate in the construction of personas. First, **identifying the user preferences with respect to collaborating** in order to achieve certain goals; second, ensuring users' privacy will not be violated; and lastly, **rewarding** the users for their participation in the project. We also find several **frameworks and guidelines** from the selected studies which can be used to create personas. As an example, [P21] combines *Riegels-bergers's* framework [26] and *Persona Case* framework [27] to create personas. [P24] proposes *PATHY 2.0* to establish empathy toward the end users. Some studies modify existing persona construction approaches. For instance, three publications [P1, P11, P12] modify *Alan Coopers' Persona Technique*. Similarly, [P9] suggests additional steps to *Lene Nielsen's 10 Steps to Personas* method. Furthermore, [P5] creates personas using a modified version of *Kim Goodwin's guideline*. In order to create personas quantitatively, [P3] proposes a Persona-based method for *Adaptive Feedback Acquisition* (PAFA). The method is a modification of the existing *Mulder and Yaar's guideline*. Selecting a suitable approach can be troublesome for developers unfamiliar with the persona creation method. Therefore, [P39] suggests a decision diagram that is useful to determine the appropriate approach to construct personas for the elderly and children. In the decision-making process, the study considers the availability of existing data sources, developers' skills, data size, and available resources.

**Answer to RQ3:** The challenges of persona incorporation in RE lead to implications that can be reflected in the created personas. Criticisms towards personas are including not sufficiently representing the actual end users and not being used across domains or in different contexts or having too much bias and subjectivity based on pre-existing assumptions. There are also challenges during the personas' construction process, which have implications on creating personas and, later on, narrating the personas. Consequently, this can lead to adding more activities to create and evaluate personas; therefore, an increase in time and budget allocation can be an obstacle. Furthermore, we identify challenges during the persona implementation. The engineers complain about the difficulty of memorising personas and distinguishing their roles within the project. Also, personas incorporation requires particular skills from the engineers involved in the process. On the other hand, we also identify mitigation strategies from the selected studies. Some studies deliberately suggest those mitigations strategies to overcome reported personas limitations. However, these strategies only address half of the identified challenges and consequent implications. In addition, we identify several strategies from the selected studies that potentially address some of the reported challenges.

#### 4.5. Threats to validity

Even though we follow a well-acknowledged set of guidelines when conducting this SMS, we understand that our SMS process was exposed to some threats which may affect the result of the SMS. We describe the threats below, along with the associated mitigation strategies undertaken.

**Data source and search strategy.** We have to search different databases with their limitations regarding string length. The implication of this is that the search strategies were varied. Due to this variety, there is a possibility that we may not be able to find all possible related studies. Therefore, we derive different search strings for each database and checked the number resulting from each search string. We refine the search strings and repeat the routine until we receive the most reasonable number of related studies. We perform the Snowball method to find additional studies that may have been missed. However, there is still a chance of missing related studies published after we perform the selection process.

**Study selection.** We acknowledge a possibility of bias while selecting the studies for our SMS. Therefore, we follow Kitchenham and Charters guidelines [55] to define clear inclusion and exclusion criteria in order to minimise selection bias. All the authors are closely involved in executing the inclusion and exclusion criteria on a duplicate set of studies. When discrepancies occur, we discuss and resolve them to refine the study selection process.

**Data extraction and synthesis.** Different terms used in the selected studies make us use our assumptions when extracting and synthesising the information. As a result, some of the extracted results may be partially inaccurate. For an instance, most of the publications do not explicitly specify RE-related task(s) in where the personas used in. Therefore, all the authors refer to definition of key RE-related tasks in [2]. Moreover, all the authors extract the same set of several studies, discuss the differences and resolve it to reach a consensus.

## 5. Recommendations for future research directions

Based on the findings of this SMS, we identify several limitations related to personas incorporation in RE. We frame these limitations as a set of recommendations that will benefit the RE research community for future work in incorporating personas in RE. Need more investigation on exploring personas' incorporation in other RE-related tasks: Almost half of the selected studies focus on the use of personas in requirements elicitation-related activities only. The rest of the studies investigate personas' utilisation on the requirements specification, analysis, and validation. Conducting a research project on how personas can be incorporated into these three RE-related tasks would be valuable for both RE researchers and software practitioners.

**Need more investigation to craft a better approach to creating personas:** Among 78 reviewed studies, 61.5% use a qualitative approach in the personas' creation process. This approach involve a small number of stakeholders as the participants in activities such as interviews, brainstorming, workshop,

and focus group discussions. The small sample size of stakeholders involve in personas' creation is the reason for two identified limitations. First, the created personas are not generalisable. Secondly, the created personas are considered to be less representative. Therefore, there is an opportunity for more studies on a better approach to creating personas for use in RE.

**Need more studies on validating personas in use in RE:** Only 32% of primary studies mention how they validate the created personas. Most of the personas are validated qualitatively by conducting activities such as workshops, focus group discussions, and interviews. In order to enhance the trustworthiness of the created personas, more studies on investigating personas' validation are needed.

**Need more investigation on other human-centred approaches that can be used together with personas in RE:** Our findings show that persona is not a stand-alone tool. Based on the analysis of the primary studies, we identify human-centred approaches used together with personas, such as scenario, user story, viewpoint, and many more. Hence, there is a need to have more studies that investigate which human-centred approaches work best with personas to help the requirements engineers better understand the end-users of the proposed product.

**More studies are needed to discover persona limitations:** Twenty-four per cent of the selected studies reported challenges during the use of personas in RE. We discover that those challenges lead to several implications. Given this small number, new studies should do more investigation on this area to discover more limitations that will help RE researchers to set mitigation actions for better use of personas in RE.

**More studies to find and address persona's limitations when used in RE:** Our findings show that very few studies provide mitigation strategies on how to address reported persona's limitations when used in RE-related tasks. These strategies only address five identified issues during persona incorporation in RE. Given this situation, more investigations on practically addressing reported limitations of personas would benefit requirements engineers.

**Exploration of potential mitigation strategies to address persona limitations:** From the selected studies we discover that there are some strategies that can potentially mitigate the unaddressed issues. This give an opportunity for future research to explore these options and their effectiveness to address the issues that occur during persona incorporation in RE.

**More practical guidelines:** Based on our analysis of the selected primary studies, only a few studies present standardised methods or frameworks to create personas. Hence, more studies to provide a set of guidelines or frameworks on how to evaluate and validate personas are needed. Furthermore, our review shows that the reluctance to utilise personas in RE is due to unfamiliarity with the tool. In addition, no study investigates a set of practical guidelines on using personas in RE or SE. Therefore, there is an opportunity for more studies to set guidelines that can help RE practitioners to familiarise themselves with the concept of persona and implement it in RE. These practical guidelines, both for personas construction and implementation, will benefit requirements engineers

to comprehensively utilise personas in RE.

