What should be in a persona for use in Requirements Engineering

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Abstract. Personas are a powerful tool for use during Requirements Engineering (RE). We curated 98 persons used for various RE tasks in various domains from 41 academic publications. Using these personas, we formulated a proposed RE persona taxonomy consisting of several dimensions. To evaluate whether our proposed RE persona taxonomy could aid requirements engineers, we interviewed 20 practitioners to get their feedback on our approach. They reported several perceived benefits of our proposed RE taxonomy, including providing recommendations for relevant human factors in personas, serving as persona templates, and guiding junior requirements engineers. We also identified areas that could be improved: the need to differentiate between internal and external aspects and understand the relationships between them better, providing the taxonomy with clear instructions, and the potential to develop a tool that aids persona generation in RE practice.

Keywords: personas, requirements engineering, persona taxonomy, practitioner feedback

1 Introduction

A *persona* serves as a fictitious character that encapsulates the relevant traits of potential end-users for proposed software [17, 14]. Initially introduced by Alan Cooper [9, 10] in Software Engineering (SE), personas have become valuable in understanding end users, particularly during Requirements Engineering (RE), User Interface design, evaluation, and marketing activities. RE tasks using personas aim to elicit, document, and analyse end users' requirements while ensuring the proposed software product meets the needs of users represented by the personas[30].

Using personas in RE allows requirements engineers to identify user requirements [13, 8, 18, 28] and anticipate how they might engage with the proposed

product [6]. This approach helps to lay the foundation for defining the product's requirements [29], including both functional and non-functional specifications [26]. Moreover, personas play a pivotal role in identifying redundant requirements [29] and highlighting potential issues in the specified requirements [4, 20, 1]. However, it is important to understand that personas do not replace actual end users in the RE process but instead complement other techniques, including focus groups, co-design, surveys, and interviews. However, personas are very useful, particularly when direct access to many diverse real end-users is challenging.

The presentation of personas in RE does not adhere to a standardised format[16, 15]. Typically, personas provide context-specific depictions of target end-users, including their mindset, behaviour, goals, and motivations. Previous studies categorised persona attributes into three groups: identical attributes (consistent for all user groups), aggregate attributes (aggregated user attributes, like technology comfort in a particular age group), and cosmetic attributes (e.g., name and photograph) [2].

Earlier research has scrutinised persona templates, segmented persona information into sections or layers [3, 25, 21], and even introduced *basic personas* derived quantitatively from extensive data [27]. However, these studies did not specifically focus on the application of personas in the RE process. Additionally, their scope was often confined to particular geographic locations or quantitative methodologies. Moreover, these studies did not provide a clear delineation of which human factors should belong to each layer of the persona, and the layers breakdown was overly generic, disregarding the context-specific nature of personas. To enhance the effectiveness of personas for RE, it is essential to incorporate an additional contextual layer that ensures their relevance in diverse contexts and domains.

To address these limitations, our study explores various usages of personas in RE-related activities. We compiled a curated *Persona Corpus* [15], comprising 98 personas from 41 academic publications. Through this process, we identified 12 key domains where these personas were utilised. Moreover, we identified three key persona dimensions: narrative style, formatting, and the length of persona. Furthermore, we discovered five major demographic attributes commonly included in persona descriptions: name, photograph selection, gender, age, and tagline. Additionally, we categorised human factors presented in each persona into persona facets, aligning them with each identified domain. This categorisation served as the foundation for developing a preliminary RE-based persona taxonomy. Emphasising the context-specific nature of personas, we also formulated domain-based facets recommendations to create more effective personas tailored to specific domains.

This paper is an extended version of our previous work that appeared at Evaluation of Novel Approaches to Software Engineering (ENASE) Conference 2023 [15]. We have now conducted a detailed interview study to gather feedback on the initial persona taxonomy that we developed from RE practitioners. The purpose of this study was to obtain insights and opinions from practitioners in

the industry regarding the relevance of our proposed RE persona taxonomy in the context of our research. The key contributions of this paper include:

- identifying the preferred persona presentation by RE practitioners;
- investigating the potential benefits of our proposed RE persona taxonomy; and
- identifying areas to improve our RE persona taxonomy.

The rest of this paper is organised as follows. Section 2 present the findings resulting from our persona curation and analysis. Section 3 presents a preliminary persona taxonomy, while Section 4 provides the feedback collected from the industry. Section 5 summarises our findings, study limitations, and presents opportunities for future work. Section 6 provides a summary of the research papers that are related to our study and Section 7 concludes our research.

2 Curated RE Personas

2.1 Persona Curation Method

We first curated a set of 98 RE personas collected from 41 publications [16]. We then extracted key human factors captured in each persona and analysed the personas to understand key persona demography. We built a preliminary persona taxonomy to capture commonalities and differences between these 98 diverse personas used for RE.

Data Collection: We performed academic literature database searching to collect our data. The search was limited to articles published between January 2000 and December 2021. The search was then conducted over six databases: ACM Digital Library (ACM), SpringerLink, IEEE Xplore (IEEE), Engineering Village, Wiley Online Library, and Taylor & Francis Online. There were a total of 833 publications returned from all databases. We filtered out the returned publications by reading the title and abstract. Duplicated publications were also removed, resulting in 248 publications for final selection. For our final selection, we focused only on publications that provided concrete persona examples. Consequently, we found 41 publications from which we collected 98 persona examples.

Data Extraction and Synthesis: From 41 selected publications we collected 98 personas These can be found in our online Appendix [4]. These personas were grouped by the domain they were used in. Our next step was to identify how the personas were presented e.g. text, table, graphic, etc, and how they were constructed e.g. from the focus group, interview, from existing persona, etc. We then carefully read each persona and extracted the human factors from each persona, including both those factors that are explicitly and implicitly described in the persona. To avoid confusion during human factors identification, we used the Merriam-Webster dictionary [23] to define some of the terms used during the extraction process.

[4] https://doi.org/10.5281/zenodo.7312341

2.2 Domains of Use

We identified 12 domains in which the 98 curated personas were used, and grouped our Persona Corpus by domain. These domains include: *technology for older adults*, *software development*, *health (physical and mental)*, *education*, *sustainable living*, *culture*, *technology for children*, *architecture*, *finance*, *law*, *security*, and *transportation*. Figure 1 summarises the total number of domains personas were applied in.

