

Use Cases for Design Personas: A Systematic Review and New Frontiers

Joni Salminen

Qatar Computing Research Institute, Hamad Bin Khalifa University, Doha, Qatar; and University of Vaasa, Vaasa, Finland
joni.salminen@uwasa.fi

Soon-Gyo Jung

Qatar Computing Research Institute, Hamad Bin Khalifa University, Doha, Qatar
sjung@hbku.edu.qa

Kathleen W. Guan

University College London, London, United Kingdom
kathleen.guan.20@ucl.ac.uk

Bernard J. Jansen

Qatar Computing Research Institute, Hamad Bin Khalifa University, Doha, Qatar
bjansen@hbku.edu.qa

ABSTRACT

Personas represent the needs of users in diverse populations and impact design by endearing empathy and improving communication. While personas have been lauded for their benefits, we could locate no prior review of persona use cases in design, prompting the question: *how are personas actually used to achieve these benefits?* To address this question, we review 95 articles containing persona application across multiple domains, and identify software development, healthcare, and higher education as the top domains that employ personas. We then present a three-stage design hierarchy of persona usage to describe how personas are used in design tasks. Finally, we assess the increasing trend of persona initiatives aimed towards social good rather than solely commercial interests. Our findings establish a roadmap of best practices for how practitioners can innovatively employ personas to increase the value of designs and highlight avenues of using personas for socially impactful purposes.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI).

KEYWORDS

Personas, Use cases, Literature review, Social good

ACM Reference Format:

Joni Salminen, Kathleen W. Guan, Soon-Gyo Jung, and Bernard J. Jansen. 2022. Use Cases for Design Personas: A Systematic Review and New Frontiers. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*, April 29–May 05, 2022, New Orleans, LA, USA. ACM, New York, NY, USA, 21 pages. <https://doi.org/10.1145/3491102.3517589>

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
CHI '22, April 29–May 05, 2022, New Orleans, LA, USA

© 2022 Copyright held by the owner/author(s). Publication rights licensed to ACM.
ACM ISBN 978-1-4503-9157-3/22/04...\$15.00
<https://doi.org/10.1145/3491102.3517589>

1 INTRODUCTION

Personas are fictional persons that represent real user segments [7], enabling designers to go beyond mere descriptive segments (p. 60) and truly empathize with end-users [84]. Cooper [41] defined personas as a user-centered design (UCD) and human-computer interaction (HCI) technique that promotes immersion into end-users' needs. Since their usage in business contexts was first introduced by Cooper [41], personas have been applied to support the product design of major companies and organizations [6, 25] by introducing archetypal end-users and their requirements into early phases of the design process [4]. For example, personas have aided the design of messaging systems at Microsoft [126], as well as the design of flight entertainment systems at Sony [42]. Personas have been applied in a several industries, including but not limited to healthcare [66], gaming [35], software [14], news and media [138], and marketing [54].

However, despite the myriad of domains using personas, or perhaps because of it, forming a clear picture of how personas are concretely being used in the design process in different domains is difficult. Nevertheless, such a picture would help establish more robust guidelines for persona creation and persona use. Forming this picture is a major motivation to our study. In addition, because personas (according to the theory of personas [69]) can aptly represent end-users and end-user needs, they have been reportedly particularly beneficial for guiding design decisions by providing designers with “shared mental models” [26] (p. 63) about end-users. Personas effectively characterize vital end-user groups [135] and subsequently augment the performance and engagement levels of organizations that utilize personas [52]. A significant component of a typical design process involves showcasing product features and demonstrating how these features will help end-users in their everyday routines [20, 132, 142].

However, based on literature, the use of personas is scattered and difficult to comprehend beyond broad comments of persona benefits. *What are the design tasks in which personas are specifically useful? How do personas support designers in different stages of design?* Answers to these questions remain unformed based on the current body of knowledge on personas, prompting for a more systematic review of the design tasks completed using personas. In this work, we draw from these motivational questions to present a systematic literature review of *persona use in design*, which we define

as using personas as an informational and inspirational instrument for design tasks across any given context.

As persona use is spread across multiple application domains, bringing together this gathered knowledge constitutes a cross-domain learning activity, as persona creation and use are intertwined by the information needs of the persona stakeholders in different domains and use cases [70]. To form a more coherent understanding of persona use across application domains and design stages, we pose the following research questions (RQ):

RQ1: *How are personas used for design across different domains?*

RQ2: *How are personas used across different stages of design?*

Furthermore, personas are said to add value to the design process by bridging the gap between designers and the end-users they are designing for [4]. In such use cases, personas convey crucial information such as end-user needs and usage scenarios to the attention of designers [119], thereby allowing for further customization and relevance of design objectives and activities [26]. As a result, according to the theory [119], designers and other stakeholders making user-centric choices can utilize personas to acquire relevant information, form judgments, and make choices that benefit the end-users in the form of increased usability, better user experience (UX), or features/functions that address their problems. Despite this implicit assumption of value-generation through personas, it is not immediately clear how said value can be assessed and observed, especially going beyond anecdotal evidence. To justify personas as design tools and as targets of corporate investments (as persona creation tends to require considerable efforts [119]) a shift in focus from persona creation to an evaluation of persona use is necessary to establish and demonstrate actual value (a.k.a., benefit, utility, improvement, competitive advantage [142], or value in use [163]) from personas in different design initiatives. It is known that the methods for evaluating the goodness of persona *creation* methods vary [133], but as far as we know, no study has aimed to summarize how the impact of persona *use* is verified. Therefore, we propose RQ3:

RQ3: *How is the impact of persona use evaluated?*

Furthermore, personas are rarely enacted in isolation but rather in combination with other user-centered design techniques [119], forming the overall design process in which designers' sense-making about end-users is mediated and inspired by multiple tools with a varying degree of depth in manifesting the end-users' needs. We refer to the use of multiple design techniques where personas are one among many as 'persona-aided design'. To this end, it is critical to gain knowledge on what other UCD techniques are used in conjunction with personas. This is important because, on the one hand, knowledge about co-incurring use of methods can guide the HCI community to constructively assess the strengths that each method brings to the whole and, on the other hand, to identify design practices, patterns, and customary ways of doing things. At times, novel methods that are underexploited could be identified through examining the HCI researchers' actual toolbox. In the current body of knowledge, there is a general understanding of personas complementing other UCD techniques and *vice versa*, but the frequency of technique pairings and an understanding of what benefits each technique adds to the whole is underdeveloped. To this end, we propose RQ4:

RQ4: *How are personas used in conjunction with other UCD techniques?*

Another vital aspect of persona use is that while personas have predominantly been employed in industry to facilitate the development of commercial applications, some studies have also demonstrated how personas can go beyond design for merely commercial purposes, termed "social good" [61] (p. 1). For example, in interviews conducted by Marsden and Haag [106], personas were characterized as capable of transcending beyond commercial purposes to function as tools for empowerment. This not only broadens the personas' scope of application but also fits with the newly found notion in HCI that people should be thought of only as "users" but more broadly as human beings (i.e., individuals with a variety of roles and purposes [90, 129, 140, 150]). This contrasts with the information that is traditionally included in personas used for commercial purposes, which are frequently limited to user product requirements [14, 26]. For example, Wilson et al. [157] highlight that when the purpose of a product being designed is related to cultural and political goals rather than simply 'bringing a product to the market' (p. 25), it may be more appropriate to include information such as political convictions, social ideals, and involvement with local communities within the personas. There are also increasing calls within the HCI community for societal relevance, including using design to address sustainability goals [22, 71]. Therefore, as HCI and personas increasingly extend beyond commercial purposes, there is a need for understanding the use of personas 'for good' —i.e., for societally beneficial purposes. To present collective evidence of using personas for good, we pose our final RQ:

RQ5: *How can personas be used for good (i.e., societally beneficial purposes)?*

To address the above RQs, this systematic review (1) collects, analyzes, and aggregates studies using personas in different domains, (2) identifies the tasks that utilize personas during the design process, (3) assesses how the impact of personas use is measured, (4) summarizes how personas are used with other design methods, and (5) formulates central 'personas for good' use cases, and, from this, (6) derives implications for future research and practice, including a research agenda for expanding the horizon of persona applicability beyond its current focus.

2 RELATED WORK

Prior literature reviews have focused on personas, but none to our knowledge from the perspective of persona use in design. As foundation, we summarize the prior literature reviews in this section.

First, Goh et al. [65] mapped persona research spanning 18 years (1999-2017) to provide an overview of persona research. Their narrative literature review provided three main contributions by mapping (1) central milestone publications, (2) applied research approaches, and (3) emerging trends and issues. While the study provided significant insights and directions for future persona research, it focused on characterizing the state of persona research than mapping *how* personas are used in different domains or how personas are evaluated for design tasks.

