CRAFTER: A Persona Generation Tool for Requirements Engineering

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Abstract: Personas, a user characterisation, have been widely used in requirements engineering (RE) to enhance the understanding of end-users and their needs. However, the persona generation process is time-consuming and demands familiarity with a user-centered approach. The central issue lies in existing tools for automatically generating personas, which are restricted to generating persona templates and provide limited user control to tailor personas according to their specific needs. This paper introduces CRAFTER, a persona generation tool that uses Large Language Models (GPT-3.5 model). This tool not only automates persona creation but also offers recommendations to users for generating personas tailored to their requirements. The study involved an online questionnaire with 19 respondents who utilised the tool, providing feedback that indicated the tool's sufficiency for persona generation while identifying areas for improvement. Beyond its primary function, CRAFTER stands out by providing guidance to requirements engineers throughout the persona creation process. The tool grants users the flexibility to customise personas based on their specific requirements, acknowledging the crucial human subjectivity in persona development. Additionally, CRAFTER promotes persona reusability, allowing users to save and reuse generated personas for future projects.

1 INTRODUCTION

Requirements engineering (RE) tasks involve discovering, defining, and validating end-users' requirements (Sommerville, 2016), emphasising consistent human interaction to ensure software products meet users' needs. Personas, hypothetical archetypes and descriptive models of real users, complement human involvement in software engineering (SE) (Cooper, 1999) by representing targeted human beneficiaries (Cooper et al., 2007; Kolski and Warin, 2018). Used at every RE stage, personas aid requirements engineers in requirements elicitation, identifying diverse user perspectives (Schneidewind et al., 2012; Mayas et al., 2016) and discovering new requirements (Ho and Lin, 2019; Sim and Brouse, 2015; Cleland-Huang et al., 2013). During requirements specification, personas assist in defining (Sim and Brouse, 2014) and documenting proposed product requirements (Faily and Iacob, 2017), while in requirements validation, they help identify (Aoyama, 2005; Sim and Brouse, 2014) and refine relevant requirements (Araujo and Aquino Junior, 2014). Figure 1 shows an example of a persona used in RE-related tasks.

Emily, 15 years
Year 10 student

"My vibrant personality shines through my artistic passion and love for connecting with friends, making me joyful and creative soul"

Emily is a high school student who comes from a middle-income family and has two younger siblings. With a passion for art and music, Emily spends her free time drawing and playing the guitar. She loves being involved in her school performances.

On a daily basis, Emily relies on Google Maps to explore the city and find cool art galleries, music stores, and places to hang out with friends. However, slow loading times and occasional connectivity issues can be frustrating, especially when she's in a hurry to meet her friends at a music event or art exhibition.

Figure 1: Example of a persona.

Personas can be automatically generated either us-

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ing semi-automatic approaches (Faily and Lyle, 2013; Alvertis et al., 2016) or fully automated processes (Jung et al., 2018; An et al., 2018; Kanij et al., 2023). Large Language Models (LLMs) have also been utilised in the manual (De Paoli, 2023; Cheng et al., 2023) and automatic (Zhang et al., 2023) generation of personas. These approaches have some shortcomings, such as restricting user choices regarding human facets, providing static attributes, and resulting in reduced user control over persona generation (Karolita. et al., 2023). We wanted to develop a tool that employs LLMs to generate personas for specific domains while granting users greater control. Acknowledging the subjective nature of personas, our tool seeks to find a middle ground between automation and human input, allowing users to customise personas within predefined domains. This approach streamlines the persona generation process and is particularly beneficial for junior requirements engineers who are still familiarising themselves with the persona concept.

The rest of this paper is organised as follows: in Section 2 we provide the driving factors of our study and in Section 3 we explain how we conducted the study. Section 4 presents the feedback from user evaluation as well as presenting the areas for improvement. Section 5 provides a summary of research papers that are related to our study. Finally, Section 6 concludes the paper.