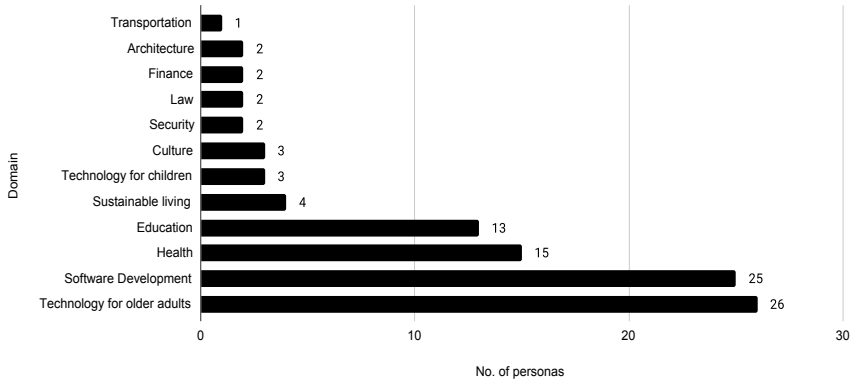

Fig. 1. Different domains personas used for (from [15])

2.3 Persona Dimensions

We focused on reviewing only text-based personas i.e. those using text to describe factors that make up the person. The main reason is that most of the collected personas in our Persona Corpus are text-based and also most of personas used in RE are text-based [16]. We discovered multiple ways, or dimensions, that text-based personas can be presented in. Based on our Persona Corpus analysis, we identified three key dimensions of text-based persona representation: **persona narration**, **persona format**, and **persona length**. An overview of these key text-based persona dimensions can be seen in Table 1.

We term **persona narration** as the way persona descriptions can be narrated. Text-based personas can be described either in a **narrative** fashion or in a straightforward manner using **bullet points**. Narrative personas are typically written in a story-like flow, narrating the characteristics of the personas from their general background information (e.g., name, age, personality) to context-specific aspects (e.g., interaction with technology, life achievement, social interaction). On the other hand, bullet-point based personas are more straightforward compared to narrative personas in terms of presenting the key persona

Table 1. Overview of text-based personas in Persona Corpus [15]

Persona narration	Narrative approach	87
	Bullet points	11
Persona format	Unstructured	47
	Semi-structured	37
	Structured	14
Persona length	Normal	54
	Brief	44

attributes (i.e., demographic information, general background, context-specific information).

Another dimension we identified is persona description **format**. We found that there are three main ways used to format text-based persona descriptions: **unstructured**, **semi-structured**, and **structured**. Narrating a persona in an unstructured manner means that the persona is described without any binding structure (and/or order) to present the persona attributes. Text-based personas can be narrated in a semi-structured fashion. The persona attributes are grouped based on their similarities; such as demographic-related attributes (e.g., name, age, gender, marital status), skills, social interaction, and computer experience. There is no binding rule in grouping the persona attributes, as we observed that even personas used in the same project can have different groupings. For structured personas, the descriptions are narrated by following a particular format defined by the persona creators.

The last dimension we defined for our curated text-based personas is **persona length**. From our Persona Corpus review, we found that text-based personas can be narrated either in **normal length** (more than ten sentences) or **briefly narrated** (ten sentences or less).

After reviewing our Persona Corpus on how the personas are narrated, we found that the majority of text-based personas in our Corpus are presented in narrative fashion (87 personas), while only 11 personas are presented using bullet points. We also found almost equal number of unstructured and semi-structured personas (47 and 37 personas respectively), whereas there are 14 structured personas. We also discovered that there were 54 normal length personas and 44 briefly written ones.

There were three methods used to create the personas in the literature: qualitative, quantitative, and mixed methods. There are 56 personas that were qualitatively created, 26 personas that were created using mixed methods, and 7 personas were created in a quantitative manner. The description of **qualitative personas** are mostly presented in a *narrative form* (51 personas), described in *no particular structure* (39 personas), and *briefly written* (37 personas). As for the personas created using **mixed methods**, 25 personas were narrated in a

narrative manner, 16 personas were formatted in a *semi-structured* fashion, and 21 personas have *normal length*. Moreover, from the personas that were **quantitatively generated**, there are 5 personas that were described *narratively*. Three personas were formatted in either *unstructured* or *semi-structured manner*, and 5 personas have *normal length*.

2.4 Demographic Information in Personas

We identified key demographic information presented in persona descriptions. These include *name*, *visual representation*, *gender*, *age*, and *tagline*. Table 2 shows the frequency of occurrence of the information for each domain that our curated personas are used for.

Domain	Name			Visual representation			Gender			Age					Quote/One-liner		
	Fullname	Firstname	NA	Photograph	Picture	NA	Male	Female	NA	0-14 years	15-24 years	25-64 years	65 years and over	NA	One-liner (describing statement)	Personal statement	NA
Technology for older adults	4	22	0	9	2	15	5	9	12	0	0	3	23	0	3	0	23
Software Development	5	20	0	23	2	0	7	7	11	1	4	16	1	3	10	9	6
Health	2	13	0	7	4	4	1	3	11	0	3	6	3	3	4	1	11
Education	2	8	3	2	2	9	2	1	10	2	0	3	0	8	3	2	8
Sustainable living	1	0	3	0	0	4	2	2	0	1	1	1	1	0	0	0	4
Technology for children	0	3	0	3	0	0	0	0	3	3	0	0	0	0	0	0	3
Culture	2	1	0	3	0	0	1	0	2	0	1	2	0	0	0	2	1
Security	0	2	0	2	0	0	0	0	2	0	0	0	0	2	2	0	0
Law	0	2	0	0	0	2	0	0	2	0	0	2	0	0	0	0	2
Finance	2	0	0	2	0	0	1	1	0	0	1	1	0	0	0	2	0
Architecture	2	0	0	2	0	0	0	2	0	0	0	2	0	0	0	2	0
Transportation	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0
Total	**21**	**71**	**6**	**53**	**10**	**35**	**19**	**25**	**54**	**7**	**10**	**36**	**29**	**16**	**22**	**19**	**58**

Table 2. General human factors in our Persona Corpus [15]

Name is the most common human factor in persona descriptions and is normally used in personas in ten domains. Seventy-one personas have only first name and 21 personas have full name. Only six personas (used in domain *education* and *sustainable living*) in our Persona Corpus do not have a name. Instead, they are labeled with a code to distinguish them one from another.