Second, Johansson and Messeter [86] reported on several cooperative designs that used a persona model. Based on their overview,

the authors proposed an approach to integrating ethnographic fieldwork, participatory inquiry, and collaborative design to enhance user presence in the product design. While the study acknowledged the use of various supporting and complementing techniques alongside personas, it did not dissect in-depth *why* these methods are used with personas, *what* is the commonness of deploying each method together with personas, or *how* personas (or other methods) are evaluated for design tasks.

Third, Nielsen et al. examined descriptions from several Danish organizations to comprehend how businesses and design groups conceptualize personas [120]. For this, they investigated 47 persona designs from 13 organizations, comparing these designs to 11 recommended templates in the literature. They observed that persona creation is inspired by co-workers and seminars instead of academic literature, which implies that the practice community has a major influence on the design of personas. However, the study did not address *how* the different persona templates are used or evaluated for design tasks. In another study, Nielsen et al. [103] investigated how the persona-scenario method might help stakeholders generate shared understandings and design concepts. While such case studies are highly useful for illustrating the potential of personas, they do not provide an overview of “*personas + x*”, in which “*x*” is another method that supports personas towards the goal of creating user-centered designs.

Fourth, Guan et al. [70] analyzed 51 studies creating personas for professional purposes and found that personas were most prevalent in domains of UX design, healthcare, market research, and social media. The UX design personas were described by activity goals; the health personas were centered on physical symptoms of medical patients; the market research personas focused on customers’ lifestyles; and the social media personas emphasized behaviors in online social networks. Guan and colleagues provided guidelines for persona developers, including how to represent persona details related to lifestyle and health, contexts of product usage, and online user data. However, the authors did not review *how* personas were used or evaluated in these professional domains.

Fifth, Salminen et al. [133] reviewed research articles focused on quantitative persona creation between 2005 and 2019. The authors identified three stages of quantitative persona research—(1) emergence, (2) diversification, and (3) sophistication – with the fourth stage of (4) maturity that could be reached by sharing research resources such as datasets, source code, and persona-generation algorithms in order to nurture an open-source community among persona enthusiasts. The authors provided implications for organizations regarding their persona readiness, but the authors did not discuss how quantitative personas *are* or *should* be used or evaluated after their creation, given specific design tasks.

Sixth, in a follow-up study, Salminen et al. [134] identified five major challenges in persona research, including (1) lack of inclusivity, (2) lack of robust evaluation methods, (3) lack of shared resources, (4) lack of standardized persona creation, and the risk of losing immersive user insights due to seeing persona creation predominantly as a technical exercise. However, the authors were more focused on persona *creation* than their *use* for design tasks.

Seventh, there are popular textbooks [2, 41, 113, 119] that present various use cases for personas. While these sources are inspirational and serve a clear purpose of explaining personas, the cases

described in them tend to be anecdotal and no book to our knowledge systematically summarizes the knowledge about persona use in design.

Finally, several papers summarize the pros and cons of personas (e.g., [82, 121, 131]). The so-called ‘back and forth’ concerning applicability of personas has been in progress since the introduction of the method, including concerns about stereotyping and misrepresenting end-users [106, 151]. While there is currently no consensus about the ultimate value of personas, there is a consensus about persona research requiring a higher degree of rigor and integration of findings [13, 65, 88], a goal in which systematic reviews can be instrumental [23].

Overall, the previous literature reviews on personas have contributed to understanding personas’ strengths and challenges in the design practice. However, at the same time, there remain gaps in synthesizing the current body of knowledge on persona use in design. Most of the prior literature reviews can be characterized as scoping reviews that are limited by the lack of using a systematic methodology in collecting their evidence base (i.e., the literature sources). Moreover, while a number of studies report personas’ use in design, these studies tend to apply a case study methodology that has limited generalizability [160]. Therefore, a systematic analysis of such studies can yield invaluable information for design practice about the use of personas in design and synthesize useful experiences from previous work into a broader framework, including identification of central gaps and avenues for future research [48].

Particularly striking is that there are currently few studies that synthesize how personas have been adopted in *non-commercial settings* (i.e., developing products, such as software, user interfaces, or marketing communications). This lack of attention hinders the ability of personas as a design technique to provide broader *value in use* [115, 163] for organizations and groups across the social strata, leaving the full potential of personas untapped. As a result, a systematic analysis is needed to provide key information for researchers and design professionals alike.

3 METHOD

A systematic literature review collects secondary data (i.e., research articles and their content) and analyzes it in order to aggregate findings and lessons in a research field, establish important patterns for others interested in previous research, and identify prominent gaps for future research [48, 152]. This is achieved by formulating clear RQs and identifying, selecting, and critically appraising the selected articles to address the questions [109], often with the purpose of understanding the scope and depth of the existing body of knowledge [159]. These properties match well also with our research purpose, which is why systematic literature review was chosen as a method to address our RQs.

Although systematic reviews are relatively uncommon in HCI (compared to health care studies, for example, that frequently use them to summarize key findings [56]), the method seems to be gaining momentum in HCI [23, 55, 80, 125, 133]. The general steps of a systematic review include [133]: (1) identification of potentially relevant articles for addressing the RQs defined by the researchers, (2) title and abstract screening to include/exclude the candidate articles, (3) full-text screening, and (4) final inclusion and analysis.

Table 1: Data categories for information extracted from the articles.

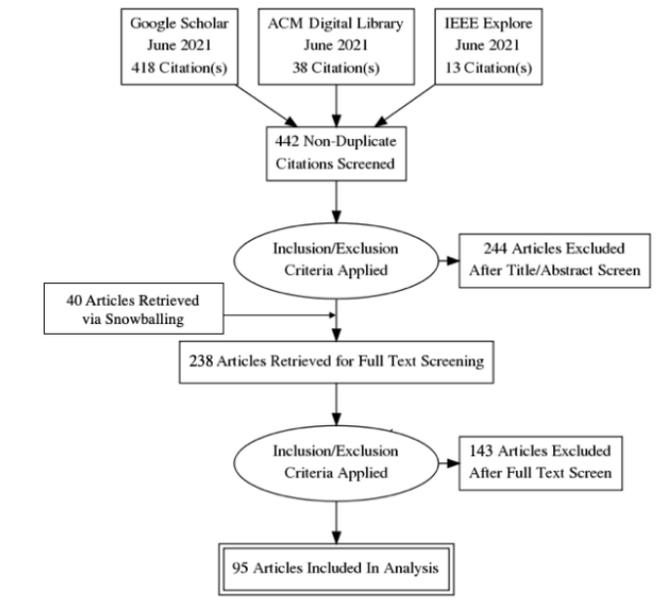
Category	Description	RQ Addressed
BASIC INFORMATION	Title, year, keywords	N/A
DESIGN TASK	Specific design task for which the personas were used	RQ1, RQ2
OUTCOME MEASUREMENT	Methods used to measure usage outcomes of designs	RQ3
DOMAIN OF APPLICATION	Industry and/or sector under which design activities took place and were ultimately used for, e.g., healthcare, software development	RQ1
LARGER MISSION OF DESIGNS	Purposes of personas, such as social versus commercial good, e.g., carry out health interventions, improve privacy awareness.	RQ4, RQ5

To identify potentially relevant articles, three databases were chosen, one based on its scope (i.e., Google Scholar) and two based on their relevance to human-computer interaction, personas, and design (i.e., ACM Digital Library (DL) and IEEE Explore). Identical literature searches were carried out for each database in June 2021 with the keywords “personas”, “design task”, and “human-computer interaction.” The initial search yielded 469 articles, of which 418 (89.1%) were from Google Scholar, 38 (8.1%) from ACM, and 13 (2.8%) from IEEE. The results were combined and deduplicated using the Covidence systematic review software [102]. The deduplicated articles (N=442) were manually screened by two reviewers reading the abstracts. Disagreements about an article’s relevance were resolved through consensus-based discussions, as recommended for systematic reviews [49].

The articles that passed the first screening stage were subsequently read in full and further assessed to ensure the inclusion criteria were met (see Figure 1). At this point, additional articles were also further retrieved by applying snowball sampling based on reading the screened articles and identifying other relevant research articles, as suggested for the implementation of systematic literature reviews [68]. The snowballing was conducted by a member of the research team, who had extensive experience reviewing persona research articles over a multitude of years. The snowballing was based on a public repository of persona studies, available in an open-source Zotero repository ([link masked for anonymity]). All the articles retrieved via snowball sampling (N=40) were assessed through full text screening as well. The inclusion criteria were as follows:

- *contains* a full research article (no short articles, book chapters, or dissertations) [screening stage]
- *is* published in peer-reviewed journal or conference [screening]
- *is* written in English language [screening]
- *develops* and applies personas in the context of design tasks [screening/assessment]
- *evaluates* the efficacy of designs created with personas [screening/assessment]

We also specifically focused on contexts wherein design teams used personas in the initial construction and/or formulation of new products for new users so as to exclude articles using personas to improve existing (re)designs for existing end-users. This allowed us to focus on personas adopted specifically for design for new users rather than to continue existing activities. The final collection included 95 articles, and the information shown in Table 1 was

**Figure 1: PRISMA Diagram.**

extracted from the articles using a standardized data extraction form [149]. The extracted data were analyzed, and the findings are presented in the following sections.