2 MOTIVATION

Our previous investigation into personas in RE highlighted their significant role, particularly during the requirements elicitation and analysis task (Karolita et al., 2023). Personas proved effective in enhancing understanding of the needs of software's human beneficiaries. Additionally, many studies underscored the value of personas in revealing potential interactions between end-users and the software. This aspect is crucial for pinpointing and addressing possible challenges in user-software interactions. This insight into personas' utility in RE tasks underscores their importance in creating software that is closely aligned with user needs and preferences.

The generation of personas, while beneficial, presents several challenges. Obtaining representative data or participants for the target population is often difficult, posing a significant hurdle in creating accurate personas (Lachner et al., 2015; Nielsen et al., 2013; McIntosh et al., 2021). Furthermore, crafting personas requires an in-depth understanding of a user-centric approach in software development (Idoughi et al., 2012), which can be quite time-consuming (Acuna et al., 2012; Lopez-Lorca et al., 2014) and potentially expensive to implement effectively (Cleland-Huang et al., 2013). These challenges highlight the need for efficient and cost-effective methods in persona creation within the context of software development.

Emerging persona generation tools aim to address challenges in persona creation but come with their own limitations. Kanij et al.'s tool (Kanij et al., 2023) focuses on age-specific personas like those for children and older adults, yet it restricts users in integrating diverse human aspects besides age. Similarly, the "Automatic Persona Generation" tool (Jung et al., 2018; An et al., 2018; Jansen et al., 2020), utilising social media data, is constrained in user control over persona development. Additionally, "PersonaGen," leveraging Large Language Models (Zhang et al., 2023), primarily offers limited persona templates, lacking the depth of more comprehensive persona profiles. These tools indicate progress but also highlight the need for more versatile and user-controllable persona generation methods.

Addressing the limitations of existing persona generation tools, we introduced a novel approach with our tool, Crafting Recommendations and Advice for Tailored, Effective Personas (CRAFTER). This tool is specifically designed to assist requirements engineers in creating personas tailored to specific domains for RE-related tasks. CRAFTER aims to provide a balanced blend of automation and human input, enabling users to customise personas to meet their unique needs within specific domains. This approach enhances the user's control over persona generation, adding a more personalised touch to the process.

In order to achieve our goal, we wanted to answer the following key research questions:

RQ1. Can a persona recommendation tool be developed to generate better personas for use in RE? We wanted to create a tool that not only helps in the generation of personas but also proactively offers recommendations for key elements to include in a persona tailored to a specific domain.

RQ2. To what extent can such a persona recommendation tool usable for requirements engineers generate personas for use in RE? We aimed to assess our proposed tool's usability in aiding requirements engineers with persona generation and provide recommendations for the tool refinement.

3 OUR APPROACH

We developed CRAFTER, a tool designed to automatically generate personas while offering users flexibility in both the persona development process and the ability to adjust the generated personas. The tool was developed based on the persona taxonomy and persona dimensions resulting from our earlier persona curation study (Karolita. et al., 2023). It incorporates two major persona layers (internal and external), each incorporating human factors (i.e., persona attributes). This includes the layout of the generated personas which adhere to the persona dimensions, including human factors captured, persona length and persona narration style. CRAFTER was developed as a web application utilising a NoSQL database to record domains of use and persona attributes. Additionally, we integrated GPT-3.5 model to help in creating persona descriptions. The tool is publicly accessible [1]. CRAFTER's main processes are illustrated in Figure 2.

3.1 CRAFTER Features

3.1.1 Guided Persona Development

One of CRAFTER's major features is to generate personas based on users' specific requirements using a detailed persona taxonomy we formulated in our persona curation study. This detailed persona taxonomy and persona dimensions resulted from our curation of 98 personas collected from 41 academic publications (Karolita. et al., 2023). CRAFTER also extends beyond persona generation to provide recommendations to the users about human factors to incorporate into the personas.