There are 82 personas in our Corpus that include an **age** in their description, especially personas used in age-related domain (*technology for older adults* and *technology for children*). People aged **25-64 years** are the most presented population in our Persona Corpus (36 personas), followed by people aged 65 years and over (29 personas). There are some personas used in four domains that do not mention any age in their descriptions. Interestingly, personas used in the *security* domain do not have information about age.

Based on our analysis, we found that either **photograph** (real person) or **picture** (cartoon-like image) are used to provide a visual representation of a persona. In our Corpus, there are 53 personas that included photograph and ten personas used picture. All personas used in domain of *sustainable living*, *law*, and *transportation* do not provide any visual representation. In total, there are 35 personas that do not include photograph or picture.

In regard to **gender** representation, 54 personas do not include any gender-related information, particularly personas used in domain of *technology for chil-*

dren, *security*, *law*, and *transportation*. For personas that presented gender information, there are 25 personas representing **female** population and 19 personas representing **male** population. No non-binary personas were found. We also found some personas do not explicitly mention a gender. Persona gender is usually presented using gender-related terms, such as "72-year-old woman".

We also observed that some personas included a **tagline** that summarises persona characteristics in one-line statements. This approach is argued can enhance the memorability of the persona [5]. In total, there are 40 personas that included a one-line statement in their description. Based on our review, *software development* is a domain in which the most personas included tagline (19 personas).

Twenty-two personas used a third-person perspective (referred to as **one-liner (describing statement)**) to succinctly describe the persona, such as *'Sedentary old person'*, *'Passive and stingy'*, and *'Insurance seeker*. In addition, there are 19 personas that concisely described persona characteristics using a first-person manner (referred to as **personal statement**). Some of the examples are *"The main thing is that I arrive punctually at the destination"*, *"Between work and college, I always need cash to pay a thousand thing"*, and *"I only drive the car if I have to"*.

3 A Preliminary RE Persona Taxonomy

3.1 Persona Human Factors

We wanted to develop a preliminary persona taxonomy that can divide persona descriptions into two layers: (1) generic information; and (2) context-specific information.

Firstly, we identified a number of human factors reflected in persona descriptions from our Persona Corpus analysis. We then grouped these identified human factors into persona facets on the basis of their similarities. Those facets then were divided into a more general set of groups based on a preliminary taxonomy of human aspects introduced by Grundy et al. [12]. We categorised the identified persona attributes into three human aspect groups: (1) Personal characteristics; (2) Skill, experiential or environmental-influenced characteristics; and (3) Group or multiple human characteristics (see Table 3).

Human facets that fall into **personal characteristics** group are *demographic information* (age, name, gender), *personal attributes* (attitude, behaviour, personality, preference, interest, hobby), *physical well-being* (health challenge, health status, body measurement), and *mental well-being* (mental challenge, emotional feeling). In **skill, experiential or environmental-influenced characteristics** group, we included *personal story* (activity, achievement, memorable incident, life experience, life value), *interaction with technology* (ICT usage, ICT literacy, adaptation to technology, possesions of gadgets, wearable device usage), *skill level* (skill, health literacy), *education* (education, learning experience), *environmental-influenced characteristics* (spoken language), *human values*

Table 3. Human factors categorisation in Persona Corpus (from [15])

Human factors	Human facets	Human aspect groups
age, name, and gender	Demographic information	**Personal characteristics**
attitude, behaviour, personality, preference, interest, and hobby	Personal attributes	
health challenge, health status, and body measurement	Physical well-being	
mental challenge, emotional feeling	Mental well-being	
activity, achievement, memorable incident, life experience, and life value	Personal story	**Skill, experiential or environmental-influenced characteristics**
ICT usage, ICT literacy, adaptation to technology, possessions of gadgets, and wearable device usage	Interaction with technology	
skill, health literacy	Skill level	
education, learning experience	Education	
spoken language	Environmental-influenced characteristics	
life value, family tradition, religious belief	Human values	
financial situation	Socio-economic status	
occupation, income	Work status	**Group or multiple human characteristics**
living arrangement, family structure, parent intervention	Family environment	
current location	Geographic location	
work experience, social interaction, complain experience	Collaboration and communication style	
culture suitability, culture	Culture	

(life value, family tradition, religious belief), and *socio-economic status* (financial situation). Under **group or multiple human characteristics** group, we put *work status* (occupation, income), *family environment* (living arrangement, family structure, parental intervention), *geographic location* (current location), *collaboration and communication style* (work experience, social interaction, complain experience), and *culture* (cultural suitability, culture).

3.2 Persona Facets to Domain

Secondly, we mapped the human facets identified in each domain in which our curated personas were used in. Table 4 summarises the human facets mapping of our Persona Corpus. We divided these facets into two main layers: (1) **internal layer**; and (2) **external layer**. The internal layer of persona consists of a general background information of persona which falls into personal characteristic group. On the other hand, the external layer consists of context-specific information depending on the context and (or) the domain the personas are used in. We found that most of the personas included **motivation**, **goal**, and **concern/frustration/pain point** in their descriptions. There are a few domains that did not include all of these three attributes in the description (*security*, *law*, *finance*, *architecture*, and *transportation*). We acknowledge that this results from only a small number of collected personas used in these domains.

In addition to these three persona attributes, we also discovered that there are some facets on each human aspects group that were included in personas used in all identified domains. Under *personal characteristics* aspect of persona, **demographic information** and **personal attributes** are the facets with a high occurrence. Whereas for the *skill, experiential or environmental-influence characteristics* aspect, we identified that most of personas in our Corpus included **personal story** and **interaction with technology** facets. We also