4 RESULTS

4.1 Persona Use Across Domains (RQ1)

We determined the domains where personas were most commonly used by noting the industry and/or sector for which stakeholders were conducting the designs. The domains were identified in the analysis stage, after searching and screening the articles. The domains we identified are listed in Table 2—note that frequencies exceed the sample size count because some articles applied personas cross-sectionally in more than one domain. Software development was the most frequently observed professional domain that personas were applied to (40%), followed by healthcare (20%) and higher education (16%). The next subsections discuss the persona applications to design in each of these domains.

4.1.1 Software Development. One prominent example from software development is Dow et al.’s study [51], which observed the

Table 2: Domains of persona application to design.

Domain	Definition and Main Benefit Identified	Frequency	Examples
Software development	The process of generating and maintaining applications, frameworks, and other software components. Main benefit of personas: <i>Eliciting user preferences and requirements necessary for designing key software components.</i>	42 (40%)	[1, 8, 27]
Healthcare	The systematic delivery of medical care to individuals or groups of people. Main benefit of personas: <i>Contextualizing multiple circumstances affecting health outcomes, including adherence, caregiver support, and physical factors.</i>	21 (20%)	[74, 75, 77]
Higher education	Education in universities or similar educational institutions, particularly at the bachelor's degree level and higher. Main benefit of personas: <i>Promoting inclusivity in education by identifying non-traditional students as well as how characteristics of different student groups interact with one another to shape learning experiences.</i>	17 (16%)	[32, 62, 104]
Marketing	Process through which a corporation promotes the purchase or sale of a product or service. Main benefit of personas: <i>Creating empathy among marketing professionals towards their customers to ensure more effective targeting of services.</i>	8 (8%)	[37, 85, 100]
Robotics	The design, manufacturing, operation, and use of robots to support humans and human activity. <i>Further research is needed to identify main benefit of personas beyond general user understanding.</i>	5 (5%)	[127, 139, 147]
Dialogue systems	A computer program that can interact with humans on both input and output channels, through text, speech, haptics, and other means of communication. <i>Further research is needed to identify main benefit of personas beyond general user understanding.</i>	4 (4%)	[3, 97, 155]
Videogames	Electronic game that uses a user interface or input device to create visual feedback for entertainment purposes. Main benefit of personas: <i>Explore parameters of game dynamics and archetypes to enhance gaming experiences. Further research is also needed to identify additional benefits of personas beyond general user understanding.</i>	3 (3%)	[35, 91, 98]
Privacy and security	The implementation of safeguards to protect against unwanted access to digital systems and confidential user data. Main benefit of personas: <i>Inform risk factors for cybersecurity and privacy attacks for software designers to create safeguards This involves identifying both attacker characteristics as well as user characteristics.</i>	3 (3%)	[19, 94, 144]
Recommendation systems	Information filtering system that aims to forecast a user's rating or preference for a given item. <i>Further research is needed to identify main benefit of personas beyond general user understanding.</i>	2 (2%)	[30, 47, 60]

N=105

processes of a design team to develop a new computing device and associated software. The authors outline how personas were created as part of the designers' preliminary research in order to better understand how users could potentially interact with their software product. Similarly, Arikoglu et al. [16] evaluated the usage of personas in the design of a digital calendar. The designers in this study created personas for different family members who would

potentially benefit from a shared digital scheduling system. Both these examples reveal the value of personas in gathering key user information to guide usability of software systems under design. A typical way of using personas in software development is mental modeling (e.g., "Rick would use this product to..."). Furthermore, research by several authors in this sample [17, 51, 101] shows how personas can benefit every level of the requirements design process,

from eliciting requirements through use cases to validate requirements. This is accomplished by aligning the content of personas with various requirements engineering and design processes that require user insights. For example, Armitage [17] describes how different personas were allocated to different designers and software developers in their organization, based on the relevance of the different personas to the key software components the employees were responsible for designing. The design process may start from brainstorming features and needs that the eventual users would have – at this requirements engineering stage, developers can apply ad-hoc or imaginary personas to create a design space for potential features. Each feature represents a hypothesis for further validation when creating personas based on qualitative and/or quantitative data [83].

In sum, personas are beneficial to software teams by aiding in documenting requirements to steer individual aspects of software design and development. Personas contain relevant information and contexts by emphasizing user preferences and needs, which improve user recognition and design team collaboration on knowledge exchange at different stages of design – all of which can strengthen the finished products of software applications.

4.1.2 Healthcare. Holden et al. [79] noted in 2017 that “while personas are ubiquitous in UCD for IT design outside of healthcare, there are few published, detailed accounts of personas development for health IT” (p. 159). Notwithstanding, while persona usage remains dominated by software development initiatives, healthcare was the second top domain in the current sample (N=21, 20%), perhaps reflecting their increasing adoption in social good purposes in recent years. Studies employing personas in designing healthcare solutions addressed both the patient and clinician perspectives and their related needs. For example, Hendricks et al. [74] assessed how personas could be used to better communicate as well as stimulate ideas during participatory design sessions with users. The authors discussed using a persona called TheSuperHero to help individuals with dementia (the target user group) identify the topmost urgent mobility issues in their daily lives (e.g., operating a television). As such, the fictive persona enabled the target users to imagine and highlight how the technology that was undergoing designs could be best integrated into their daily activities, regardless of their level of familiarity with technical terminology. In another example in this domain, Reeder et al. [128] developed two personas (one to represent a public health nurse, another to represent a nurse manager) to understand the needs of potential users of an information system designed to support public health nursing practices.

Incorporating a whole host of clinical, cognitive, and social aspects that identify actual patient users distinguishes personas developed for healthcare design initiatives. This is particularly important in healthcare because patients’ capacities to interact with medical services are determined by a range of factors, such as life circumstances and behavioral traits. By including this range of biopsychosocial data, personas are a useful tool for “care-centred design orientation, that can span the different needs of patient, professional and service, and help [healthcare practitioners] define priorities for intervention and redesign” [87:15]. Indeed, in Holden et al.’s [79] study on elderly caregiving needs, personas enabled designers to take into account differences between those who are discharged

from the hospital with versus without caregiving assistance in their residences, and how for the latter, the technology being designed might provide better access to one’s physically distanced loved ones. As a result, using multidimensional personas in designs directly highlights the unique circumstances of health-seekers.

4.1.3 Higher Education. Studies focused on product and service design in higher education (N=17, 16%) primarily focused on catering to student needs. Brooks and Greer [32] reported the use of predictive models to create learner personas of typical student circumstances in a higher education context. Based on the results of a student records survey, the authors were able to develop personas of student learner types to enable the design of appropriate accommodation services. Meanwhile, Khambete et al. [93] discussed the use of personas to develop an education service. In their study, design students were tasked with developing a service for potential employers to visit their university and conduct campus recruitment to employ students. In another article, Ozkan et al. [124] discussed how personas be a useful tool for inspiring curriculum designers to include more diverse student profiles. Personas were employed in their research to broaden the scope of who might seek out an engineering degree at a major university. By producing profiles of non-conventional students, personas were employed to facilitate departmental culture change with more inclusive curriculum redesign. As a result, personas utilized in educational design projects can strengthen institutional responses to diversity and equality while also facilitating intersectional educational methods. Such an intersectional approach [58] to education involves considering not only the overall student population at these universities but also the numerous ways in which student groups interact to influence their participation in higher education. Consequently, personas can be used to go beyond merely supporting the physical accommodations necessary to access educational services (e.g., ease of interface of online courses [12]) by also supporting the creation of socially inclusive content in university learning initiatives.

4.1.4 Marketing. A number of articles (N=8, 8%) in the current sample also applied personas to design marketing initiatives. For example, Lee et al. [100] disseminated personas to guide design students to create webpages to market professional services. Meanwhile, Salminen et al. [137] highlighted important user group information (e.g., age, gender, location, subjects of interest) in personified profile layouts to assist online marketing professionals in generating relevant online adverts. The authors found that personas improved the marketing professionals’ capacity to empathize with users, which in turn, enhanced the competitiveness of the ads they designed when compared to automatic ad design algorithms. Together, these two examples show how personas can be flexibly adopted to different facets and stakeholders in marketing; whether to inform how services should be marketed while aligning with a company and/or independent contractor’s branding goals, or to segment existing customer populations to market relevant services to them. In either case, personas can effectively reconcile the distance between an organization’s branding preferences and meeting target audiences where they are. Such considerations are even more pertinent when services are marketed to and intended for foreign audiences. Relevantly, Vestergaard et al. noted in their article on designing a waste management system: “A lack of familiarity often

applies to situations where the context is socially, culturally and geographically unknown to the designer. This is why developing and using personas as a tool may be especially useful when designing for a foreign culture” [154:271]. They go on to explain how personas are especially useful when it comes to segmenting customer audiences and designing products and marketing materials when direct customer participation is not possible. As such, personas can be applied with great results for customer engagement in marketing and design initiatives.