3.1.2 Human-Centred Customisation

A major feature that distinguishes CRAFTER from other persona development tools is its capacity to offer users a highly tailored persona development experience. This feature places the power of personalisation in the hand of the users, allowing them to adjust the personas to meet their needs. Users have the flexibility to choose the domain of implementation and fine-tune the human factors depicted in the persona to align with their specific requirements. This level of personalisation provides valuable recommendations to users, granting them greater control over the persona generation process. This feature is especially advantageous for individuals who are new to or in the process of familiarising themselves with the concept of personas making the tool more user-friendly and accessible to a wider audience.

3.1.3 Leveraging a Large Language Models (LLMs)

To facilitate persona generation, we employed the GPT-3.5 model in our CRAFTER persona tool. This enables users to input descriptions about the intended domain of use and specific human aspects required for the personas. The resulting CRAFTER personas are more highly customised and contextually relevant to the domain and specified human characteristics of interest. The use of the LLM ensures consistency in descriptions and is scalable, accommodating single or multiple personas for diverse scenarios. Its user-friendliness reduces the skill barrier for persona creation, making it accessible to a broader audience. Leveraging a very large language model with deep information about many software domains and human characteristics, CRAFTER provides high accuracy and high-quality persona descriptions.

3.1.4 Persona Reusability

CRAFTER includes a feature allowing users to save the generated personas for refinement and reuse. These saved personas can be readily reused or adjusted in accordance with the users' requirements. This functionality offers users the flexibility to work with previously developed personas, saving them time and effort in the persona creation process.

3.2 CRAFTER's Persona Taxonomy

We developed CRAFTER based on our detailed persona taxonomy and persona dimensions (Karolita. et al., 2023): we developed a *Persona Corpus*, then mapped the persona attributes (i.e., human factors included in the personas) and divided them into two layers: the *internal layer* and the *external layer* (see Table 1). The internal layer of a persona consists of general background information including personal characteristics and the external layer contains context-specific information based on the context and/or the domain in which the personas are used.

As personas are context-specific tools, we know that a persona used in a particular domain requires some customisation in terms of attributes for that domain and might not be applicable to other domains. Therefore, we have also recommended persona attributes for each domain to address the specific requirements. We also discovered multiple persona styles (referred to as persona dimensions), in which text-based personas can be presented. Our Persona

[1] http://54.206.127.165:3000/

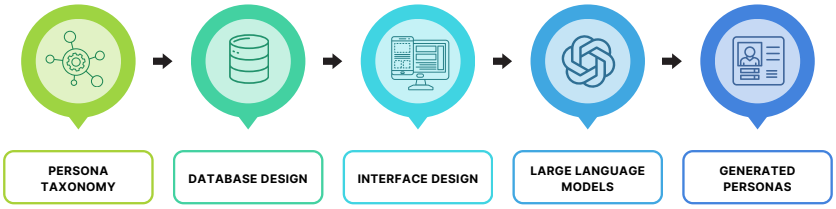

Figure 2: The main processes of CRAFTER.

Table 1: Persona taxonomy (from (Karolita. et al., 2023)).

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

Corpus identified three key dimensions for representing text-based personas: *persona narration*, *persona format*, and *persona length*.

3.3 CRAFTER Example Usage

When users access CRAFTER for persona generation, they must either sign in (for new users) or log in with their existing account. This requirement is in place because CRAFTER offers users the flexibility to either initiate the persona generation process or review their previously saved personas, as depicted in Figure 3. This functionality ensures a personalised experience, allowing users to access and manage their unique persona creations efficiently.

In the persona generation process with CRAFTER, users begin by selecting the domain of use for their persona, as shown in Figure 4. The tool offers a range of predefined domains, but users also have the flexibility to add new ones as required. Next, users can refine their persona by specifying various human factors, which include both internal and external elements. There's also an option to introduce new human factors, enhancing the tool's versatility. This feature makes CRAFTER dynamic, catering to diverse and specific persona development needs.