Domain	Motivation	Goal	Concern/frustration/pain point	INTERNAL LAYER: Personal Characteristics				EXTERNAL LAYER: Skill, experiential or environmental-influenced characteristics							EXTERNAL LAYER: Group or multiple human characteristics				
				Demographic information	Personal attributes	Physical well-being	Mental well-being	Personal story	Interaction with technology	Skill level	Education	Environmental-influenced characteristics	Human values	Socio-economic status	Work status	Family environment	Geographic location	Collaboration and communication style	Culture
Technology for older adults	✓	✓	✓	✓	✓			✓	✓	✓					✓	✓	✓		
Software development	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓		✓	✓	✓		✓
Physical health	✓	✓	✓	✓	✓	✓		✓	✓	✓				✓	✓	✓	✓	✓	
Mental health	✓	✓	✓	✓	✓		✓	✓			✓		✓		✓	✓		✓	
Education	✓	✓	✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓
Sustainable living	✓	✓	✓	✓	✓			✓	✓						✓	✓	✓		
Technology for children	✓	✓	✓	✓	✓			✓	✓		✓				✓	✓	✓	✓	
Culture	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Security	✓	✓		✓	✓		✓	✓		✓					✓	✓		✓	
Law	✓			✓												✓		✓	
Finance		✓		✓	✓								✓		✓	✓	✓	✓	
Architecture		✓		✓	✓			✓	✓						✓	✓	✓		
Transportation		✓	✓	✓	✓			✓							✓	✓	✓	✓	

Table 4. The mapping of identified human facets in Persona Corpus (from [15])

identified that under *group or multiple human characteristics* facets, most of the personas included **work status**, **family environment**, **geographic location**, and **collaboration and communication style**.

3.3 Persona Taxonomy

Based on this analysis, we developed a preliminary persona taxonomy that can be used for requirements engineering in different domains and contexts. This is outlined in Table 5. Based on our Persona Corpus analysis, the *Demographic information* and *Personal attributes* in **Internal layer** of persona consist of human factors we mentioned in Table 3 for personas used in different domain and context.

However, for the **External layer** of persona there are some considerations need to be taken. First, the set of human factors for each human aspect may differ from domain to domain, not to mention from context to context. As an example, *interaction with technology* in domain **technology for older adults** contains information about how the elderly adapt with technology as an addition to technology usage-related information.

Secondly, the value assigned to each human factor may also be different across domains. For instance, in domain of **education**, human factors under *interaction with technology* facet depict how personas use technology to support their learning and teaching activity, while in **physical health** domain, those human factors portray the use of technology to help persona to maintain their physical well-being.

Each domain that we identified from our Persona Corpus analysis requires some different customisation in terms of the persona attributes that need to be included in a persona description for that domain. Therefore, we recommend

INTERNAL LAYER	
Personal characteristics	Demographic information
	Personal attributes
EXTERNAL LAYER	
Motivation	
Goal	
Concern/frustration/pain point	
Skill/experiential/environmental-influenced characteristics	Personal story
	Interaction with technology
Group or multiple human characteristics	Work status
	Family environment
	Geographic location
	Collaboration and communication style

Table 5. Preliminary persona taxonomy (from [15])

persona facets for each domain to address the requirements which can be seen in Table 6.

Based on this recommendation, we can see the alignment of persona facets recommendations for certain domains. For an example, in the **physical health** domain, we recommend that persona descriptions should include key facets as follow: *physical well-being* (e.g., health challenge, health status), *skill level* (e.g., health literacy), and *socio-economic status* (i.e., financial situation). We also recommend that personas used in the **technology for older adults** domain should include *skill level* facet that shows technology literacy of the persona.

4 Industry Practitioner Feedback

4.1 Study Method

To collect feedback on our persona dimensions and evaluate our proposed persona taxonomy and domain-based customisation (DBC), we conducted one-to-one semi-structured interviews with software and User Experience (UX) practitioners.

We recruited the interviewees by promoting our call-for-participants in social media (specifically, Twitter and LinkedIn) and by directly contacting to potential interviewees through our personal contact. In total, we recruited 20 practitioners to participate in our interview study. These interviewees held various roles, including Software Engineer, Product Designer, UX Designer, UX Researcher, and Product Manager.

The interviews were conducted both online and in-person, following an interview guide that encompassed questions about their preferred persona presentations, potential benefits of using the persona taxonomy and DBC, and

	Human aspects	Persona facets	Human factors	Domain
INTERNAL LAYER	Personal characteristics	Physical well-being	health challenge	Software development, Physical health
			health status	Physical health
			body measurement	
		Mental well-being	mental health	Mental health
			emotional feeling	Security
EXTERNAL LAYER	Skill/experiential/environmental-influenced characteristics	Skill level	health literacy	Technology for older adults
				Physical health
			skill	Software development
				Education
				Culture
				Security
		Education	education	Software development
				Mental health
				Education
				Technology for children
				Culture
			learning experience	Education
		Environmental-influenced characteristics	spoken language	Culture
		Human values	life value	Software development
				Finance
			religious belief, family tradition	Mental health
		Socio-economic status	financial situation	Physical health
				Culture
	Group or multiple human characteristics	Culture	culture suitability	Software development
			culture	Education

Table 6. Recommendation to customise domain-based persona facets (from [15])

suggestions for improvements. Ethics approval for the study was obtained from Monash University Human Research Ethics Committee, Approval #35897, to ensure compliance with ethical research practices.

To analyse the interview data, we employed a commercial transcription service to transcribe the interview recordings into written transcripts. Subsequently, we conducted a thematic coding analysis in NVivo. During this process, we performed open coding against the transcripts, identifying various codes related to the participants' responses. These codes were then grouped into themes based on their similarity, creating a thematic framework. To gain a comprehensive understanding of the relationships between the identified themes, we further organised them using a mind map. This allowed us to visualise the connections and associations among the themes, if any, and to derive meaningful insights from the data.

4.2 Participants

A total of 20 software and user experience (UX) practitioners (referred as P1 to P20) were interviewed in this study. Table 7 summarises the demographics of our participants. Over a third were software engineers, with a number of others product designers, UX designers, analysts, and managers. Most had less than 10 years

of industry experience. The majority of our participants were male (75%), with ages ranging between 26 to 34 years (52.17%). Predominantly, the educational background was at the university level, with degrees in Software Engineering or Computer Science (34.78%). Among the participants, the majority (58.62%) employed agile software development methodologies such as scrum, lean agile, and SAFE. In contrast, 37.93% adhered to traditional (waterfall) software development approaches, and a smaller proportion (3.4%) embraced a co-design approach.