4.1.5 Robotics, Dialogue Systems, and Recommendation Systems. A small number of articles in the current sample employed personas in the design of dialogue systems (N=4, 4%) and recommendation systems (N=2, 2%), of which the majority (N=5, 5%) also overlapped with use cases in robotics.

Akner-Koler et al. [2] developed personas to serve as “credible hybrid characters” (p. 11) to represent the user/player dynamics in haptic interactions. Meanwhile, Kroger et al. [96] used personas to create a tangible interface for capturing internal force sensors and thereby facilitating communication between patients and therapists in telemental health treatments. A major goal for this haptic device was to “stimulate reflection on and awareness of affect” (p. 11) in teletherapy. In addition, Rea et al. [127] integrated personas directly into the end-product design of a teleoperation system. Specifically, the authors aimed to integrate an interactive, robotic agent to a simple teleoperation interface to react to individuals’ driving behavior. This was achieved by deploying two different robotic personas (an “anxious” persona and a “daredevil” persona, p. 20) to represent virtual passengers. Both the daredevil and the anxious personas aimed to elicit real-time social feedback to encourage individuals to assess and alter any unsafe driving behavior. Meanwhile, Fan et al. [59] developed a personal digital assistant device for smartphones called Health Pal, to auto-notify elderly individuals of healthy habits as well as sync to personal medical data over Bluetooth. Personas were created to help designers understand the necessary smart features for a typical elderly individual’s activities of daily living. These features included access to emergency services, which were provided through embedded physical medical sensors in the device. Notwithstanding, while these articles anecdotally reported the use and value of personas in their design processes, little evaluation was conducted and use cases were primarily still in the initial exploratory phases. This is likely due to the nascence of these new technologies and hence, the limited number of early adopters of personas. Future research will be necessary to evaluate the specific contributions and usefulness of personas to this area.

4.1.6 Videogames. Gaming represents another interesting use domain for personas. As described by Lazzaro, “A [video]game’s value proposition is how it makes its players think and feel. Players don’t buy games, they buy experiences” [99:1]. It is unsurprising, therefore, that personas have been used to enhance the design philosophy for videogames. Canossa and Drachen [35] describe how play-personas are “clusters of preferential interaction (what) and navigation (where) attitudes, temporally expressed (when)” (p. 513) and converging across the numerous forms of affordances in game artifacts. In this sense, personas in video games represent the parameters of the different interaction and navigation possibilities within the games and player journeys. In their study, Canossa

and Drachen [35] describe different personas used to represent the player archetype options provided to players, such as the “Grunt Persona,” a play persona skilled at shooting but lacking in problem-solving skills and jumping. Similarly, Laine et al. [98] used personas to design a multiplayer digital game to encourage active transport (e.g., bicycling, as opposed to motorized transport) to the workplace. Personas were created to establish how gamification (i.e., the application of game elements in contexts that are not traditionally associated with games) could be precisely delivered to encourage this healthy behavior change in employees. As such, personas address a major challenge for game designers: maintaining the best possible experience for a wide range of player tastes to attain the largest possible target audience. Nevertheless, similar to the previous subsection, articles concerning videogame designs in this sample provided little evaluation of how personas directly contributed to player experiences. More research is required to assess the value of persona use cases in this area.

4.1.7 Privacy and Security. Beyond overlaps with personas used for designing software in general (and the recognition of how user preferences for software will inadvertently shape how software security features should be designed alongside other features), personas have also been deployed to comprehend risk factors for privacy and security issues. For example, Atzeni et al. [19] describe the employment of personas to illustrate archetypical characteristics of cyber-attackers, in order to better prevent infringements to privacy and cybersecurity. The authors discuss how attacker personas include characteristics of attackers that are backed up by references for what motivates those specific characteristics. Such argumentation models are particularly useful because they succinctly present and validate existing assumptions cybersecurity specialists have about attackers. Moreover, personas also shed light on the specific contexts and circumstances of potential attackers. For example, Atzeni et al. [19] created personas to represent anyone from “irrational (ex) staff member(s), with unrevoked system access” to “intellectual property thieves” (p. 3).

Meanwhile, Kim et al. [95] were focused on the other side of cybersecurity risk management, which is determining different users’ vulnerabilities to being cyber-attacked and having their privacy compromised. To create these user personas, the authors identified various user characteristics that are intrinsic to cybersecurity awareness, such as knowledge of security issues, general comfort levels with technology use, and proactiveness to establishing privacy safeguards (e.g., prior to attacks or only in response to attacks). In this way, personas aided the designers in anticipating how their target user groups would respond to prospective cybersecurity threats, thereby guiding them to design cybersecurity initiatives accordingly. As such, personas allow security professionals to not only better understand the capabilities and motives of cyber-attackers, but also different levels of vulnerabilities to cyber-attacks for different user groups. In both these use cases, personas can be used to aid the design of effective buffers against external threats.

4.2 Design Tasks for Employing Personas (RQ2)

In addition to the examples highlighting the diverse domains of persona application, we observed their use across several stages

Table 3: Hierarchy of persona usage in design: three stages of application.

Stage	Description	Applicable design tasks	Task description	Frequency
1	Personas help organize information about the	Organization Conceptualization	Organizing information about users via personas Making sense of a phenomenon via personas	3 (2%) 56 (30%)
2	Personas are adapted for short-term tasks.	Ideation Prototyping	Brainstorming new ideas via personas Rough design sketches of products via personas	30 (16%) 42 (22%)
3	Elaborate usage of personas to meet explicit long-term goals of stakeholders.	Education Copywriting Prioritization Communication	Establish design philosophy via teaching of persona techniques Design marketing material using personas Ranking user needs and preferences via personas Sharing important user information to stakeholders via personas	7 (4%) 1 (1%) 17 (9%) 31 (17%)
				N=187

of the design process. Rather than imposing a specific design paradigm, we took an inductive approach. We determined stages of the design process by extracting the specific purpose and stage of the design process noted by the authors in their article. We then de-confounded labels for the same/similar design levels and collapsed these design levels to higher-order stages (Stages 1 through 4). This process resulted in eight design tasks levels, which are: Organization, Conceptualization, Ideation, Prototyping, Education, Copywriting, Prioritization, and Communication. We then manually tallied the design stages mentioned in each article, assign each to one of the four stages.

We found that conceptualization (29.9%) was the top design task employed in the studies, followed by prototyping (22.5%). Moreover, most articles (N=92, 96.8%) deployed personas in two different design tasks, with conceptualization and prototyping being the top combination (N=15, 16.3% of 92). Subsequently, a hierarchy of persona usage in design was established. This hierarchy is demonstrated in Table 3 that outlines three different stages of intensiveness for persona use in design tasks. As shown in Table 3, personas used for “organization” and “conceptualization” (Stage 1) enable designers to dynamically organize and brainstorm general information about users, as exemplified by the aforementioned articles [77, 111], among others. This level occurs before designers initiate prototypes and more comprehensive exploration of customer segments, as outlined above [28]. At the end of the spectrum at Stage 3, personas are used to meet explicit end goals and long-term objectives, such as designing marketing material. The next subsections discuss examples of the design tasks from each of these levels.

4.2.1 Stage 1: Personas Help Organize Information About the Users.

Prior to any design tasks, designers sought to organize information about user needs and characteristics. Personas were primarily used to guide this initial step in three articles [9, 76, 146]. For example, Anvari and Richards used personas to classify initial information on users’ personality dimensions, following initial demographic and personality tests taken by the participants [9]. Similarly, Taffe’s study leveraged personas to identify user’s demographic information and categorize such information accordingly [146]. Moreover, the top design task in this level as well as in the sample overall was

conceptualization in design. One example is the digital human modeling study by Hogberg et al. [77]. The authors developed narrative descriptions through personas to conceptualize five different levels of functional mobility among elderly individuals. These persona descriptions were subsequently mapped onto elderly manikins to be used during later design stages. Similarly, Millen et al. [111] described the development of personas to work with children with autism to conceptualize ideas for game design. Neuroscientific and child development research has shown that children with autism frequently exhibit “limited imagination skills” which can inhibit communication [43, 111]. Personas are, therefore, also an effective medium for obtaining an initial understanding of user needs in neurodivergent populations (i.e., atypical cognition), and can enable both designers and neurodivergent individuals to effectively communicate together. These examples illustrate how personas are used in initial stages of design when design teams require consolidation and conceptualization of relevant user information, including distinct user goals and needs.