Figure 5 shows the subsequent steps in CRAFTER, where users can choose their desired persona length and narrative style. Regarding persona length, users have the option to select the word range for the generated persona. Additionally, users can specify the persona's narration style, choosing between a narrative format or a bullet-points style. These user-defined persona requirements (i.e., the domain of use, human factors, persona length, and narration style) serve as a prompt GPT-3.5 to generate the persona. An example of the generated persona is presented in Figure 6. Users can re-generate the persona and once users are satisfied with the generated personas, they can save them for future access.

4 EVALUATION

The CRAFTER tool underwent a usability evaluation involving the System Usability Scale (SUS) (Brooke, 1995) and qualitative feedback to assess its effectiveness. The evaluation was conducted through an online questionnaire[2], which had received ethical approval from the Monash University Human Research Ethics Committee (Approval #38469), ensuring adherence to ethical research standards. This thorough assessment aimed to gather insightful feedback on CRAFTER's usability and overall user experience in the context of persona generation for RE tasks.

4.1 Participants

Nineteen respondents answered our questionnaire, which included demographics, the SUS scale, and follow-up in-depth questions. The respondents' current roles included Software Practitioner, Requirements Engineer, UX Practitioner, Software Architect, Artificial Intelligence (AI) Practitioner, and Academic; some holding multiple roles. The majority were male and aged between 26 to 34 years. They were predominantly university-educated, with degrees in Software Engineering or Computer Science (Figure 7). The majority of the respondents were familiar with persona concepts and had designed one or more personas. They also incorporated personas in RE-related tasks (such as eliciting, specifying, and

[2]https://doi.org/10.5281/zenodo.10662689

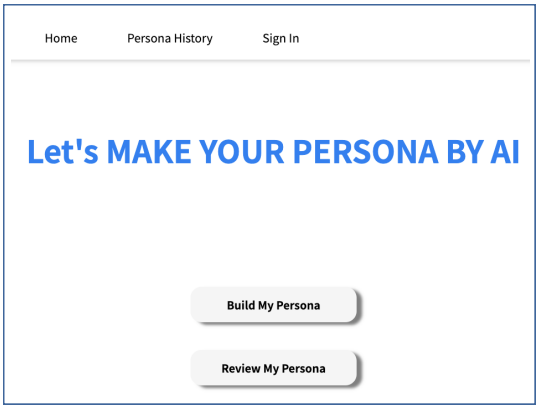

Figure 3: CRAFTER home page.

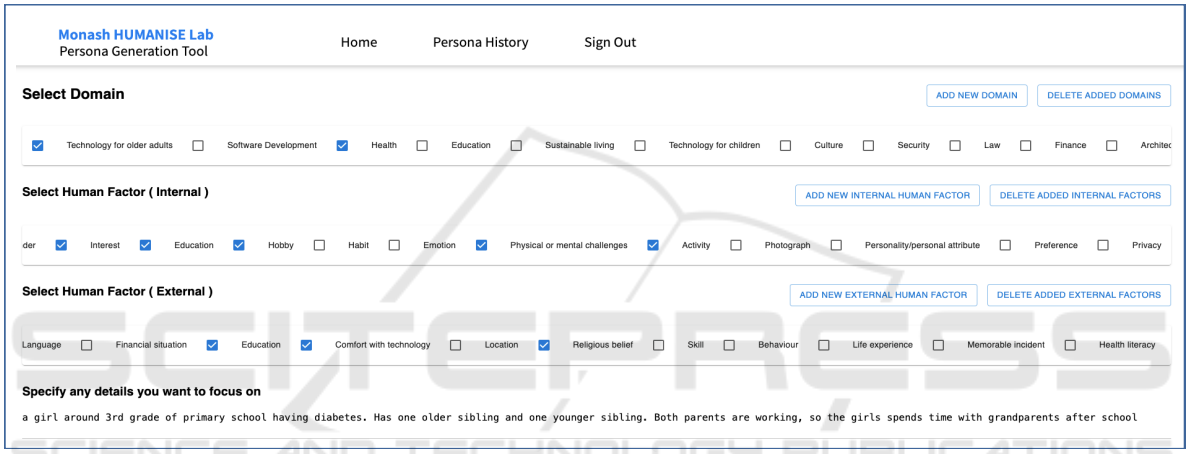

Figure 4: Customising a persona's domain of use and human factors.

validating user requirements). Figure 8 summarises the persona's domain of use and how the respondents used personas in their project.