## 6. Conclusion

Our SMS aims to lay out how personas have been used in RE to-date, including methods to construct personas, benefits, and challenges during their application in RE. We review 78 studies related to the use of persona in RE, resulting in several findings. Personas are primarily used within the requirements elicitation-related activities to help the requirements engineers better understand the proposed product’s end-users, empathise with them, and identify their key requirements rather than using their own assumptions about what the users might need. A qualitative method is the most commonly used approach to construct and validate the persona, such as interviews, workshops, and focus group discussions. The created personas then are presented as text-based representations consisting of two types of information: generic and context-specific. In application in RE, there are human-centred tools used together with personas, such as scenarios. Personas on their own used in RE are not without potential flaws. We categorise these challenges during the persona construction (i.e., representing end-users in an unrepresentative manner, cannot be generalised) and challenges that occurred on its applicability in the real world (i.e., the unfamiliarity of the software development team towards persona’s concept, lack of practical guidelines).

Based on the key findings, we also identify gaps that can be useful for future research paths in RE. Most reviewed studies focus on personas’ utilisation in the requirements elicitation activity. Therefore, there is an opportunity to investigate the use of personas in other RE-relates tasks: analysis, specification, and validation of the requirements. In this SMS, we also identify personas’ construction and validation. We discover the limitation of the qualitative approach, a heavily used approach to creating and validating the personas, which indicates the need for more studies to better construct personas for use in RE. Moreover, through the SMS, we identify the reported objectives of using personas in RE and how personas benefit requirements engineers. In addition, from the primary studies, we also map the reported challenges of using personas in RE along with the measures to mitigate those problems. However, there are only a few studies investigating the limitations of personas and the recommendation to solve the problems.

The findings of our SMS will be beneficial to understanding personas incorporation in RE including the construction and applicability of personas. The research community can focus on the under-research area in regard to the better use of personas in RE. The outcome of the future research will also benefit requirements engineers in using personas to enhance the satisfaction of their targeted users.

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## References

- [1] A. Cooper, The inmates are running the asylum, The inmates are running the asylum : why high-tech products drive us crazy and how to restore the sanity, Indianapolis, Ind. : Sams Hemel Hempstead : Prentice Hall, Indianapolis, Ind. : Hemel Hempstead, 1999.
- [2] I. Sommerville, Software Engineering, Global Edition, Pearson Education Limited, Harlow, UNITED KINGDOM, 2016.
- [3] R. L. Yussof, H. Abas, T. N. S. T. Paris, Persona design analysis of digital storybook for remedial students, in: Proceedings of the International Conference on Science, Technology and Social Sciences (ICSTSS) 2012, Springer, 2014, pp. 739–750.
- [4] S.-H. Ho, C. J. Lin, The requirement analysis for developing the assisted living technology for the elderly, in: International Cognitive Cities Conference, Springer, 2019, pp. 563–568.
- [5] J. Cleland-Huang, A. Czauderna, E. Keenan, A persona-based approach for exploring architecturally significant requirements in agile projects, in: International Working Conference on Requirements Engineering: Foundation for Software Quality, Springer, 2013, pp. 18–33. doi:10.1007/978-3-642-37422-7\\_2.
- [6] C. LeRouge, J. Ma, User profiles and personas in consumer health technologies, in: 2010 43rd Hawaii International Conference on System Sciences, IEEE, 2010, pp. 1–10. doi:10.1109/HICSS.2010.426.
- [7] W. W. Sim, P. Brouse, Developing ontologies and persona to support and enhance requirements engineering activities – a case study, Procedia computer science 44 (2015) 275–284. doi:10.1016/j.procs.2015.03.060.
- [8] W. W. Sim, P. S. Brouse, Empowering requirements engineering activities with personas, Vol. 28, Elsevier, 2014, pp. 237–246. doi:10.1016/j.procs.2014.03.030.
- [9] S. Faily, C. Iacob, Design as code: Facilitating collaboration between usability and security engineers using cairis, in: 2017 IEEE 25th International Requirements Engineering Conference Workshops (REW), 2017, pp. 76–82. doi:10.1109/REW.2017.23.
- [10] G. Nunes Rodrigues, C. Joel Tavares, N. Watanabe, C. Alves, R. Ali, A persona-based modelling for contextual requirements, in: International Working Conference on Requirements Engineering: Foundation for Software Quality, Springer, 2018, pp. 352–368. doi:10.1007/978-3-319-77243-1\\_23.
- [11] M. Aoyama, Persona-and-scenario based requirements engineering for software embedded in digital consumer products, in: 13th IEEE International Conference on Requirements Engineering (RE'05), IEEE, 2005, pp. 85–94. doi:https://doi.org/10.1109/RE.2005.50.