4.2.2 Stage 2: Personas Are Adapted for Short-Term Tasks.

Beyond initial organization and conceptualization, personas were also widely used in short-term tasks to guide the designs in progress. In this level, which takes place after initial consolidation of user traits, personas were referred to for brainstorming new ideas for design. For example, Dow et al. [51] used the personas to brainstorm scenario activities that families would participate in each day and how this may affect how they interact with computing devices. Personas were similarly used for prototyping. For example, Bodker et al. [28] used personas to design various digital government platforms. In their article, personas were specifically developed for designers to guide both conceptualizations as well as the design of prototype interfaces for the project. The authors also noted how the personas – which were based on quantitative data from real citizens – were consulted frequently throughout the prototyping process, alongside the explicit consideration of the question: “How do personas talk back in design?” Similarly, Jensen et al. [85] used personas to strengthen prototypes for design to ultimately consider three questions: “How does the prototype help the company discover requirements in terms of known knowns, known unknowns, unknown knowns and unknown unknowns?” Here, personas were specifically used to document prototype use cases. These examples

Table 4: Top evaluation heuristics for designs using personas

Evaluation heuristic	Definition	Frequency	Examples
Ethnographic anecdotes, as adopted in anthropology	Qualitative and unstructured observations to holistically identify naturally occurring patterns and habits.	37 (42%)	[1, 27, 124]
Expert verification	The assessment of the validity and accuracy of a prototype or design by a subject matter expert.	20 (23%)	[12, 44, 51]
Usability testing	A technique for evaluating a product's interface by putting it to the test on real people and assessing their interactions.	18 (20%)	[101, 156, 161]
Semi-structured interviews	Interviews guided by open-ended questions to facilitate dialogue with participants.	13 (15%)	[18, 85, 128]
		N=88	

show how personas are applied beyond mere conceptualization or organization of ideas to guide initial testing of designs.

4.2.3 Stage 3: Elaborate Usage of Personas to Meet Explicit Long-Term Goals of Stakeholders. The final level is characterized by the application of personas for long-term goals. At this level, personas are primarily used to inform executive objectives, i.e., strategic goals that impact an organization's overall functioning and ethos. For example, the third most common use case in the sample saw the application of personas to communicate with stakeholders. In the aforementioned article by Jensen et al. [85], they developed personas in conjunction with prototypes to investigate how stakeholder involvement shapes the identified requirements of products. Personas, which enhanced prototypes to communicate use cases to stakeholders, were particularly key in meeting these communication goals. Meanwhile, Boyce et al. [31] developed personas to design an information platform to facilitate retrieval of reliable information on fatal drug interactions. This application of personas was guided by the notion that patient outcomes can be compromised by pharmacologic interactions between different medications. These extensive interactions pose particular obstacles for scientists and, therefore, demanded clear communication methods that were strengthened through personas. Examples of persona usage in this level also exemplify how personas are used beyond commercial purposes as tools for advocacy and/or user empowerment.

4.3 Methods for Evaluating Persona Impact (RQ3)

Our findings thus far have demonstrated the flexibility and versatility of persona applications across several domains and through multiple stages of design cycles. We now turn our attention to how the benefits of persona-aided designs are assessed. Table 4 categorizes different methods presented in the literature, and we then provide examples of how they can be used to assess the quality of designs created using personas (i.e., persona-aided designs).

4.3.1 Ethnographic Anecdotes. We found that evaluation heuristics for the efficacy of persona applications in design contexts were varied, with most articles solely reporting results through *unstructured anecdotes* derived through ethnographic approaches. For example, several articles reported satisfaction with the use of personas in design (e.g., "Personas seem to have satisfied a large unmet need in the organization, as there was high demand for them to be used

as a guide for future strategy" [17] (p. 15), "They [personas] were called on repeatedly in discussions of concept, content, functionality, user interface and usability" [8] (p. 28), "From the comments left by the students we conclude that the technique has met its learning objectives" [11] (p. 62), yet did not use an objective or systematic heuristic for grounding these evaluations. Moreover, as demonstrated in the example in the previous section of how participants of interviews were at times conducted with designers, and at other times the target users themselves, there is an inconsistent integration of different stakeholder perspectives in the different studies. Future research should standardize the inclusion of perspectives of all stakeholders in order to provide more comprehensive evaluations. Authors primarily interested in conducting evaluations through ethnographic anecdotes should attempt to define all relevant parties involved in design processes, from users to the designers themselves, and ensure that observations are collected equally from these different stakeholders. Most likely, however, an additional evaluation method will be necessary to ensure the efficacy of the personas.

4.3.2 Expert Verification. Followed by unstructured anecdotes, external expert assessment of designs and persona usage was the next most common evaluation heuristic. While these articles adopted a more systematic evaluation of persona usage in design activities compared to unstructured anecdotes, they also varied significantly in the metrics that they used. For example, in the study by Chen et al. [38] on personas applied to mobile interface design, external design experts were asked to evaluate the students' designs for novelty, uniqueness, relevance, and suitability with user needs, each on an 11-point Likert scale. Meanwhile, Anvari et al. [10] developed a scoring rubric for assessing the design tasks. In their study, students were provided with a persona and asked to develop designs for a wellness application based on it. The scoring rubric included several metrics for how directly the persona's characteristics were incorporated into the designs, such as the presence of mobile notifications that were relevant to the users' wellness goals. External assessors used the rubric to tally up the subscores for the designs. In yet another example, Akner-Koler et al. [3] discussed the efforts of a team of designers to create haptic wearables to support autonomous horseback riding for people with deaf-blindness. The design team directly solicited feedback from an equestrian instructor who has worked with the target user population and also sits

on the board of a company building a communication training system for the same group. Expert verification addresses some of the limitations of unstructured ethnographic anecdotes by providing more conclusive assessments for how personas can best enhance design processes. By considering expert perspectives, designers are able to validate the information captured in personas and further accelerate adoption rates for their products. However, the direct relationship of evaluation metrics to personas only, versus other aspects within the design process is questionable.

4.3.3 Usability Testing. The third most common evaluation heuristic among the articles was standard usability tests akin to processes commonly adopted in industry. For example, three articles used the “Think Aloud” methodology [98, 110, 141]. Several articles also considered usage logs to analyze users’ time spent on different interfaces [47, 100, 111]. In one article by Long et al. [101], Nielsen’s Usability Heuristics was consulted. This specifically encompassed factors such as “visibility of system status,” “match between system and the real world,” “user control and freedom,” “aesthetic and minimalist design,” and “flexibility and efficiency of use,” among others [117]. These examples demonstrate how usability testing can crucially provide insights into how well users interact with a particular design prototype. Similar to expert verification, these usability tests provide further substantiation of the benefits of personas to design. By directly inviting individuals to test design and using objective measures to capture these interactions, designers can increase confidence that their creations are relevant for the intended users. Again, the direct ties to personas themselves are often questionable.

4.3.4 Semi-Structured Interviews. Similar to usability testing, semi-structured interviews can be used to capture insights from users on how they perceive designs. In turn, this can help designers validate the personas (and any other techniques) they used to enhance their designs. For example, Reeder et al. [128] conducted qualitative interviews to evaluate representativeness of their personas before finalizing designs. They discussed how participants provided additional details that were helpful for improving and providing further context to the personas. This information allowed the authors to confirm the need for more design iterations before deploying them to the public. Likewise, Subrahmaniyan et al. [145] conducted semi-structured interviews and specifically asked participants if the personas intended to guide designs reminded the participants of people they knew in real life. It is also important to note here that one particular benefit of semi-structured interviews is that they enable answers to specific questions designers have while also lending room to organic qualitative insights that may not necessarily be captured in usability tests. In a sense, semi-structured interviews provide a balance between the benefits of ethnographic anecdotes, expert verification, and usability testing. Nonetheless, practitioners must prepare questions and discussion points adequately ahead of time to ensure sufficient insights can be gleaned.

4.4 Frequent and Emerging Methods Used with Personas (RQ4)

Given the wide range of different design stages that have employed personas, it is unsurprising that the additional methods adopted by

designers were quite diverse as well. Indeed, in the current sample, around three out of four (75.8%, N=72) of the articles used at least one method in conjunction with personas in their design tasks (see Figure 2). We derived this information by manually tallying the frequencies of different methods used in conjunction with personas in the articles. The observed integration of multiple methods for design is important to consider, given that teams often intentionally select personas alongside another complementary method to aid the design process. Such information also sheds insight on the versatility of persona formats when combined with other methods. The following subsections detail the methods used in conjunction with personas in design and how they specifically complemented one another.