4.2 User Feedback

In our questionnaire, we calculated the results using the System Usability Scale (SUS) methodology (Brooke, 1995). The SUS scores for each participant, identified as *R-i* for the *i*th respondent, are presented in Table 2. This table includes the *Score-i*, which is the total SUS score assigned to each respondent, and the *Final Score-i*, representing the respondent's ultimate SUS score. This approach allows us to quantitatively assess the usability of CRAFTER based on participants' feedback.

In the evaluation of CRAFTER, we categorised the final SUS scores of the respondents into three levels of acceptance as per Bangor et al.'s criteria (Bangor et al., 2009): *Not acceptable*, *Marginal*, and *Acceptable*. Out of the respondents, six rated CRAFTER as "Acceptable", five found it "Marginal", and eight considered it "Not acceptable". This categorisation, based on the SUS methodology, provides insight into the users' perceptions of CRAFTER's usability. The distribution of these scores, depicted in a Figure 9, offers a clear understanding of how the tool fares in terms of user satisfaction and acceptability.

Positive feedback from respondents regarding CRAFTER includes comments on its straightforward nature. One respondent commended the tool for being easy to use, while another acknowledged its utility but suggested a learning curve. An unexpected positive reaction came from a respondent who was pleasantly surprised by the tool's ability to generate complete personas. Two respondents emphasised the essential features offered by CRAFTER, highlighting its role in streamlining the persona generation process and eliminating the need to start from scratch. Additionally, a respondent expressed satisfaction with the tool's flexibility, appreciating the ability to customise personas according to specific needs.

We identified several limitations in CRAFTER based on the respondents' feedback which were cate-

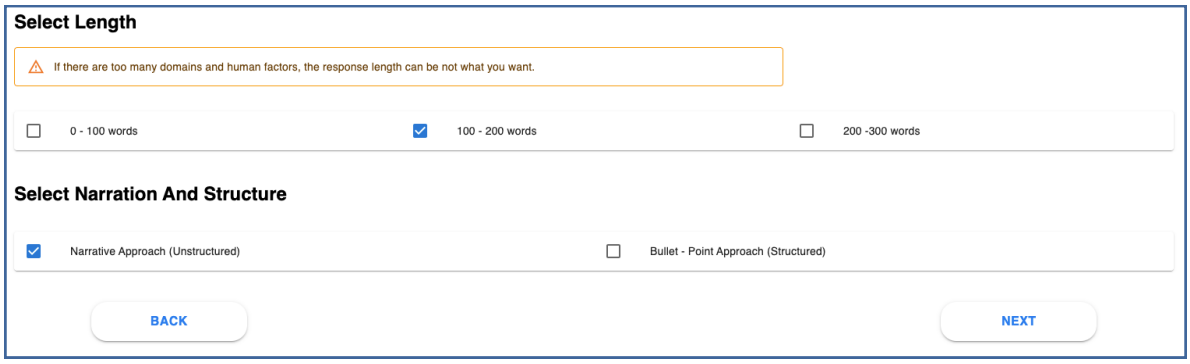

Figure 5: Selecting preferred persona style.

Table 2: SUS individual results.