- [12] A. A. Lopez-Lorca, T. Miller, S. Pedell, A. Mendoza, A. Keirnan, L. Sterling, One size doesn't fit all: diversifying" the user" using personas and emotional scenarios, in: Proceedings of the 6th International Workshop on Social Software Engineering, 2014, pp. 25–32. doi:<https://doi.org/10.1145/2661685.2661691>.
- [13] S. Abd Malik, M. Azuddin, Mobile technology for older people: Use of personas, in: 2013 International Conference on Research and Innovation in Information Systems (ICRIIS), IEEE, 2013, pp. 97–101. doi:<https://doi.org/10.1109/ICRIIS.2013.6716692>.
- [14] C. F. d. Araujo, P. T. Aquino Junior, Psychological personas for universal user modeling in human-computer interaction, in: International Conference on Human-Computer Interaction, Springer, 2014, pp. 3–13. doi:[https://doi.org/10.1007/978-3-319-07233-3\\_1](https://doi.org/10.1007/978-3-319-07233-3_1).
- [15] N. Tu, Q. He, T. Zhang, H. Zhang, Y. Li, H. Xu, Y. Xiang, Combine qualitative and quantitative methods to create persona, in: 2010 3rd International Conference on Information Management, Innovation Management and Industrial Engineering, Vol. 3, IEEE, 2010, pp. 597–603.
- [16] J. Jansen, S.-G. Jung, J. Salminen, K. Guan, L. Nielsen, Strengths and weaknesses of persona creation methods: Guidelines and opportunities for digital innovations, 2021. doi:10.24251/HICSS.2021.604.
- [17] B. J. Jansen, J. Soon-Gyo, L. Nielsen, K. W. Guan, J. Salminen, How to create personas: Three persona creation methodologies with implications for practical employment, Pacific Asia Journal of the Association for Information Systems 14 (3) (2022) 1. doi:<https://doi.org/10.17705/1pais.14301>.
- [18] C. Kolski, B. Warin, From Persona to Living Persona, Preliminary Data from a Pilot Study in HCI Education, Cham: Springer International Publishing, Cham, 2018, pp. 136–146. doi:10.1007/978-3-319-91743-6\_10.
- [19] L. Nielsen, Design personas - new ways, new contexts, Persona Studies 4 (2) (2018) 1–4. doi:10.21153/psj2018vol14no2art799.
- [20] A. Cooper, R. Reimann, D. Cronin, About Face 3 : The Essentials of Interaction Design, Wiley, Newark, UNITED STATES, 2007.
- [21] I. Alvertis, D. Papaspyros, S. Koussouris, S. Mouzakitis, D. Askounis, Using crowd-sourced and anonymized personas in the requirements elicitation and software development phases of software engineering, in: 2016 11th International Conference on Availability, Reliability and Security (ARES), IEEE, 2016, pp. 851–856. doi:10.1109/ARES.2016.71.
- [22] E. C. Groen, M. Koch, A. Maier, Vicus-a persona for towns: Towards innovation management through co-creation and predictive situation analytics., in: REFSQ Workshops, 2017.
- [23] S. Dirks, Persona design in participatory agile software development, in: International Conference on Human-Computer Interaction, Springer, 2020, pp. 52–64. doi:[https://doi.org/10.1007/978-3-030-60149-2\\_5](https://doi.org/10.1007/978-3-030-60149-2_5).
- [24] D. Ferreira, D. Melo, A. Santo, P. Silva, S. C. Soares, S. Silva, Stop anxiety: Tackling anxiety in the academic campus through an mhealth multidisciplinary user-centred approach, in: International Conference on Wireless Mobile Communication and Healthcare, Springer, 2019, pp. 112–126. doi:[https://doi.org/10.1007/978-3-030-49289-2\\_9](https://doi.org/10.1007/978-3-030-49289-2_9).
- [25] C. Li, Y. Yu, J. Leckning, W. Xing, C. L. Fong, J. Grundy, D. Karolita, J. McIntosh, H. O. Obie, A human-centric approach to building a smarter and better parking application, in: 2021 IEEE 45th Annual Computers, Software, and Applications Conference (COMPSAC), IEEE, 2021, pp. 514–519. doi:10.1109/COMPSAC51774.2021.00076.



- [26] B. Ferreira, S. Barbosa, T. Conte, Eliciting requirements using personas and empathy map to enhance the user experience, 2015. doi:10.1109/SBES.2015.14.
- [27] B. Ferreira, G. Santos, T. Conte, Identifying possible requirements using personas, in: 19th International Conference on Enterprise Information Systems, ICEIS 2017, April 26, 2017 - April 29, 2017, Vol. 2 of ICEIS 2017 - Proceedings of the 19th International Conference on Enterprise Information Systems, SciTePress, 2017, pp. 64–75. doi:10.5220/0006311600640075.
- [28] P. Forbrig, A. Dittmar, Applying agile methods and personas to s-bpm, in: Proceedings of the 11th International Conference on Subject-Oriented Business Process Management, Association for Computing Machinery, 2019, pp. 1–10. doi:https://doi.org/10.1145/3329007.3329010.
- [29] L. Nielsen, K. Storgaard Hansen, Personas is applicable: a study on the use of personas in denmark, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2014, pp. 1665–1674. doi:10.1145/2556288.2557080.
- [30] J. Castro, S. Acua, N. Juristo, Integrating the personas technique into the requirements analysis activity, in: 2008 Mexican International Conference on Computer Science, IEEE, 2008, pp. 104–112. doi:10.1109/ENC.2008.40.
- [31] F. Nunes, P. Silva, F. Abrantes, Human-computer interaction and the older adult: an example using user research and personas, in: Proceedings of the 3rd International Conference on pervasive technologies related to assistive environments, PETRA '10, ACM, 2010, pp. 1–8. doi:10.1145/1839294.1839353.
- [32] H. M. T. Tran, F. Anvari, D. Richards, Holistic personas and the five-dimensional framework to assist practitioners in designing context-aware accounting information system e-learning applications, in: Context-Aware Systems and Applications, and Nature of Computation and Communication, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, Springer International Publishing, Cham, 2018, pp. 184–194. doi:10.1007/978-3-319-77818-1\_18.
- [33] A. Caraban, L. Konstantinou, E. Karapanos, The Nudge Deck: A Design Support Tool for Technology-Mediated Nudging, Association for Computing Machinery, 2020, pp. 395–406. doi:10.1145/3357236.3395485.
- [34] F. Lachner, C. von Saucken, F. ‘Floyd’ Mueller, U. Lindemann, Cross-cultural user experience design helping product designers to consider cultural differences, in: Cross-Cultural Design Methods, Practice and Impact, Lecture Notes in Computer Science, Springer International Publishing, Cham, 2015, pp. 58–70.
- [35] C. Moser, V. Fuchsberger, M. Tscheligi, Using probes to create child personas for games, in: Proceedings of the 8th International Conference on advances in computer entertainment technology, ACE '11, ACM, 2011, pp. 1–8. doi:10.1145/2071423.2071472.
- [36] J. W. Castro, S. T. Acuña, Extension of personas technique for the requirements stage, in: International Symposium on Communicability, Computer-Graphics and Innovative Design for Interactive Systems, Lecture Notes in Computer Science, Springer, 2011, pp. 94–103. doi:10.1007/978-3-642-33760-4\_8.
- [37] A. Dittmar, P. Forbrig, Integrating personas and use case models, in: Human-Computer Interaction – INTERACT 2019, Lecture Notes in Computer Science, Springer International Publishing, Cham, 2019, pp. 666–686. doi:10.1007/978-3-030-29381-9\_40.
- [38] S. Faily, Engaging stakeholders in security design: An assumption-driven approach, 2014, pp. 21–29.