Table 7. Interviewees' Demographics

Job roles	
Software Engineer	35.29%
Product Designer, UX Designer, UX Researcher, Software Company Owner	11.76% each
Business System Analyst, Project Manager, Product Manager	5.88% each
Years of experience	
Between 1 - 4 years	47.62%
Between 5 - 10 years	38.1%
More than 15 years	9.52%
Between 11 - 15 years	4.76%
Countries of the interviewees	
Australia	42.86%
Canada, Indonesia	23.81% each
Sri Lanka, United States of America	4.76% each

4.3 Persona Dimensions

In the interviews, we presented Persona Dimensions to our participants and asked them which persona presentation they prefer to be incorporated in their projects. Figure 2 summarises our participants' preferences. Most of our participants prefer to narrate their personas in **bullet-points** (14 participants), format them in a **structured** manner (14 participants), and keep the length of the personas **brief** (nine participants). Furthermore, we conducted an investigation to explore the reasons behind these preferences.

Persona Narration: Our study participants expressed the rationale that a **narrative persona** is *detail-oriented* and capable of *enhancing empathy* among the persona audience. These traits of a narrative persona make it *more memorable*. As mentioned by P16, *"... the narrative approach has interesting detail"* and P6 stated, *"... it's our metaphorical part of the language that helps to illustrate, and it sticks."*

However, narrative personas have their downsides. Criticisms of narrative personas revolve around their *implicit* nature, which can create room for *various interpretations* and lead to *bias*. Furthermore, consuming a narrative persona *takes more time*, and one might *miss some critical information* while doing so.

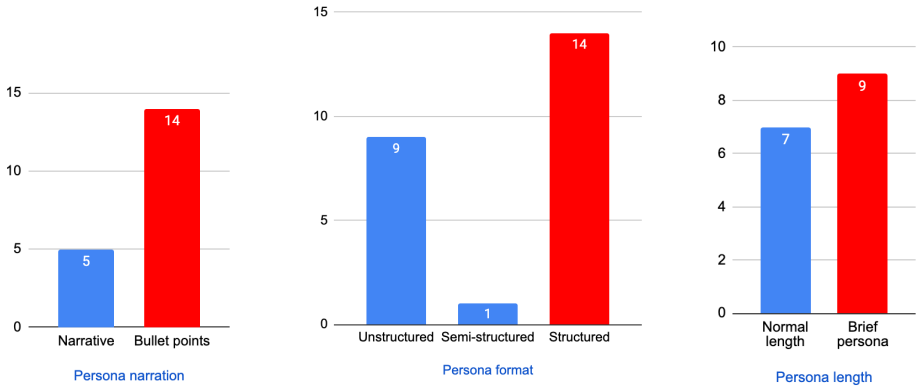

Fig. 2. Persona dimensions

P16 stated, *"But I'd rather not spend my time reading that [persona]"* Similar opinions were also expressed by P7, *"I have to actually read from start to end again and again"* and P4 mentioned, *"And I can't just kind of scan them [personas], because I'll probably miss some critical information"*.

On the other hand, participants who prefer **bullet-point personas** mentioned that this type of narration is more *consumable* because it is *concise* and *straightforward*, making it *easier to scan*. Another strength of bullet-point personas is that they are *more factual* compared to narrative personas. These strengths of bullet-point personas make it easier for developers to understand user requirements. Our participants expressed their preference for bullet-point personas by saying: *"As short as possible, very concise"* mentioned by P9, and P16 said: *"...quicker to read. Straightforward."* P5 mentioned that *"...it's [persona] really quick...you can sort of skim read it [persona]."* P10 stated, *"Developers would not be interested in knowing the person and how we present it. But it's about understanding the requirements."*

However, bullet-point personas also have flaws. This way of presenting personas is claimed not to be helpful for gaining a better understanding of represented individuals as they lack depth when it comes to describing people. P8 argued, *"[bullet-point persona] doesn't really help you to understand the person more"* and P8 also added, *"You cannot describe a person all in the relatively small space."* A similar statement was made by P6, *"I feel like I am losing the storytelling side of the persona."*

Persona Structure: We asked about perceived strengths and weaknesses the ways of structuring a persona. Participants who prefer **unstructured personas** argued that this format is more *comprehensive* due to its storytelling nature. Therefore, it is more helpful to pitch solutions to clients. P8 mentioned, *"[the persona] gives the persona audience a little more depth."*

Nevertheless, unstructured personas were also criticised for taking *more time to consume* and having the potential to be *misinterpreted* by the persona audience due to their *implicit* nature. As mentioned by P11, *"But after reading the story, you're not really sure what the person wants... not really good for gaining user insights."* P20 stated, *"...they [personas] just open up to many ways of interpreting the same information."* P20 expressed that it makes *"consuming information [in a persona] harder for people,"* and P8 said, *"I have to do a bit of reading and so on."*

In comparison, **structured personas** have several advantages, as mentioned by our participants. Structured personas are more *consumable* due to their *scannable*, *organised*, and *straightforward* nature. The organised manner of structured personas makes them reusable, as persona creators can re-purpose certain parts of existing personas for different projects. Additionally, structured personas can serve as *quick reminders* of represented individuals and complement narrative or unstructured personas. P12 supported this by stating, *"So it [persona] needs to be short, straightforward, and structured so that the persona audience can easily search for the information they want."* Similar statements were made by P15: *"...it [persona] becomes more clear, more neat,"* P5: *"You can sort of skim read it [persona], you don't have to read every single thing,"* and P3: *"...a person who just looks at it [persona] can pick up on those few key points."*

Despite the positive aspects of structured personas, we find that this persona format *lacks depth* as it provides *fewer details* about people's traits or presents *inconsistent* information. Additionally, having to adhere to a particular structure can be *limiting*. P8 argued, *"...if you just focus on the structured ones, then it's a very shallow image and might even be inconsistent and missing the point in many ways."* P6 stated, *"Your content needs to be dictating the format, not limited by the format."*

Persona Length: Based on our analysis of the participants' feedback, those who created **brief personas** argued that personas written in less than ten sentences are more consumable because of their *simplicity*, resulting in *less time needed to consume* them. Brief personas can serve as *a good starting point* that can later be elaborated into a more detailed persona. P19 stated that brief personas are *"fairly simple"* and P6 said, *"I know it [persona] has to be short and sweet. Keep it simple."* Similarly, P15 expressed, *"I don't think anyone would like to read, ..., but the method that worked for us is brief persona that is convenient for us to work with."*

In contrast, brief personas are criticised for having *less information* compared to longer personas, as they are confined to a small space of less than ten sentences for narration. The concern is that this lack of information *might not be helpful in creating connections* and could lead to *assumptions* creeping in during the process of understanding the end users. The weakness of brief personas was mentioned by P3, *"It [persona] does not have too much of textual information,"* and P8 stated, *"What I'm afraid of is people taking the short form version [of*

the persona] and then reaching their own conclusions, which may not be the ones that were actually intended by the person who created the persona."