4.4.1 Scenarios. Out of the 72 papers that used methods in addition to personas to guide design, *scenarios* – the descriptive narrative of user activities [36] – was the most common (26.4%, N=19) (see Figure 2). Typically, scenarios complemented the personas to describe the narrative contexts target users experienced during daily activities. For example, Blomquist et al. [27] initially used scenarios to provide descriptions of the personas’ general work tasks. The scenarios became more detailed and focused on specific tasks as design meetings progressed, which allowed the designers to subsequently develop storyboards for each of the personas. Al Sabban et al. [5] similarly described the use of scenario-based personas to identify different use contexts. Their platform for aiding visually impaired individuals considered different color identification scenarios for the personas such as shopping for groceries or clothes to provide further context for user needs. Arikoglu et al. [16] discussed the varied conceptions of the term “scenario” in both wider literature as well as within their own study, finding that scenarios exist in many different forms. The lack of standardization of how scenarios are integrated into designs in conjunction with personas warrants a more comprehensive analysis of how different scenario types compare in their relevance and usefulness for designs. Notwithstanding, all of these examples reveal how discrete characteristics presented in personas are not always sufficient and can be strengthened with scenarios to improve applicability and information richness for design tasks.

4.4.2 Semi-Structured Interviews. The next most common pairing for personas was semi-structured interviews (23.6%, N=17), which are interviews with flexible guidelines yet varying in scope and nature due to the unique circumstances of each interview’s organically flowing conversations. Some papers involved preliminary guided discussions with members of the target user groups to both inform and refine the personas, while others focused on the designers’ experiences of using personas to inform best practices. For example, Dow et al. [51] discuss the facilitation of a semi-structured discussion with designers about the different stages of design and how tools (including personas) were used. Meanwhile, Reeder et al. [128] conducted semi-structured focus groups with public health nurses, who were target users of a potential health administration platform. During these discussions, participants were specifically asked to reflect on the representativeness of the personas, i.e., how strongly the participants identified with the personas. Similarly, Subrahmaniyan et al. [145] observed that themes presented during their follow-up interviews were consistent with those developed

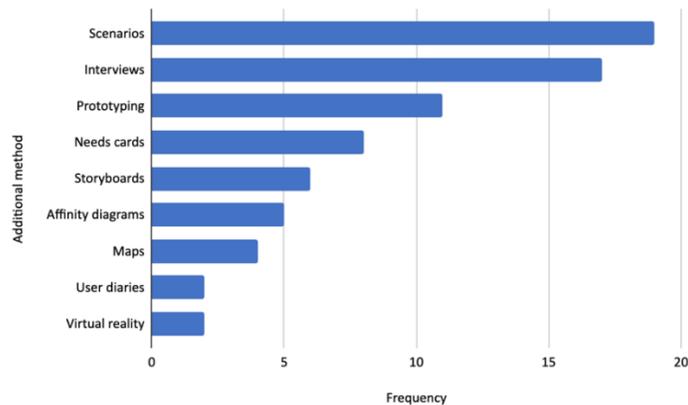


Figure 2: Methods used in conjunction with personas in design.

alongside personas, with interview participants’ characteristics overlapping significantly with the personas. Similar to scenarios, these examples reveal how the efficacy of personas can be enhanced as well as validated with insights from semi-structured interviews.

4.4.3 Prototyping. The third most common technique combined with personas in the design use cases was prototyping, or initial mock-ups of designs (15.3%, N=11). Gal and Lewis [63] developed personas to enable stakeholders to understand specific preferences of the students they were designing for. Based on the personas, the authors were subsequently able to determine key features and layout considerations to be prototyped prior to final designs. Similarly, Topham et al. combined scenarios, personas, and prototypes to develop designs for a mobile mental health application [148]. The personas and interaction scenarios directly inspired the design decisions for the required functionality included in the prototypes. While prototypes are used eventually in all design processes (including those that do not employ personas at all), these examples specifically outline how personas can directly inform prototypes to enhance final designs. Designers can greatly benefit from developing initial personas prior to any prototypes to ensure the relevance of designs.

4.4.4 Needs Cards. Van der Veer et al. [153] used cards to concisely identify and analyze user challenges. Needs cards are physical cards that outline user information. Van der Veer et al. discussed how in the same way personas can help identify user segments, cards can quickly generate common use cases. Similarly, Kauppinen et al. [91] used both “persona cards” (cards displaying personas to give basic information about citizens) and needs cards to provide information about citizens’ needs for different digital services. Similar to both scenarios and semi-structured interviews, needs cards can be used to strengthen and validate information found in personas to optimize insights for design.

4.4.5 Storyboards. Storyboards consist of a succinct graphical depiction of narratives to help designers visualize UX [89]. They can be considered an extension beyond needs cards to further narrate the challenges faced by users in different situations. Dow et al. [51]

created storyboards in conjunction with personas to contextualize daily scenarios families find themselves, and how this might affect how they interact with computing devices (Figure 4). In doing so, stories are communicated to bring the personas and how they interact with the products being designed to life. Meanwhile, Kagohashi et al. [89] took storyboards a step further by using physical dolls to represent personas and act out the storyboards live. Similar to scenarios (which are perhaps less detailed and sophisticated storyboards), these examples reveal how personas can be combined with narrative methods to inform designers of typical use cases of their products.

4.4.6 Affinity diagrams. We also observed the use of affinity diagrams in conjunction with personas in design use cases. Affinity diagrams are diagram tools that organize ideas and issues into patterns and relationships. Specifically, in this sample affinity diagrams were used to capture data and segments to directly inform the personas. For example, in their study on patient decision-making, Holden et al. [78] used affinity diagrams to identify 14 differentiating factors to produce a set of personas. These differentiating factors included disease knowledge, relationship with caregivers, and current health status. Similarly, Atzeni et al. [19] used affinity diagrams in their study focused on cyber “attacker” personas to mitigate cybersecurity issues. The authors discuss how information gathered regarding users was individually written on post-it notes and subsequently clustered until they formed characters sufficient for personas. Meanwhile, van der Veer [153] described the value of affinity diagrams as helping to identify “positive and negative aspects of the intended services in actual context” (p. 30) before personas were deployed for use in design. These examples provide an additional validation technique for the refinement of personas used for design.

4.4.7 Maps. Similar to affinity diagrams, maps can be used to consolidate information prior to constructing personas to be used for design. These maps consist of diagrams to represent information visually, with central ideas found in the middle and associated ideas stemming from this central focus. Adlin et al. [1] described their use of maps in conjunction with personas as depicting “the entire

Table 5: Use cases of persona for social good.

Social good purpose	Category	Definition	Frequency	Examples
Improve delivery of healthcare services	Health	Aid public, private, and non-profit organizations that help a jurisdiction deliver important healthcare services.	16 (40%)	[31, 128, 148]
Increase accessibility (physical and social)	Accessibility	Enhance, increase and expand the quality, value, or scope of activities for more people to take advantage of and use.	13 (33%)	[5, 8, 111]
Enhance civic participation	Politics	Facilitate activities carried out by an individual or a group to address issues of public importance in society.	6 (15%)	[28, 45, 91]
Foster cross-cultural dialogue	Community	Create opportunities for members of diverse groups and those holding opposing views to speak to and learn from one another.	5 (13%)	[11, 57, 154]
			N=40	

topology” (p. 3) of UX, to capture challenges and elicit ideas for designing future products. They further describe maps as picture books that tell the stories behind the personas. Meanwhile, Hendriks et al. [74] described an entire mapping methodology called “Map-It” which consists of stickers, scenarios, and maps to guide conversations with participants and subsequently construct personas. In their study focused on needs of adults with dementia, the authors found that this mapping methodology was particularly helpful to overcome verbal communication difficulties with participants. Just like affinity diagrams, these examples show how maps can help to validate as well as inform the data presented for in personas used for design.

4.4.8 Virtual Reality. In addition to the above top methods, we observed increasing attempts at integrating virtual reality (VR) technology in personas and design in recent years. In an initial exploratory study, Bonnardel et al. [29] described the use of a “dynamic persona in a virtual environment” (p. 222). They created two separate versions of the same persona, one “static” (i.e., on paper only) and another in virtual reality. In the latter, stakeholders would enter the same virtual space of the personas and interact with them in real-time conversations to uncover information. To further compare how well dynamic personas facilitate design processes, the authors conducted another study in 2020 [30] and found enhanced overall creativity and higher levels of empathy when compared directly with static personas. They surmised that this is because dynamic personas in virtual reality settings require stakeholders to engage more actively with the personas, subsequently leading to a more comprehensive understanding of the overall experiences of target users. While further studies are needed to assess these findings, these initial results show promise for how the goals of personas can be augmented with increasing technological advances.

4.5 Personas for Social Versus Commercial Good (RQ5)

We observed a divergence between projects leveraging personas to design for social (34.7%, N=33) versus commercial good (65.3%, N=62) in the current sample. The former, social good, was identified

based on whether the organization’s product goals were largely centered towards user empowerment and advocacy, as well as enhancing mental and physical wellbeing. These studies were motivated to make a positive impact on society at large. Meanwhile, commercial projects, which certainly did not ignore user needs, were nonetheless focused primarily on bringing a product to market rather than solving a specific social problem and could be generalized in terms of business interests. The current sample, therefore, reflects an increasing adoption of personas in design for social good rather than solely business purposes.