- [39] O. Adagha, S. Carpendale, R. M. Levy, Decision support requirements for wind farm placement planning in alberta, *Journal of Decision Systems* 24 (2) (2015) 178–205. doi:10.1080/12460125.2015.1046703.
- [40] M. Kifle, Y. Dittrich, D. Teka, Contextualizing user centered design with agile methods in ethiopia, in: 2017 IEEE AFRICON, IEEE, 2017, pp. 911–916. doi:10.1109/AFRCON.2017.8095603.
- [41] L. Rivero, C. Portela, J. Boaro, P. Santos, V. Rego, G. Braz Junior, A. Paiva, E. Alves, M. Oliveira, R. Moraes, M. Mendes, Lessons learned from applying requirements and design techniques in the development of a machine learning system for predicting lawsuits against power companies, in: *Human Interface and the Management of Information. Information Presentation and Visualization, Lecture Notes in Computer Science*, Springer International Publishing, Cham, 2021, pp. 227–243. doi:10.1007/978-3-030-78321-1\\_18.
- [42] W. W. Sim, P. Brouse, Towards an ontology-based persona-driven requirements and knowledge engineering, Vol. 36, Elsevier B.V, 2014, pp. 314–321. doi:10.1016/j.procs.2014.09.099.
- [43] N. T. Khanh, J. Daengdej, H. H. Arifin, Human stories: A new written technique in agile software requirements, in: *Proceedings of the 6th International Conference on Software and Computer Applications*, 2017, pp. 15–22.
- [44] N. N. B. Abdullah, J. Grundy, J. McIntosh, Y. C. How, S. Saharuddin, K. K. Tat, E. ShinYe, A. J. A. Rastom, N. L. Othman, Using work system design, user stories and emotional goal modeling for an mhealth system, in: 2020 IEEE First International Workshop on Requirements Engineering for Well-Being, Aging, and Health (REWBAH), 2020, pp. 1–10. doi:10.1109/REWBAH51211.2020.00007.
- [45] M. Almaliki, C. Ncube, R. Ali, Adaptive software-based feedback acquisition: A persona-based design, in: 2015 IEEE 9th International Conference on Research Challenges in Information Science (RCIS), IEEE, 2015, pp. 100–111. doi:10.1109/RCIS.2015.7128868.
- [46] M. Aoyama, Persona-scenario-goal methodology for user-centered requirements engineering, in: 15th IEEE International Requirements Engineering Conference (RE 2007), IEEE, 2007, pp. 185–194. doi:10.1109/RE.2007.50.
- [47] A. N. Antle, Child-based personas: Need, ability and experience, *Cognition, Technology and Work* 10 (2) (2008) 155–166. doi:10.1007/s10111-007-0071-2.
- [48] C. Moser, V. Fuchsberger, K. Neureiter, W. Sellner, M. Tscheligi, Revisiting personas: The making-of for special user groups, in: *CHI '12 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '12, Association for Computing Machinery, New York, NY, USA, 2012, p. 453–468. doi:https://doi.org/10.1145/2212776.2212822.
- [49] J. McIntosh, X. Du, Z. Wu, G. Truong, Q. Ly, R. How, S. Viswanathan, T. Kanij, Evaluating age bias in e-commerce, in: 2021 IEEE/ACM 13th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE), IEEE, 2021, pp. 31–40. doi:10.1109/CHASE52884.2021.00012.
- [50] S. Abd Malik, A. D. Edwards, Investigation of cultural dependency in mobile technology and older adults, in: *CHI'10 Extended Abstracts on Human Factors in Computing Systems*, 2010, pp. 3835–3840.
- [51] K. Schafer, P. Rasche, C. Brohl, S. Theis, L. Barton, C. Brandl, M. Wille, V. Nitsch, A. Mertens, Survey-based personas for a target-group-specific consideration of elderly end users of information and communication systems in the german health-care sector, *International Journal of Medical Informatics* 132 (2019). doi:10.1016/j.ijmedinf.2019.07.003.

- [52] A. Queirós, A. G. Silva, P. Simões, C. Santos, C. Martins, N. P. da Rocha, M. Rodrigues, Smartwalk: Personas and scenarios definition and functional requirements, in: 2018 2nd International Conference on Technology and Innovation in Sports, Health and Wellbeing (TISHW), IEEE, 2018, pp. 1–7. doi:10.1109/TISHW.2018.8559574.
- [53] A. Teixeira, F. Ferreira, N. Almeida, S. Silva, A. F. Rosa, J. C. Pereira, D. Vieira, Design and development of medication assistant: older adults centred design to go beyond simple medication reminders, *Universal Access in the Information Society* 16 (3) (2017) 545–560. doi:10.1007/s10209-016-0487-7.
- [54] L. Nielsen, K. S. Nielsen, J. Stage, J. Billestrup, Going global with personas, in: *Human-Computer Interaction – INTERACT 2013*, Vol. 8120 of *Lecture Notes in Computer Science*, Springer Berlin Heidelberg, Berlin, Heidelberg, 2013, pp. 350–357. doi:10.1007/978-3-642-40498-6\_27.
- [55] P. Björndal, M. J. Rissanen, S. Murphy, Lessons learned from using personas and scenarios for requirements specification of next-generation industrial robots, in: *Design, User Experience, and Usability. Theory, Methods, Tools and Practice*, Vol. 6769 of *Lecture Notes in Computer Science*, Springer Berlin Heidelberg, Berlin, Heidelberg, 2011, pp. 378–387. doi:10.1007/978-3-642-21675-6\_44.
- [56] E.-M. Schön, J. Thomaschewski, M. J. Escalona, Agile requirements engineering: A systematic literature review, *Computer standards and interfaces* 49 (2017) 79–91. doi:10.1016/j.csi.2016.08.011.
- [57] P. Losana, J. W. Castro, X. Ferre, E. Villalba-Mora, S. T. Acuna, A systematic mapping study on integration proposals of the personas technique in agile methodologies, *Sensors (Basel, Switzerland)* 21 (18) (2021) 6298. doi:10.3390/s21186298.
- [58] J. Salminen, K. Guan, S.-G. Jung, S. Chowdhury, B. J. Jansen, A literature review of quantitative persona creation, in: *Conference on Human Factors in Computing Systems - Proceedings, CHI '20*, ACM, 2020, pp. 1–14. doi:10.1145/3313831.3376502.
- [59] J. Salminen, K. Guan, S.-G. Jung, B. J. Jansen, A survey of 15 years of data-driven persona development, *International Journal of Human-Computer Interaction* 37 (18) (2021) 1685–1708.
- [60] K. Ba, S. Charters, Guidelines for performing systematic literature reviews in software engineering 2 (2007).
- [61] G. Hofstede, J. G. Draguns, Culture’s consequences: comparing values, behaviors, institutions, and organizations across nations, *Reviews in anthropology* 36 (1) (2007) 43–58.
- [62] S. E. Toulmin, *The Uses of Argument*, 2nd Edition, Cambridge : Cambridge University Press, Cambridge, 2003.
- [63] M. Price, Circle of care modelling: an approach to assist in reasoning about healthcare change using a patient-centric system, *BMC Health Services Research* 16 (1) (2016) 546. doi:10.1186/s12913-016-1806-7.
- [64] S. Faily, C. Iacob, R. Ali, D. Ki-Aries, Visualising personas as goal models to find security tensions, *Information and Computer Security* 29 (5) (2021) 787–815. doi:10.1108/ICS-03-2021-0035.
- [65] J. Riegelsberger, M. A. Sasse, J. D. McCarthy, The mechanics of trust: A framework for research and design, *International journal of human-computer studies* 62 (3) (2005) 381–422. doi:10.1016/j.ijhcs.2005.01.001.
- [66] S. Faily, I. Flechais, Persona cases: a technique for grounding personas, in: *Conference on Human Factors in Computing Systems - Proceedings, CHI '11*, ACM, 2011, pp. 2267–2270. doi:10.1145/1978942.1979274.