> **Observation#1.** Personas should be easily **consumable**, meaning they require minimal time and effort to understand. As such, personas must be *concise*, *straightforward*, and *well-structured*, enabling the persona audience to find relevant information at a glance. Many participants prefer **bullet-point** or **brief** formats, following a specific **structure**. However, this preference poses potential risks. A focus on brevity and simplicity may lead to a *lack of detailed information* about the represented individuals, potentially leaving room for different interpretations that diverge from the original intent.

4.4 Persona taxonomy

During our interviews, we presented a persona taxonomy to our participants. The majority of the participants mentioned that the persona taxonomy serves as **a good summary**. They appreciated the separation of the persona into internal and external layers, which they found to **resemble the taxonomy of human traits**. Participant P6 remarked, *"I think it's pretty good. It's a really good summary."* Similarly, P9 commented, *"That's a really comprehensive taxonomy because you cover almost all aspects of the persona."* Additionally, P4 expressed, *"So I think that's sort of like having the layers, internal and external, kind of make sense, towards who we are as humans."*

Interestingly, our participants were not previously aware of this method of separating information in a persona, but they **have unconsciously employed a similar approach** while creating personas for use in their projects. As expressed by P1, *"I think it's generally in agreement with my approach as well."* P7 also mentioned, *"I'm also thinking we have to have that general information,"* while P17 stated, *"It's similar, the persona is defined to section is generic, and the context-specific about what we are looking for."*

Motivations, Goals, and Pain-points

Our participants also mentioned essential attributes of a persona: *motivation*, *goal*, and *pain-points*. P10 mentioned, *"I would consider motivation, goals, and concerns as the main parts."* Similarly, P13 expressed, *"... their motivation, for example, their concerns, their personality, their demographic information..."*

Some participants further emphasised the importance of these three elements in a persona. **Motivation** helps to **understand end-users' behaviour** under certain situations, which, in turn, helps to discover their needs. P3 stated, *"I would say the motivation, because for anybody to accept anything, you need to identify what motivates them to do something. And based on those motivations, what are the needs that address these motivations?"* Similarly, P12 explained, *"... we use their [end-users'] actual motivation as the navigation for saying that is the actual behavior of the user in this situation. And how can we evaluate*

that is, we normally look at the behaviour and then we double-check it with the motivations."

Based on our analysis, the **goal** is also helpful as it **conveys what end-users want to achieve**, which leads to the discovery of end-users' key needs. As justified by P10, goals are *"what they [end-users] want to achieve."* Furthermore, goals serve as a checklist to ensure that end-users' needs are met. P9 commented, *"... because at the end of the day, what we're trying to achieve from a product is to make sure that their [end-users'] goals are met."* P16 mentioned, *"I'll check my assumptions against the goals I said the persona had because as long as it aligned with their goals, then I'm probably in the right place."*

Moreover, we find that **pain-points** are crucial since they are helpful in identifying the **problems that end-users want to be solved**, as well as **obstacles they want to avoid**. This information can then help the requirements engineers specify how to improve the proposed software to make end-users' lives easier. As argued by P12, *"But it is more about like, okay, this is the problem that they tried to solve and it is the solution that orders tasks that we think of like it can be achieved to solve the problems."* P15 added, *"... pain points are the main thing that I'm concerned about because that's what we are trying to do: make their lives easier by improving the project or the product."* P5 noted, *"I feel like the most we did about the human side was to try and understand the pressures that the persona was under... so just to try and understand the effect that has on humans."*

> **Observation#2.** The majority of our participants expressed that our proposed persona taxonomy serves as a **good summary**, *resembling the taxonomy of human traits*. Despite being previously unaware of persona information separation, they acknowledged having *applied a similar approach in their projects*. Additionally, most participants agreed on the importance of including **motivation**, **goal**, and **pain-points** as essential attributes of a persona. These three key attributes play a crucial role in enabling requirements engineers to **comprehend end-users' behaviour**, **identify their objectives**, and **recognise the problems** they seek to solve and avoid. Such insights are pivotal in *discovering the needs of end-users* and *formulating improvements for the proposed software*.

Prospective Benefits

After showing our proposed persona taxonomy and domain-based customisation (DBC) to our participants, they provided valuable insights into its practical applications. Based on their feedback, we identify that the taxonomy and the DBC can be beneficial for persona creation.

Persona creation: Both the persona taxonomy and domain-based customization offer multiple perspectives about the represented individuals. These tools serve as *an excellent starting point*, encouraging persona creators to explore various angles and elaborate on end-users' information. As P5 stated, *"I think this is fantastic because it gets your brain thinking about the person from*

all different angles." Participants acknowledged that the taxonomy and DBC assist in structuring suitable personas for their projects, as illustrated by P15, who mentioned that *the understandable structure helps develop a better persona plan.* Notably, the practical implementation of persona taxonomy and DBC involves their early incorporation in the persona creation process. They can guide the formulation of questions to be asked during workshops or interviews, as articulated by P5, *"I think it's good to have something like this [persona taxonomy and DBC] in front of you when you're creating the questions to be asked during the workshop or interview."*

Comprehensively cover key human aspects: Additionally, our participants recognised that our persona taxonomy and DBC address key human aspects that should be included in a persona. P3 stated, *"But I think this best represents it. So because I do notice a lot of key similarities of what I would be looking at when developing a persona."* Participants emphasised the importance of personal information and context-specific details in personas. P20 expressed, *"... if you create a persona, you need to have information about the persona and personality, information that helps you interpret the rest. And the rest is the context-specific information where you put things into the context of the problem that is meant to be solved."* Understanding such relevant information also helps in reducing assumptions during the persona creation process, as pointed out by P5, *"... you can assume you know what is important to these people. But until you actually have something like this [persona taxonomy and DBC], you can go 'Oh, I hadn't considered that!'."*