Table 5 highlights the social good categories we identified. Note that there were several overlaps between different purposes, and their frequencies were double-counted in the table. In the following subsections, we discuss each purpose.

4.5.1 Improve Delivery of Healthcare Services. The majority of articles aimed at solving social issues were concerned with public health systems and the culture of healthcare (40%, N=16). For example, many elderly persons require long-term treatment and frequently take many medications simultaneously. Almost all of them have experienced the pain and discomfort of forgetting doses as well as the concern of possible drug interactions. To alleviate such concerns with treatment adherence and thus overall patient wellbeing, Fan et al. [59] used personas to design a custom phone that could manage prescriptions to prevent major conflicts, notify patients of their medication timetables, and adapt calendars to adjust for missed dosages. Meanwhile, Hendriks et al. [74] conducted participatory design with a specific patient population to improve diagnosis and recognition of their symptoms, thereby improving health outcomes through earlier detection. In particular, they applied personas to design tools for people suffering from symptoms such as aphasia, amnesia, or aging, which are beset by symptoms such as memory loss and impaired social interactions. In addition, Reeder et al. [128] examined the larger context of public health informatics, wherein strengthening data exchange systems among health personnel remains a top factor for preventing catastrophes and lost lives. The authors used personas to guide the design of an administrative tool to support public health nurses and public health nurse managers during normal and emergency public

health operations. In all of these studies, personas included vital health-related information such as patient circumstances, health practitioner needs, and healthcare service contexts – differentiating them from the user information traditionally captured for commercial contexts by focussing on healthcare-specific considerations.

4.5.2 Increase Accessibility (Physical and Social). The second most common goal concerned accessibility. In all of these articles, the personas included user preferences and needs related to navigation and current inhibitors to accessing opportunities. Several articles were interested in accessibility in conjunction with addressing public health challenges (33%, N=13). Krogel et al. [96] used personas to improve affective engagement in mental health therapy to improve mental health problems in the general population. The goal of the project was to design and test graphics for an iPad app to help patients and caregivers communicate during mental health therapy. In their aesthetic design, the authors considered user accessibility as well as factors necessary for efficient doctor-patient communication. Meanwhile, Millen et al. aimed to increase accessibility of design activities to neurodivergent populations [111]. Their goal was to directly engage children with autism in the design of the technology. Structured surroundings and activities are typically preferred by children with autism, and compared to non-autistic children, when given too many undefined choices, they can get overwhelmed or agitated. As a result, children with autism have highly specific demands that limits the approaches that can be employed to engage them in product design. Driven by this need for design methodologies that are accessible, the authors tested the use of personas in participatory design sessions with the population, with great reception from the target population.

4.5.3 Enhance Civic Participation in Political Contexts. The third most common goal related to social good was enhancing civic participation (15%, N=6). The personas in these articles included relevant information on users' current political affiliations and activities, as well as perceptions they had of existing governing systems. For example, Bodker et al. [28] created 12 personas to represent behaviors of real individuals and segment the general Danish population according to desired communication methods with state and local authorities. By investigating factors influencing citizens' interaction with government entities, they successfully gathered relevant information to design effective digital platforms for civic engagement. Similarly, Kauppinen et al. [91] aimed to shift the administration-centered approach of public digital services into a new type of open innovation policy. Personas were created to determine factors necessary to encourage citizens to participate in governance processes.

4.5.4 Foster Cross-Cultural Communication. The fourth social good theme we identified was fostering cross-cultural communication. These articles developed personas specifically to create designs that would enhance diversity and inclusivity, particularly for underrepresented demographic groups. While certain articles meeting this aim were also concerned with increasing accessibility more generally (another aim we identified above, e.g. [111]), these articles were also distinguished by their focus on promoting dialogue between diverse groups. Personas in these articles included

data specifically aimed at celebrating diversity. For example, Elliott describes how persona posters, in particular, can facilitate bilingual collaboration in design initiatives. Among a group of designers where half spoke Japanese, and the other half spoke English, Japanese language materials were incorporated into the personas to reinforce that their “end-users were Japanese and that during the process of designing for them speaking Japanese is normal and necessary” [57:160]. This, in turn, reduced the prevalence of self-censorship in meetings where the Japanese designers would entertain whether their ideas were worth having translated into English. Indeed, the bilingual personas incentivized an open exchange of ideas by making it easier for the Japanese designers to take part nonverbally as well as feel included. Meanwhile, Anvari et al. [11] disseminated a set of six cross-cultural personas – each created to represent individuals in different cultures – to teach design students how to design for individuals from distinct cultural backgrounds. The authors reported that these cross-cultural personas successfully taught design students to think outside the box for users in diverse contexts that were different from their own.

5 DISCUSSION AND FUTURE RESEARCH DIRECTIONS

5.1 Discussion About Findings

The highlights from our findings are as follows:

- While software development unsurprisingly remains the top domain personas are applied to, increasingly more persona initiatives are aimed towards social good rather than mere business interests. Designs that applied personas to solve social issues were concerned with improving public health systems, accessibility, and civic participation, among others.
- Personas are versatile and can be flexibly applied to several stages of the design process, from initial conceptualization to final communication with stakeholders. As such, personas can be employed at virtually any stage prior to product and/or service deployment, including organization, prototyping, and user needs prioritization. Relatedly, personas can be combined with different methods to further strengthen decision-making. These assorted methods complement one another to validate observations and inform designs.
- Practitioners use a variety of heuristics to assess the quality of designs and the personas used to build them, such as ethnographic observations, expert verification, and usability testing. Further standardization is necessary so that the impact of personas in design can be reliably evaluated. Ideally, persona use cases will employ at least one to two methods in constructing designs.
- Corroborating the impact of persona use mainly relies on anecdotes instead of rigorous empirical testing or even systematically conducted case studies. This can be seen as a symptom of focusing on persona creation methods and considerably less on the application and impact side.
- Conceptual work is needed for mapping different problem areas requiring social change, then ideating ways personas could be part of solutions to socio-technical problems.

We identified several top domains of persona application—i.e., software development, healthcare, and higher education, among others—a feasible first step towards standardization could therefore be identifying best persona practices for effective design within domains. It would also be interesting to determine why personas are so prevalent in these relatively limited domains relative to others and not prevalent or widely used in other user-facing domains (e.g., information searching services, social media platforms, tourism). While there is great versatility in persona use cases in design, there is also a lack of standardization in documenting persona use cases. Such efforts are greatly needed to ensure the reliability of both personas and the designs they are applied to. Among the articles we reviewed, exemplary cases of reporting persona use include the following: [40, 76, 108, 141]. Researchers are encouraged to adopt aspects of reporting persona use from these studies, including (a) clear problem statement, (b) description of stakeholders, (c) documenting stakeholder involvement in persona creation, and (d) describing the precise use case of persona application.

Our review also highlights the flexibility of personas across different design stages, from initial conceptualization to final stakeholder communications. The analysis also revealed emerging innovations in personas' applicability to designs in robotic personas, along with increasing applications of personas to sophisticated dialogue and recommendation systems. Because the underlying technologies are evolving rapidly, there is limited evidence to substantiate how personas in these contexts benefit design. Further research is needed to identify the main benefits of personas in these contexts beyond general user understanding. Nevertheless, these examples demonstrate continuous possibilities for the refinement of personas; practitioners are therefore encouraged to test and report the adoption of these new technologies to further the field of personas.

Crucially, our findings also challenge the widely spread assumption that personas are very broadly used across different domains, which is a truism in the field [136]. While this is true to some extent, it is relatively straightforward to find areas where personas are actually underutilized. This observation is both concerning and promising at the same time – concerning in the sense that persona use shows some tendency of centralization or staling but promising in that there remains a large array of opportunities where personas can be of value. A useful analogy in this regard is the following: *as long as user insights are important in a given design case, personas have potential value*. Concerning the staling, we believe this is an artifact of HCI focus on specific types of design contexts: therefore, as HCI itself expands to new domains (which it does [22, 112]), personas can be expected to 'piggyback' in the wake. Especially important is the nascent trend of personas being applied to designs for social good (e.g., sustainability), as this movement encourages personas' applicability beyond business interests. There can be a growing recognition of personas outside of the software, UX, and marketing and personas' evolution towards becoming a user-centered knowledge generation method in other problem spaces. Practitioners and academics tackling challenges related to social good can look to the examples in the current study for how personas can enhance their understanding of segments of interest (which can also include "negative behaviors", such as toxic end-user types [105], as well as vulnerable/marginalized segments [67]). As personas continue to be adopted for social purposes, future research

should assess how persona use differs when applied for social versus commercial good. We will discuss these aspects in the following subsection.