- [67] J. Cleland-Huang, R. Settimi, X. Zou, P. Solc, Automated classification of non-functional requirements, *Requirements engineering* 12 (2) (2007) 103–120. doi:10.1007/s00766-007-0045-1.
- [68] R. D. Luce, J. W. Tukey, Simultaneous conjoint measurement: A new type of fundamental measurement, *Journal of mathematical psychology* 1 (1) (1964) 1–27.
- [69] S. Faily, I. Fléchais, The secret lives of assumptions: Developing and refining assumption personas for secure system design, in: *Human-Centred Software Engineering*, Vol. 6409 of *Lecture Notes in Computer Science*, Springer Berlin Heidelberg, Berlin, Heidelberg, 2010, pp. 111–118. doi:10.1007/978-3-642-16488-0\\_9.
- [70] R. Halvorsrud, K. Kvale, A. Følstad, Improving service quality through customer journey analysis, *Journal of service theory and practice* (2016).

## Appendix A. Data extractions questions

### Details of the publication

1. Publication ID
2. Publication title
3. Published year
4. Venue (name of the journal/conference published)
5. Venue reputation
6. Author’s affiliation
7. Number of citations of the study
8. Abstract of the publication

### Domain and motivation of the study

1. Application domain of the study
2. Aim/motivation/goal of the study
3. Key research problems that are addressed in the study

### Personas in RE

1. The key RE-related task(s) where personas are used in the study
2. The reason(s) given for using personas during these phases of the RE
3. Does the study identify the most affected RE or other SE-related task(s) by personas?
  - Yes
  - No
4. If Yes, what are the most affected RE or other SE-related task(s) by personas?
5. What kinds of personas were used in the study?
6. How many different personas were used in the study?
7. The techniques/methods that have been used in the study to create the personas
8. How were the personas defined/described/modelled in the study?
9. What human-centric issues were captured in personas?
10. Are there any methods used in the study in addition to personas?
11. How were the personas validated/evaluated in the study?

### Result of the study

1. Is the study conducted in academia or industry?
2. What were the research method(s) used in the study?
  - Theoretical analysis
  - Conceptual model development

- Application to developing a case study
  - Building a software system
  - Evaluation using heuristics
  - Evaluation using students
  - Evaluation using real world end users
  - Other
3. How many is the number of participants used in the study?
  4. The benefits of using personas stated in the study
  5. The limitations or problems relating to the personas that were recorded in the study
  6. Recommendations for improving/extending the personas that were reported in the study
  7. Any other observations or comments of interest from the study
  8. The key research gaps/future work identified in the study

## Appendix B. List of Selected Studies

- [P1] Acuña, Silvia T, Castro, John W, & Juristo, Natalia. (2012). A HCI technique for improving requirements elicitation. *Information and Software Technology*, 54(12), 1357–1375. <https://doi.org/10.1016/j.infsof.2012.07.011>
- [P2] Adagha, Ovo, Carpendale, Sheelagh, & Levy, Richard M. (2015). Decision support requirements for wind farm placement planning in Alberta. *Journal of Decision Systems*, 24(2), 178–205. <https://doi.org/10.1080/12460125.2015.1046703>
- [P3] Almaliki, Malik, Ncube, Cornelius, & Ali, Raian. (2015). Adaptive software-based Feedback Acquisition: A Persona-based design. 2015 IEEE 9th International Conference on Research Challenges in Information Science (RCIS), 100–111. <https://doi.org/10.1109/RCIS.2015.7128868>
- [P4] Alvertis, Iosif, Papaspyros, Dimitris, Koussouris, Sotiris, Mouzakis, Spyros, & Askounis, Dimitris. (2016). Using Crowdsourced and Anonymized Personas in the Requirements Elicitation and Software Development Phases of Software Engineering. 2016 11th International Conference on Availability, Reliability and Security (ARES), 851–856. <https://doi.org/10.1109/ARES.2016.71>
- [P5] Antle, Alissa N. (2007). Child-based personas: need, ability and experience. *Cognition, Technology & Work*, 10(2), 155–166. <https://doi.org/10.1007/s10111-007-0071-2>
- [P6] Aoyama, M. (2005). Persona-and-scenario based requirements engineering for software embedded in digital consumer products. 13th IEEE International Conference on Requirements Engineering (RE'05), 85–94. <https://doi.org/10.1109/RE.2005.50>
- [P7] Aoyama, M. (2007, October). Persona-scenario-goal methodology for user-centered requirements engineering. In 15th IEEE International Requirements Engineering Conference (RE 2007) (pp. 185-194). IEEE.
- [P8] Barré, Jessy, Buisine, Stéphanie, & Aoussat, Améziane. (2018). Persona logical thinking: improving requirements elicitation for multidisciplinary teams. *CoDesign*, 14(3), 218–237. <https://doi.org/10.1080/15710882.2017.1301959>
- [P9] Björndal, Petra, Rissanen, Mikko J., & Murphy, Steve. (n.d.). Lessons Learned from Using Personas and Scenarios for Requirements Specification of Next-Generation Industrial Robots. *Design, User Experience, and Usability. Theory, Methods, Tools and Practice*, 378–387.
- [P10] Bowles, J.B. (2007). The Personification of Reliability, Safety, and Security. 2007 Annual

Reliability and Maintainability Symposium, 161–166. <https://doi.org/10.1109/RAMS.2007.328118>

[P11] Castro, John W., & Acuña, Silvia T. (n.d.). Extension of Personas Technique for the Requirements Stage. In *Communicability, Computer Graphics and Innovative Design for Interactive Systems* (pp. 94–103). Springer Berlin Heidelberg.

[P12] Castro, J.W, Acua, S.T, & Juristo, N. (2008). Integrating the Personas Technique into the Requirements Analysis Activity. 2008 Mexican International Conference on Computer Science, 104–112. <https://doi.org/10.1109/ENC.2008.40>

[P13] Cleland-Huang, Jane, Czauderna, Adam, & Keenan, Ed. (n.d.). A Persona-Based Approach for Exploring Architecturally Significant Requirements in Agile Projects. In *Requirements Engineering: Foundation for Software Quality* (pp. 18–33). Springer Berlin Heidelberg.