R-i	Score-i	Final Score-i	R-i	Score-i	Final Score-i
R1	19	47.50	R11	35	87.50
R2	26	65	R12	19	47.50
R3	27	67.50	R13	39	97.50
R4	16	40	R14	20	50
R5	23	57.50	R15	19	47.50
R6	7	17.50	R16	12	30
R7	17	42.50	R17	29	72.50
R8	34	85	R18	14	35
R9	31	77.50	R19	33	82.50
R10	23	57.50			

Areef is 70 years old and is retired. After retirement, he found that he has too much free time and he used to feel bored. Sometimes, he tutors primary school children voluntarily as he was a primary school teacher before.

His friends are also mostly retired and he does not want to disturbs them during their working hours. He also has children but they are staying quite far from his place.

He love to socialise with other older adults through community centres but due to his physical challenge he could not frequent these centres as often as he wish.

Lately he found out that he enjoys using smartphone, especially on discovering news, and he thinks that by using smartphone he does not always need to go to community centres to get updates about activities that he is interested in.

Figure 6: An example of persona generated by CRAFTER.

gorised into two major groups: (1) *limitations related to the developed personas* and (2) *limitations related to the tool*.

Limitations related to the generated personas included some of our respondents noting that the persona layout does not resemble the actual personas used in RE practices. They also found that the generated personas sometimes lacked specificity and did not align with their requirements.

Limitations related to the tool were identified as due to user experience problems, including findability, affordance, and interaction cost. Findability encompasses issues where users struggle to locate information or navigate within the tool. Many of the limitations associated with the tool were centred around findability, where Users found it challenging to access the necessary information. For instance, our respondents expressed difficulties in understanding the tool's purpose and how it aids in persona generation.

There were comments about the lack of sufficient information about the specific details to be provided for the generated persona. We also identified limitations related to interaction cost, where users had to engage in excessive interactions to perform certain tasks. For example, they needed to scroll excessively to access certain persona attributes. Respondents mentioned difficulties in navigation and expressed confusion about the steps required to generated personas. Limitations related to affordance indicate a lack of guidance for users to interact with the interface and anticipate what to expect. For instance, users were unsure whether the generated personas were saved or not.

4.3 Areas for Improvement

Based on the user feedback, we have identified several areas for improvement to enhance our tool (summarised in Table 3). To address limitations related to the tool itself, we aim to *refine the user interface* to offer a more intuitive experience. This involves facilitating smoother navigation and interaction, incorporating features such as a filter function to prevent excessive scrolling, providing an option for one-off users to generate personas without creating an account, and clearly describing each task required to generate a persona. Moreover, we recognise the im-

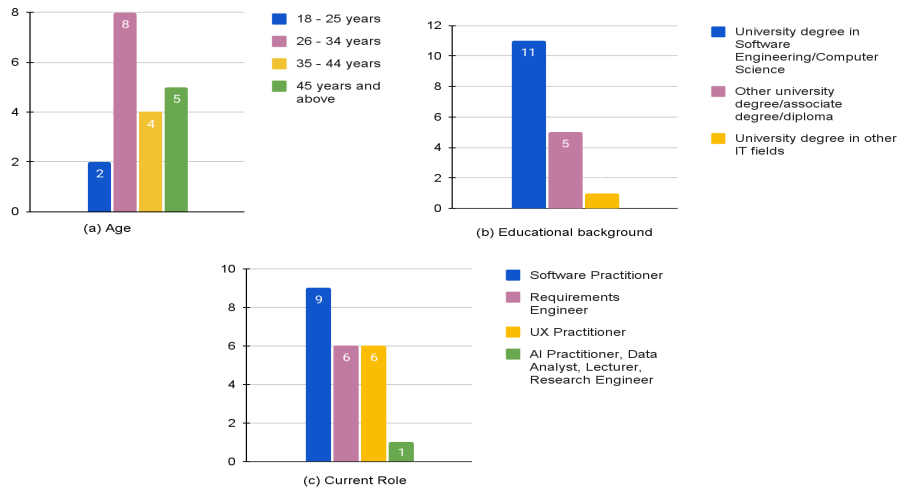

Figure 7: Questionnaire respondents' demographics.