Persona templates: Persona creators can utilise the structure provided in our taxonomy and leverage DBC for recommendations on tailoring the persona to their project domain. P12 noted, *"I consider it [persona taxonomy] a general structure we can use... So yeah, I mean for the current structure, I think that can be applicable for many cases."* P6 added, *"And sometimes it's just kind of like people pick a template. And it's kind of a template that we're going to be using for user testing or user research."* Some participants even suggested that persona taxonomy and DBC might surpass existing persona templates due to their comprehensive coverage, as mentioned by P13 *" One template focuses on one area, another one focusing on area, but you couldn't find a perfect line."* P1 also supported it by saying *"I started by using those template and then I realised that there are some things that's not in those template."*

Valuable for those new to the persona concept: Our proposed persona taxonomy and DBC are particularly useful for novices, as expressed by P1, *"I think it's [good] for someone new. They wouldn't know what's more relevant to be included in their persona."* P20 supported this notion, stating, *"So for somebody who has never created a persona before, they might like this [persona taxonomy and DBC], because it gives them ideas about what they could put in there."* These newcomers can use the taxonomy and DBC as guidance, offering general recommendations on attributes and human aspects to include in their personas, as mentioned by P9, *"That's [persona taxonomy] helpful to some extent, as the end-users of the persona taxonomy get an overview of the guidelines*

[to create personas]." P11 added, *"I would say it [DBC] could be very helpful because with all the domains that you listed, the persona creator or developer would go through everything, so it's more like guidance for them."*

Less time-consuming approach: The benefits of our persona taxonomy and DBC in the persona creation process can lead to a addressing a common criticism related to persona incorporation [16]. P11 expressed, *"... and I think with your customisation and taxonomy, it reduces the time needed to create specific personas based on different domains."* P13 concurred, stating, *"So that [persona taxonomy and DBC] will be very helpful. Because when you're drafting, you normally don't have lots of knowledge about persona. I don't think people will spend lots of time learning about the persona."*

> **Observation#3.** Participant feedback suggested that our proposed persona taxonomy and DBC offer significant benefits for the RE persona creation process. We observed that these tools provide **a good starting point**, offering a structured approach for developing well-defined personas. Additionally, they serve as **guidance** in formulating pertinent questions to be asked during the persona creation process. By doing so, our persona taxonomy and DBC help to **reduce the reliance on assumptions**, as they aid requirements engineers in **comprehending the essential human aspects** that should be incorporated in the personas. Furthermore, persona taxonomy and DBC facilitate the creation of **persona templates**, providing a structured framework for persona development. Moreover, these tools are particularly valuable for newcomers to the persona concept, as they offer **recommendations** on what information should be included in personas. In conclusion, the benefits offered by persona taxonomy and DBC have the potential to **streamline the persona creation process**.

Areas for Improvement

Differentiate between internal and external aspects: Concerning motivations, goals, and pain-points, it is essential to differentiate these aspects. Internal motivations, goals, and pain-points should be more generic, while external ones should be specific to the project where the personas are utilised. As P2 stated, *"What goals do you have in life? What motivates you in life? And what frustrates you in life with your human existence in general, right?"* P8 added, *"Because there's the internal motivation, which we said could be very different."* Understanding and acknowledging the connection between internal and external motivations, goals, and pain-points is crucial, as exemplified by P2's remark, *"So, there is external motivation, which is basically preaching the external environment to the internal motivation... How are your goals in work relating to your personal goals in life?"*

Relationships between human aspects: Our participants emphasised the importance of considering relationships among the human aspects within a persona. They advocated for comprehending the connections and interactions between various human aspects, including cross-domain human aspects, as they often influence each other in real-life situations. As P6 pointed out, *"The fact is*

that sometimes one domain connects with the other." P8 highlighted that these factors are not independent dimensions and suggested, *"What you should know is that these are fuzzy boundaries. For example, culture and education might be linked."*

Provide clearer instructions: Our participants suggested providing clear instructions on how to use our proposed persona taxonomy and DBC. P1 expressed concerns about how newcomers might find the format overwhelming and questioned, *"How are they going to go about using it?"* Additionally, offering examples on how to describe each recommended human factor could assist users in better understanding how to incorporate them into personas. P20 supported this idea, stating, *"And then you can give an example here on how to describe a health status, how would you describe body measurement, that sort of thing."* Moreover, to enhance usability, the inclusion of a glossary defining the terms used in these tools would be beneficial, as proposed by P8, *"I would suggest that all of these terms that you have here, for example, internal versus external, can you provide a one or two sentence definition of what is internal and what is external."*

Developing a tool: Participants suggested a tool that could aid requirements engineers in automatically creating suitable personas based on our persona taxonomy and DBC could be valuable. The tool should maintain dynamism, allowing users to add new information (both human aspects and domains) or remove existing information that may no longer be relevant. As P10 suggested, *"I think we should always allow room to do changes, rather than just sticking to it."* P9 emphasised the importance of accommodating changes in reality, stating, *"... because in literature, probably we can't cover some aspects that the researchers haven't revealed. Especially in reality, everything's changing rapidly."* P12 mentioned the need for decision-making regarding the information to be included, suggesting, *"I think that there might be some missing information on how I make the decision on which information I should put in if I have more information than the current structure."*

Observation#4. We identified several potential improvements for our proposed persona taxonomy and DBC. Firstly, enhancing the taxonomy and DBC involves **differentiating between internal and external motivations, goals, and pain-points,** as they are interconnected in real-life scenarios. By distinguishing these aspects, a more rounded personas can be achieved. Secondly, improving persona taxonomy and DBC necessitates establishing **links between related human aspects**, making the recommendations more comprehensive. **Clear instructions** are also vital to facilitate the use of persona taxonomy and DBC in persona creation. By providing explicit guidance on how to utilise these tools, users will find it easier to incorporate the recommended human aspects into their personas effectively. Furthermore, the development of a **persona generation tool** based on the taxonomy and DBC could significantly enhance the persona creation process. This tool can maintain dynamism by allowing users to add or remove information, ensuring the tool

remains adaptable to evolving requirements. Consequently, the **persona creation process can be streamlined**, resulting in more efficient and informed persona development.