[P14] de Araujo, Caio Felix,& Aquino Junior, Plinio Thomaz. (n.d.). Psychological Personas for Universal User Modeling in Human-Computer Interaction. In *Human-Computer Interaction. Theories, Methods, and Tools* (pp. 3–13). Springer International Publishing.

[P15] Dittmar, Anke,& Forbrig, Peter. (2019). Integrating Personas and Use Case Models. In *Human-Computer Interaction – INTERACT 2019* (pp. 666–686). Springer International Publishing.

[P16] Dittmar, Anke,& Hensch, Maximilian. (2015). Two-Level Personas for Nested Design Spaces. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 3265–3274. <https://doi.org/10.1145/2702123.2702168>

[P17] Dodge, Jonathan, Hilton, Michael, Metoyer, Ronald, Hunter, Josie, Smeltzer, Karl, Vijay, Catharina,& Atkinson, Andrew. (2017). Deriving Age Diverse Personas from a Participatory Design Study on Home Electricity Feedback. *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 959–968. <https://doi.org/10.1145/3027063.3053354>

[P18] Faily, S. (2014). Engaging Stakeholders in Security Design: An Assumption-Driven Approach.

[P19] Faily, Shamal,& Fléchais, Ivan. (2010). A meta-model for usable secure requirements engineering. *Proceedings of the 2010 ICSE Workshop on Software Engineering for Secure Systems*, 29–35. <https://doi.org/10.1145/1809100.1809105>

[P20] Faily, Shamal,& Fléchais, Ivan. (n.d.). The Secret Lives of Assumptions: Developing and Refining Assumption Personas for Secure System Design. *Human-Centred Software Engineering*, 111–118.

[P21] Faily, Shamal,& Fléchais, Ivan. (2014). Eliciting and visualising trust expectations using persona trust characteristics and goal models. *Proceedings of the 6th International Workshop on Social Software Engineering*, 17–24. <https://doi.org/10.1145/2661685.2661690>

[P22] Faily, S.,& Iacob, C. (2017, September). Design as code: facilitating collaboration between usability and security engineers using CAIRIS. In *2017 IEEE 25th International Requirements Engineering Conference Workshops (REW)* (pp. 76–82). IEEE.

[P23] Faily, Shamal,& Lyle, John. (2013). Guidelines for integrating personas into software engineering tools. *Proceedings of the 5th ACM SIGCHI Symposium on Engineering Interactive Computing Systems*, 69–74. <https://doi.org/10.1145/2494603.2480318>

[P24] Ferreira, B., Santos, G.,& Conte, T. (2017). Identifying Possible Requirements using Personas.

- [P25] Forbrig, Peter,& Dittmar, Anke. (2019). Applying agile methods and personas to S-BPM. Proceedings of the 11th International Conference on Subject-Oriented Business Process Management, 1–10. <https://doi.org/10.1145/3329007.3329010>
- [P26] Groen, E. C., Koch, M.,& Maier, A. (2017). Vicus-A Persona for Towns: Towards Innovation Management through Co-Creation and Predictive Situation Analytics. In REFSQ Workshops.
- [P27] Hosono, S., Hasegawa, M., Hara, T., Shimomura, Y.,& Arai, T. (2009). A methodology of persona-centric service design. In Proceedings of the 19th CIRP Design Conference–Competitive Design. Cranfield University Press.
- [P28] Idoughi, Djilali, Seffah, Ahmed,& Kolski, Christophe. (2012). Adding user experience into the interactive service design loop: a persona-based approach. Behaviour& Information Technology, 31(3), 287–303. <https://doi.org/10.1080/0144929X.2011.563799>
- [P29] Khanh, N. T., Daengdej, J.,& Arifin, H. H. (2017, February). Human stories: A new written technique in agile software requirements. In Proceedings of the 6th International Conference on Software and Computer Applications (pp. 15-22).
- [P30] Lachner, Florian, von Saucken, Constantin, ‘Floyd’ Mueller, Florian,& Lindemann, Udo. (2015). Cross-Cultural User Experience Design Helping Product Designers to Consider Cultural Differences. In Cross-Cultural Design Methods, Practice and Impact (pp. 58–70). Springer International Publishing.
- [P31] LeRouge, C,& Jiao Ma. (2010). User Profiles and Personas in Consumer Health Technologies. 2010 43rd Hawaii International Conference on System Sciences, 1–10. <https://doi.org/10.1109/HICSS.2010.426>
- [P32] Lopez-Lorca, Antonio A, Miller, Tim, Pedell, Sonja, Mendoza, Antonette, Keirnan, Alen,& Sterling, Leon. (2014). One size doesn’t fit all: diversifying ”the user” using personas and emotional scenarios. Proceedings of the 6th International Workshop on Social Software Engineering, 25–32. <https://doi.org/10.1145/2661685.2661691>
- [P33] Malik, Sofianiza Abd,& Azuddin, Muna. (2013). Mobile technology for older people: Use of personas. 2013 International Conference on Research and Innovation in Information Systems (ICRIIS), 97–101. <https://doi.org/10.1109/ICRIIS.2013.6716692>
- [P34] Abd Malik, Sofianiza,& Edwards, Alistair. (2010). Investigation of cultural dependency in mobile technology and older adults. CHI ’10 Extended Abstracts on Human Factors in Computing Systems, 3835–3840. <https://doi.org/10.1145/1753846.1754065>
- [P35] Markensten, Erik,& Artman, Henrik. (2004). Procuring a usable system using unemployed personas. ACM International Conference Proceeding Series; Vol. 82: Proceedings of the Third Nordic Conference on Human-Computer Interaction; 23-27 Oct. 2004, 13–22. <https://doi.org/10.1145/1028014.1028017>
- [P36] Mayas, Cindy, Hörold, Stephan,& Krömker, Heidi. (2016). Personas for Requirements Engineering. In Usability- and Accessibility-Focused Requirements Engineering (pp. 34–46). Springer International Publishing.
- [P37] Mead, Nancy, Shull, Forrest, Spears, Janine, Heibl, Stefan, Weber, Sam,& Cleland-Huang, Jane. (2017). Crowd Sourcing the Creation of Personae Non Gratae for Requirements-Phase Threat Modeling. 2017 IEEE 25th International Requirements Engineering Conference (RE), 412–417. <https://doi.org/10.1109/RE.2017.63>
- [P38] Mesgari, Mostafa, Okoli, Chitu,& de Guinea, Ana Ortiz. (2019). Creating Rich and Representative Personas by Discovering Affordances. IEEE Transactions on Software Engi-

neering, 45(10), 967–983. <https://doi.org/10.1109/TSE.2018.2826537>

[P39] Moser, Christiane, Fuchsberger, Verena, Neureiter, Katja, Sellner, Wolfgang,& Tscheligi, Manfred. (2012). Revisiting personas. CHI '12 Extended Abstracts on Human Factors in Computing Systems, 453–468. <https://doi.org/10.1145/2212776.2212822>