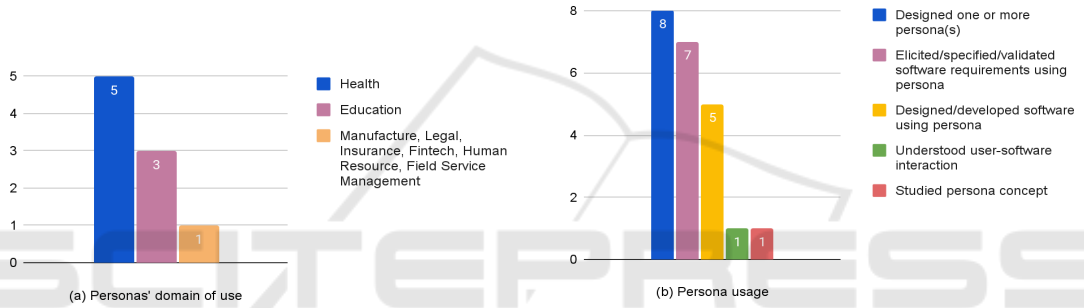

Figure 8: Questionnaire respondents' persona usage.

portance of *offering comprehensive information* about persona concepts, and their significance in RE-related tasks, and especially targeting users who may be new to or unfamiliar with persona concepts. *A preliminary introduction* detailing the tool's purpose, features, and functionalities can guide users more effectively through the persona generation process.

One suggestion for improving CRAFTER includes *integrating the latest Large Language Models (LLMs)* like GPT-4 for more accurate persona generation. This could result in personas that are closely aligned with users' specific needs and requirements. Additionally, enhancing the tool with options to *customise the layout of generated personas* would allow users to tailor the design according to their preferences and team standards, potentially increasing the tool's usability and relevance across different scenarios. We aim to make CRAFTER more *adaptable to diverse domains and contexts* of persona use. To achieve this, we plan to allow users to specify not only the domain of use but also the context of use for the persona. For example, in the health domain, a user might want to create a persona for a patient, health worker, or caregiver. This will allow a broader range of users to harness the tool's capabilities effectively. We are considering the implementation of collaborative features that *enable multiple users to work together* in generating personas. This supports persona usage teamwork and knowledge sharing, ultimately enhancing the persona generation process.

5 RELATED WORK

In practice, most personas are predominantly generated through manual methods (Karolita et al., 2023). Three primary techniques are commonly employed: qualitative, quantitative, and mixed methods techniques (Tu et al., 2010; Jansen et al., 2021; Jansen et al., 2022). Qualitative methods represent the most prevalent approach, involving activities like interviews, focus group discussions, brainstorming, and workshops. Mixed-methods approaches to persona creation generally begin with qualitative techniques in the initial phase of the process. This includes methods such as interviews, observations, and field studies, followed by the application of quantitative techniques for data analysis (Mesgari et al., 2019;

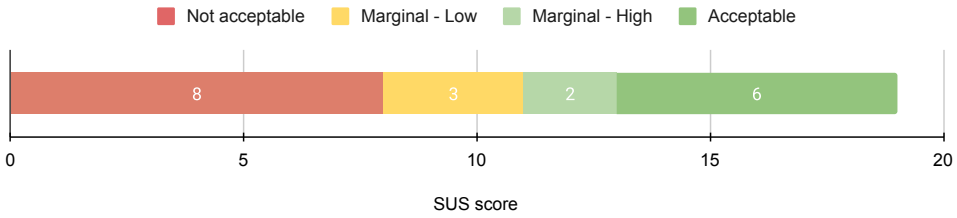

Figure 9: CRAFTER's acceptability ranges.

Table 3: Areas for improvement.