5 Discussion

After constructing candidate RE persona dimensions, we conducted an interview study with practitioners who have used personas in their projects to investigate their preferences for persona presentations in industry settings. According to our participants' feedback industry professionals prefer concise and well-structured personas presented as bullet points. The primary reason for this preference is that personas should be easily consumable, allowing quick access to the information without requiring significant time investment. Industry practitioners appreciate personas that are straightforward and efficiently convey the required information for their tasks. We concluded that when selecting the appropriate persona presentation, consideration must be given to the audience and the specific tasks they will undertake using the personas.

Additionally, our interview study collected valuable feedback on the persona taxonomy and DBC. Participants found that our proposed taxonomy effectively summarises human traits commonly captured in personas, and many have unconsciously used similar approaches in their projects. The persona taxonomy and DBC are seen to offer significant benefits in streamlining the persona creation process. They provide guidance to requirements engineers when approaching end-users, reducing the influence of assumptions, and serving as a foundation for creating persona templates. Furthermore, the taxonomy and DBC proved helpful for individuals new to the concept of personas, offering recommendations on the essential information to be incorporated.

Based on participants' suggestions, improvements to our proposed persona taxonomy and DBC should include distinguishing internal and external motivations, goals, and pain-points while addressing the relationships between these factors. This differentiation would enable better comprehension of end-users and their needs. The persona taxonomy and DBC should also come equipped with clear instructions, enabling requirements engineers to easily utilise these tools for persona creation.

Furthermore, our investigation highlights potential directions for future research. First, it would be valuable to explore how personas can be presented to specific persona audiences, considering the level of detail necessary for a better understanding of end-users and their needs. Second, investigating the relationship between internal and external motivations, goals, and pain-points could deepen our understanding and lead to more insightful persona development. Third, further studying on using persona taxonomy and DBC to review and evaluate the created personas. Finally, building on our study, future research could develop a persona generation tool to recommend relevant human factors

(and their values) for inclusion in personas, streamlining the persona creation process and enhancing their effectiveness.

6 Related work

Nielsen et al. conducted an analysis of personas used in the industry setting [25]. They employed a literature study to analyse 12 existing persona templates and categorised the information into five main groups: background information, design-related information, business and marketing-related information, graphics, and miscellaneous details. Subsequently, the researchers compared these templates with the descriptions of 47 personas utilised in 13 Danish industries and organisations. The findings revealed that the Danish persona style differed from the recommendations provided by the existing templates, particularly in the business and marketing aspects.

Matthews et al. explored the perspectives of designers and user experience professionals regarding the use of personas [22]. Their study indicated that practitioners frequently use personas for communication but seldom for design. The participants identified four key problems with personas: too abstract, too impersonal, potentially misleading, and can be distracting. Based on these results, the authors advocated for new approaches to persona deployment.

Salminen et al. conducted a study to create a data-driven persona template, focusing on analyzing personas generated through quantitative techniques [27]. They examined 31 personas and categorised the richness of quantitative personas into three levels: simple, moderate, and high. The study also highlighted the disparities between information contained in quantitative personas and those created using mixed methods. Quantitative personas were depicted with chart-like presentations, while mixed-method personas offered more contextual and narrative-like descriptions. Notably, none of these studies specifically focused on the use of personas in requirements engineering (RE).

Some previous works investigated how personas can be decomposed to aid reusability. The idea is to streamline the process of persona creation. The division can be performed by separating persona attributes that are static (or have less likelihood to change) that can be reused in different contexts [3, 24]. A study that proposed Child-Persona technique argued that a persona description be divided into context-free dimensions and a context-dependent one [3]. Context-free dimensions of persona consist of data concluded from theoretical understanding, while a context-dependent dimension consists of data specific to the project.

A concept of *basic persona* was proposed with the purpose to streamline persona development process and enhance reusability [32]. Using data retrieved from a survey on European older adults, the researchers generated 30 personas representing the elderly. The study discovered some major clusters variables of persona description, including *self-perceived general health*, *self-reported limitations with Activities of Daily Living*, *cognitive function*, *make use of home care services*, *economic situation*, and *social activities*. In addition, the study also proposed additional variables to elaborate each cluster to give more detail infor-

mation. The resultant personas were claimed to applicable in different projects and were extendable to specific contexts. Marcengo et al. decomposed persona into two major sections: the basic persona and the external layer [21]. The basic persona serves as the base of a persona that consists of information that have less likelihood to change through different contexts. Therefor, this layer of persona is can be reusable for different contexts and domains. The external layer of a persona consists of context-specific information which enables the persona to be more relevant to a particular project or context.

Two of these studies ([3] and [32]) were designed for a particular group of age which resulting to a limited applicability. While the persona layering framework was argued being able to allow persona creators to develop reusable personas [21], however it has to be equipped with a practical recommendation that can be used to formulate a more contextual external layer of personas.

Several tools have been proposed for persona construction, and several curated set of personas have been collated. In earlier work we curated a set of personas used in RE[15], our taxonomy based on later evaluated by practitioners the study reported in this paper. Brickey et al. [7] describe clustering methods using multiple personas to aid their development. Liu et al. [19] propose a tool combining curated personas of diverse, challenged end users and published guidelines for designing for these challenged end users. Wockle et al.[31] propose a set of curated 'basic' ageing user personas and an associated design tool. Kanij et al[14] curate a set of elderly and children personas and propose a tool to aid developers designing for these target end user groups. Ford et al. [11] interviewed 21 and surveyed nearly 900 software engineers about use of personas in their work. They used findings to define a set of personas of software engineers to characterise their knowledge work.

7 Conclusion

In this study, we curated 98 personas used in RE-related tasks, collected from 41 academic publications. From this curation, we identified three key dimensions of personas: (1) persona narration (narrative and bullet-points personas); (2) persona format (unstructured, semi-structured, and structured personas); and (3) persona length (normal-length and brief personas). Our analysis also resulted in the formulation of a persona taxonomy and domain-based customisation (DBC). To investigate industry views on our proposed persona taxonomy for RE persona presentation, we conducted an interview study with 20 software practitioners. This study involved evaluating our proposd persona taxonomy, leading to the identification of several potential benefits and some areas for its improvement. Our future work includes the exploration of specific persona presentations tailored to particular audience needs, including the appropriate level of detail required for each persona audience. Additionally, future study can examine the use of the persona taxonomy and DBC as tools for reviewing and evaluating personas in practical settings. Moreover, future study can develop a persona generation tool based on the persona taxonomy and DBC.

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