[P40] Moser, Christiane, Fuchsberger, Verena,& Tscheligi, Manfred. (2011). Using probes to create child personas for games. Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology, 1–8. <https://doi.org/10.1145/2071423.2071472>

[P41] Nomura, Norifumi, Kikushima, Yasuhiro,& Aoyama, Mikio. (2014). A Test Scenario Design Methodology Based on Business Context Modeling and Its Evaluation. 2014 21st Asia-Pacific Software Engineering Conference, 1, 3–10. <https://doi.org/10.1109/APSEC.2014.10>

[P42] Nunes, Francisco, Silva, Paula,& Abrantes, Filipe. (2010). Human-computer interaction and the older adult. Proceedings of the 3rd International Conference on Pervasive Technologies Related to Assistive Environments, 1–8. <https://doi.org/10.1145/1839294.1839353>

[P43] Nunes Rodrigues, Genáina, Joel Tavares, Carlos, Watanabe, Naiara, Alves, Carina,& Ali, Raian. (2018). A Persona-Based Modelling for Contextual Requirements. In Requirements Engineering: Foundation for Software Quality (pp. 352–368). Springer International Publishing.

[P44] O’Flaherty, Brian& Pope, Andrew& thornton, colm& Woodworth, Simon. (2013). Capturing multi-stakeholder needs in Customer-Centric Cloud Service Design. International Conference on Information Systems (ICIS 2013): Reshaping Society Through Information Systems Design. 1.

[P45] Porter, Chris, Letier, Emmanuel,& Sasse, M. Angela. (2014). Building a National E-Service using Sentire experience report on the use of Sentire: A volere-based requirements framework driven by calibrated personas and simulated user feedback. 2014 IEEE 22nd International Requirements Engineering Conference (RE), 374–383. <https://doi.org/10.1109/RE.2014.6912288>

[P46] Price, Morgan. (2016). Circle of care modelling: an approach to assist in reasoning about healthcare change using a patient-centric system. BMC Health Services Research, 16(1), 546–546. <https://doi.org/10.1186/s12913-016-1806-7>

[P47] Queirós, A., Silva, A. G., Simões, P., Santos, C., Martins, C., da Rocha, N. P.,& Rodrigues, M. (2018, June). SmartWalk: Personas and scenarios definition and functional requirements. In 2018 2nd International Conference on Technology and Innovation in Sports, Health and Wellbeing (TISHW) (pp. 1-7). IEEE.

[P48] Rahimi, Mona,& Cleland-Huang, Jane. (2014). Personas in the middle. Proceedings of the 29th ACM/IEEE International Conference on Automated Software Engineering, 479–484. <https://doi.org/10.1145/2642937.2642958>

[P49] Rönkkö, Kari, Hellman, Mats, Kilander, Britta,& Dittrich, Yvonne. (2004). Personas is not applicable. Participatory Design: Proceedings of the Eighth Conference on Participatory Design: Artful Integration: Interweaving Media, Materials and Practices - Volume 1; 27-31 July 2004, 1, 112–120. <https://doi.org/10.1145/1011870.1011884>

[P50] Rudolph, Manuel, Polst, Svenja,& Doerr, Joerg. (2019). Enabling Users to Specify Correct Privacy Requirements. In Requirements Engineering: Foundation for Software Quality (pp. 39–54). Springer International Publishing.

[P51] Schäfer, Katharina, Rasche, Peter, Bröhl, Christina, Theis, Sabine, Barton, Laura, Brandl, Christopher, Wille, Matthias, Nitsch, Verena,& Mertens, Alexander. (2019). Survey-



based personas for a target-group-specific consideration of elderly end users of information and communication systems in the German health-care sector. *International Journal of Medical Informatics* (Shannon, Ireland), 132, 103924–103924. <https://doi.org/10.1016/j.ijmedinf.2019.07.003>

[P52] Schneidewind, Lydia, Hörold, Stephan, Mayas, Cindy, Krömker, Heidi, Falke, Sascha, & Pucklitsch, Tony. (2012). How personas support requirements engineering. 2012 First International Workshop on Usability and Accessibility Focused Requirements Engineering (UsARE), 1–5. <https://doi.org/10.1109/UsARE.2012.6226786>

[P53] Sedeño, J., Schön, E. M., Torrecilla Salinas, C. J., Thomaschewski, J., Escalona Cuaresma, M. J., & Mejías Risoto, M. (2017). Modelling agile requirements using context-based persona stories. In *WEBIST 2017: 13th International Conference on Web Information Systems and Technologies* (2017), p 196-203. ScitePress Digital Library.

[P54] Shahri, Alimohammad, Hosseini, Mahmood, Almaliki, Malik, Phalp, Keith, Taylor, Jacqui, & Ali, Raian. (2016). Engineering software-based motivation: A persona-based approach. 2016 IEEE Tenth International Conference on Research Challenges in Information Science (RCIS), 1–12. <https://doi.org/10.1109/RCIS.2016.7549312>

[P55] Sim, Wee Wee, & Brouse, Peggy. (2014). Towards an Ontology-based Persona-driven Requirements and Knowledge Engineering. *Procedia Computer Science*, 36, 314–321. <https://doi.org/10.1016/j.procs.2014.09.099>

[P56] Sim, Wee Wee, & Brouse, Peggy S. (2014). Empowering Requirements Engineering Activities with Personas. *Procedia Computer Science*, 28, 237–246. <https://doi.org/10.1016/j.procs.2014.03.030>

[P57] Teixeira, António, Ferreira, Flávio, Almeida, Nuno, Silva, Samuel, Rosa, Ana Filipa, Pereira, José Casimiro, & Vieira, Diogo. (2016). Design and development of Medication Assistant: older adults centred design to go beyond simple medication reminders. *Universal Access in the Information Society*, 16(3), 545–560. <https://doi.org/10.1007/s10209-016-0487-7>

[P58] Kifle, Mesfin, Dittrich, Yvonne, & Teka, Degif. (2017). Contextualizing user centered design with agile methods in Ethiopia. 2017 IEEE AFRICON, 911–916. <https://doi.org/10.1109/AFRCON.2017.8095603>

[P59] Tran, Hien Minh Thi, Anvari, Farshid, & Richards, Deborah. (2018). Holistic Personas and the Five-Dimensional Framework to Assist Practitioners in Designing Context-Aware Accounting Information System e-Learning Applications. In *Context-Aware Systems and Applications, and Nature of Computation and Communication* (Vol. 217, pp. 184–194). Springer International Publishing.