Tool	Generated personas
Better user interface	Flexibility to change persona layout
Use the latest advancement of LLM	Adaptability to diverse contexts or domains of use
Better tool navigation	
Provide preliminary introduction on how to navigate the tool	
Provide information about persona and why it matters	
Enabling collaborative persona creation	

Mead et al., 2017). Additionally, personas can be generated through quantitative methods by either using secondary sources (e.g., forum posts, user reviews) (Rahimi and Cleland-Huang, 2014) or employing questionnaires to gather substantial amounts of data for persona generation (Schafer et al., 2019). This approach involves data mining techniques such as cluster analysis.

Manual persona generation in Requirements Engineering, although essential, faces several challenges. Firstly, accessing representative participants or data for the target population is often difficult, which can affect the accuracy and relevance of the personas (Lachner et al., 2015; McIntosh et al., 2021). Furthermore, creating effective personas necessitates a deep understanding of user-centred design principles (Idoughi et al., 2012). This process is notably time-consuming, involving various tasks that extend the overall timeline of RE activities (Acuna et al., 2012; Lopez-Lorca et al., 2014). Consequently, it can lead to increased project durations and higher budget requirements (Cleland-Huang et al., 2013), which may be challenging for resource-constrained projects.

Consequently, several studies have explored the automation of persona generation to mitigate the aforementioned challenges associated with manual persona creation. For instance, Faily and Lyle (Faily and Lyle, 2013) integrated Computer Aided Integration of Requirements and Information Security (CAIRIS) [3] with a Persona Case framework (Faily and Flechais, 2011). They employed a framework to qualitatively analyse collected data, resulting in the identification of new persona characteristics. CAIRIS was then utilised to augment existing personas with the newly identified persona characteristics, thus generating new personas. Alvertis et al. (Alvertis et al., 2016) employed a crowd-sourcing technique, Persona Builder, to create a pool of user profiles, which also stores previously generated personas. To create personas for a proposed product, software developers utilise a computer-aided tool, known as Persona Builder. They selected persona characteristics from the pool or reused existing personas, and the tool automatically amalgamated the chosen characteristics to generate personas accordingly.

Several studies have contributed to the field of automated persona generation. One such initiative is the Automatic Persona Generation tool, which creates personas based on online behavioral data of social media users (Jung et al., 2018; An et al., 2018; Jansen et al., 2020). It employs quantitative methods, utilising users' demographic information and their online interactions. Additionally, Kanij et al. have developed a tool that specifically generates personas for certain age groups, such as children and older adults, based on age-related characteristics identified through a systematic literature review (Kanij et al., 2023). Another innovative approach involves using Large Language Models (LLMs), particularly the GPT-4 model, along with a knowledge graph to automatically generate persona templates, incorporating user feedback in the process (Zhang et al., 2023). Although these studies claim that their tools expedite persona generation, they have limitations, such as offering limited options for including diverse human facets (beyond age) (Kanij et al., 2023), and constraints in providing user control during the persona generation process (Jung et al., 2018; An et al., 2018; Jansen et al., 2020; Zhang et al., 2023).

[3]https://github.com/cairis-platform/cairis

6 SUMMARY

This paper introduces CRAFTER, an innovative tool designed to automate persona generation for RE practices. This tool uniquely combines the principles of persona taxonomy and advanced technologies like Large Language Models (LLM), facilitating the creation of high-quality, nuanced personas. CRAFTER stands out for its user-centric approach, providing requirements engineers with the ability to tailor personas to their specific project needs. This functionality is particularly advantageous for those new to persona development, offering a guided and customisable experience. In addition to its primary role, CRAFTER supports the reuse of personas, enhancing efficiency in future projects. To evaluate CRAFTER's effectiveness, we conducted an extensive questionnaire with 19 respondents, which yielded generally positive feedback and identified key areas for improvement. These insights will be instrumental in the ongoing development of CRAFTER, focusing on refining both the user interface and the depth of persona details generated. The study highlights CRAFTER's potential as a tool that not only automates but also enriches the persona creation process in RE. Future work is aimed at enhancing CRAFTER's capabilities based on user feedback, ensuring it meets the evolving needs of requirements engineers.

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