[P60] Sim, Wee Wee, & Brouse, Peggy. (2015). Developing Ontologies and Persona to Support and Enhance Requirements Engineering Activities – A Case Study. *Procedia Computer Science*, 44(C), 275–284. <https://doi.org/10.1016/j.procs.2015.03.060>

[P61] Yu, Der-Jang, & Lin, Wen-Chi. (2009). Facilitating Idea Generation Using Personas. In *Human Centered Design* (Vol. 5619, pp. 381–388). Springer Berlin Heidelberg.

[P62] Zimmermann, Gottfried, & Vanderheiden, Gregg. (2007). Accessible design and testing in the application development process: considerations for an integrated approach. *Universal Access in the Information Society*, 7(1-2), 117–128. <https://doi.org/10.1007/s10209-007-0108-6>

[P63] Nielsen, Lene, Nielsen, Kira Storgaard, Stage, Jan, & Billestrup, Jane. (2013). Going Global with Personas. *Human-Computer Interaction – INTERACT 2013*, 8120(4), 350–357.

[P64] Abdullah, N. N. B., Grundy, J., McIntosh, J., How, Y. C., Saharuddin, S., Tat, K. K., ... & Othman, N. L. (2020, August). Using work system design, user stories and emotional goal modeling for an mHealth system. In *2020 IEEE First International Workshop on Re-*

quirements Engineering for Well-Being, Aging, and Health (REWBAH) (pp. 1-10). IEEE.

[P65] Askarbekuly, Nursultan, Solovyov, Alexandr, Lukyanchikova, Elena, Pimenov, Denis,& Mazzara, Manuel. (2021). Building an Educational Product: Constructive Alignment and Requirements Engineering. In *Advances in Artificial Intelligence, Software and Systems Engineering* (Vol. 271, pp. 358-365). Springer International Publishing.

[P66] Dirks, Susanne. (2020). Persona Design in Participatory Agile Software Development. In *HCI International 2020 – Late Breaking Papers: Universal Access and Inclusive Design* (Vol. 12426, pp. 52-64). Springer International Publishing.

[P67] Faily, Shamal, Iacob, Claudia, Ali, Raian,& Ki-Aries, Duncan. (2021). Visualising personas as goal models to find security tensions. *Information and Computer Security*, 29(5), 787-815. <https://doi.org/10.1108/ICS-03-2021-0035>

[P68] Ferreira, David, Melo, Daniela, Santo, Andreia, Silva, Pedro, Soares, Sandra C.,& Silva, Samuel. (2020). Stop Anxiety: Tackling Anxiety in the Academic Campus Through an mHealth Multidisciplinary User-Centred Approach. In *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST* (Vol. 320, pp. 112-126). Springer International Publishing.

[P69] Abdullah, N. N. B., Grundy, J., McIntosh, J., How, Y. C., Saharuddin, S., Tat, K. K., ...& Othman, N. L. (2020, August). Using work system design, user stories and emotional goal modeling for an mHealth system. In *2020 IEEE First International Workshop on Requirements Engineering for Well-Being, Aging, and Health (REWBAH)* (pp. 1-10). IEEE.

[P70] Ho, Sui-Hua,& Lin, Chiuhsiang Joe. (2020). The Requirement Analysis for Developing the Assisted Living Technology for the Elderly. In *Cognitive Cities* (Vol. 1227, pp. 563-568). Springer Singapore.

[P71] McIntosh, Jennifer, Du, Xiaojiao, Wu, Zexian, Truong, Giahuy, Ly, Quang, How, Richard, Viswanathan, Sriram,& Kanij, Tanjila. (2021). Evaluating Age Bias In E-commerce. *2021 IEEE/ACM 13th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE)*, 31-40. <https://doi.org/10.1109/CHASE52884.2021.00012>

[P72] Pakhtusova, Y., Megha, S.,& Askarbekuly, N. (2021, June). A Case Study on Combining Agile and User-Centered Design. In *International Conference on Frontiers in Software Engineering* (pp. 47-62). Springer, Cham.

[P73] Rivero, Luis, Portela, Carlos, Boaro, José, Santos, Pedro, Rego, Venicius, Braz Junior, Geraldo, Paiva, Anselmo, Alves, Erika, Oliveira, Milton, Moraes, Renato,& Mendes, Marina. (2021). Lessons Learned from Applying Requirements and Design Techniques in the Development of a Machine Learning System for Predicting Lawsuits Against Power Companies. In *Human Interface and the Management of Information. Information Presentation and Visualization* (Vol. 12765, pp. 227-243). Springer International Publishing.

[P74] Spieler, B., Krnjic, V., Slany, W., Horneck, K.,& Neudorfer, U. (2020, October). Design, Code, Stitch, Wear, and Show It! Mobile Visual Pattern Design in School Contexts. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE.

[P75] Zanutdin, N. N., Sulaiman, S., Samingan, M. R., Mohamed, H.,& Raof, S. K. S. A. (2021, June). Case Study on Prototyping Educational Applications Using Persona-Based Approach. In *2021 8th International Conference on Computer and Communication Engineering (ICCCE)* (pp. 93-98). IEEE.

[P76] Oliveira, Victor Adriel & Rottermann, Gernot & Größbacher, Stefanie & Boucher, Magdalena & Judmaier, Peter. (2022). Requirements and Concepts for Interactive Media

Retrieval User Interfaces. 1-10. 10.1145/3546155.3546701.

[P77] Madeline J Halletwell, Nancy Hughes, David R Large, Catherine Harvey, James Springthorpe, and Gary Burnett. 2022. Deriving personas to inform HMI design for future autonomous taxis: a case study on user requirement elicitation. *J. Usability Studies* 17, 2 (February 2022), 41–64.

[P78] Forbrig, P., Dittmar, A. (2022). Cross-Pollination of Personas, User Stories, Use Cases and Business-Process Models. In: Babkin, E., Barjis, J., Malyzhenkov, P., Merunka, V. (eds) *Model-Driven Organizational and Business Agility. MOBA 2022. Lecture Notes in Business Information Processing*, vol 457. Springer, Cham. [https://doi.org/10.1007/978-3-031-17728-6\\_1](https://doi.org/10.1007/978-3-031-17728-6_1)