5.2 Research Opportunities for Persona Application

The key focus of personas has often been derived from the needs of commercial organizations [118, 121]. This is perhaps because personas originate from the practical purpose of helping software developers to understand their users when developing commercial applications. Nevertheless, in computer science and HCI, researchers are increasingly paying attention to the societal ramifications of their tools and designs [64]. Catch-phrases such as 'data for social good', 'machine learning for good', etc., capture the objective of creating designs that at minimum are non-harmful and at maximum increase social good [61], defined as public or common utility derived from technology—as opposed to only serving limited stakeholder parties, such as business interests. Therefore, technology for social good deals with using technology for a positive social change, where positive is something that improves current social conditions for everyone or for disadvantaged groups such as politically marginalized, the elderly, women, etc.

While research on inclusive personas [67, 107] has addressed the issue of marginalized groups, these studies have often focused on persona *creation*, not the actual application of personas to solve the problems of minority groups. Creation is certainly important as it can be seen as an antecedent to action, but the action and the impact is eventually the goal of a socially good persona project. This is particularly important because, among some, personas have a reputation as 'nice to have' exercises rather than serious instruments for social change [130, 131]. Addressing social issues via personas can thus improve the justification of personas' usefulness as a design technique.

These considerations suggest that for personas to be beneficial across different use cases, a comprehensive understanding of the different types of information necessary to meet different design objectives is needed. Moreover, as human-centered design practices expand beyond the business world, there is an increasing need to understand what distinguishes effective persona use cases in these additional contexts from more traditional commercial applications. While personas could be used to address socio-technical problems, the field is currently lacking empirical work for developing personas as instruments for social change, as well as understanding what socially beneficial personas look like and how much (if at all) they differ from traditional user or design personas. As implied by previous literature, the goal of using personas for social good is compatible with the inherent capability of personas—seeing users as people and therefore as an instrument for understanding human behavior beyond the perspective of viewing the individual through the relatively shallow concept of a "user". For example, this property of personas is compatible with conflict resolution [143], which emphasizes the need for understanding the other party in order to form mutual trust and respect, despite the fact there exist fundamental disagreements. This example illustrates the fundamental value of connections between personas (and HCI in general) and other disciplines. While there have been multiple important efforts

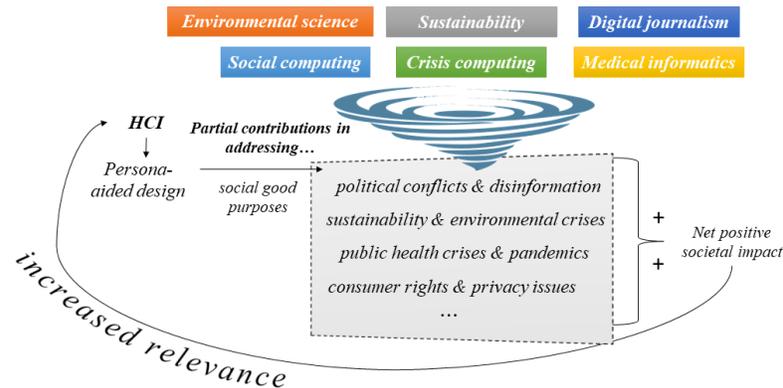


Figure 3: Illustration of example domains where persona-aided design can be part of solutions to social problems. The overarching benefit to the HCI community of applying UCD techniques to these problems is the discipline’s increased relevance.

to find mutual ground between HCI and other disciplines, including management information systems (MIS) [162], psychology [21], and politics [158], we believe this line of work should be further expanded to include personas.

As an example, applying personas to sustainable HCI (sHCI) [22, 50, 71] seems fruitful, as addressing many sustainability concerns requires understanding different human behaviors (e.g., excessive consumption). Another direction is social sciences, also referred to as social computing / computational social science, in which themes where persona-induced user understanding could be helpful include, e.g., political polarization, fake news/propaganda, online toxicity/cyberbullying, public health communication (e.g., vaccine hesitancy). Personas can both inform about different user types and the deviant behaviors taking place, but also help, by synthesizing information about different user types (e.g., victims and perpetrators), to design products, systems, apps, and algorithms that reward or penalize certain behaviors and therefore contribute to directing user behavior towards societally desirable outcomes.

Overall, many directions remain at this frontier for researchers to tackle, requiring dialogue with fields such as computational social science, digital journalism, crisis computing, sustainability, environmental science, and medical informatics, to name a few examples. Figure 3 illustrates this framework of thought.

While our review shows that persona-aided design has already established preliminary connections to several of these fields, it also reveals gaps in this regard, e.g., concerning contributions to public health crises, political conflicts and disinformation, consumer rights, and privacy, as well as sustainability and environmental issues. While we do not claim that personas (or any single design technique for that matter) are a decisive factor in addressing the world’s major problems, we do maintain that contextualizing

personas for addressing such problems is not a wasted effort. Realistically, personas and persona-aided design can have value as parts of broader socio-technical solutions [114].

Based on examples of topical social problems, in Table 6, we suggest some example social good use cases (SG) where persona-aided design could contribute to as partial solutions (including their relevance to the 17 United Nations Sustainable Development Goals, or SDGs). These originate from the authors’ past research experience.

After choosing a problem, researchers ought to think of creative ways of using personas to provide persona-aided design solutions to this problem by asking themselves, ‘How can personas be part of positive change in the problem area?’ Finding the answer is a creative, conceptual exercise, one that extends beyond software and HCI – to produce valuable social solutions through personas, researchers need to be cognizant of existing social processes, structures, and how the “real world” works when exposing personas in the wild. In most cases, the real problems cannot be solved purely with technology, but they require hybrid solutions that mix technology (personas) with some social processes. As a case in point, if personas were used to “build bridges” between opposite extremes, what are the counterarguments as to why this might *not* work? There can be many reasons. For example, people can refuse to change their existing beliefs no matter the information they are exposed to. Or, they might simply not care about personas, considering them “abstract and misleading” [108]. Therefore, researchers need to realistically assess the risks of and resistance to personas in context and be ready to adapt to unforeseen circumstances.

5.3 Future Research Questions

First, our findings imply that persona-aided design has considerable room for expansion in designing solutions across the broad spectrum of social dilemmas. To achieve such expansion, we believe

Table 6: Examples of social good persona use cases to contribute to SDGs.

SG	Persona use cases	Relevant SDGs
01	Personas for conflict resolution in political polarization. The problem of group polarization among society is well known [46, 81], with examples ranging from Israel–Palestine conflict to contemporary American politics; however, despite decades of research, group polarization remains unresolved to this day. Personas could contribute to “building bridges” across the polar extremes by communicating human qualities about one extreme side to the other side, thereby mitigating the dehumanization [72] taking place when participants vilify the other party.	Good health and well-being (SDG3); reduced inequalities (10); sustainable cities and communities (11); peace, justice, and strong institutions (16)
02	Identifying and understanding user groups that propagate fake news. Fake news propagation is a central dilemma of our time [34, 116]. Social media platforms make information dissemination easy, whether this information is used for good or bad purposes. Yet, it is not clear who spreads fake news [33]—while there are bots involved, who are the <i>people</i> involved, and what are their motives? Are there only malicious users or are people trolling out of boredom? Personas can help understand these groups and therefore be instrumental in their detection and possible isolation in social media platforms.	Good health and well-being (3); quality education (4); sustainable cities and communities (11); peace, justice, and strong institutions (16)
03	Understanding conspiracy theory communities (e.g., anti-vaccine, climate change deniers). Conspiracies can be comical, but they can also pose serious threats, such as prolonging global pandemics and increasing health crises via vaccine hesitancy [53]. Thus far, tactics like ignoring, ridiculing, or making fun of conspiracists have not proven effective [24]. Genuine understanding of the motives of these user groups, using personas, is thus suggested as a partial solution. As in the previous use case, personas can help because they portray conspiracists as human beings instead of labeling them as “raging lunatics”.	Good health and well-being (3); quality education (4); climate action (13); sustainable cities and communities (11); peace, justice, and strong institutions (16)
04	Providing aspirational personas for promoting public health. Coronary heart disease, diabetes, and other lifestyle diseases pose a public health crisis [39] – yet, research has shown that behavior change in the form of adopting a healthier lifestyle offers a feasible solution in preventing many of these diseases [123]. Nonetheless, the issue remains motivating people for action [92], even if it is for their own benefit. Can a persona representing a healthy living lifestyle act as role models to inspire consumers to make healthier choices in their everyday lives?	Good health and well-being (3); reduced inequalities (10); peace, justice, and strong institutions (16)
05	Providing aspirational personas for addressing climate change. Climate change is considered a mega-threat to human existence [15]. Scientists agree that carbon dioxide produced by human activity is at least partially affecting climate change [122]. Is it possible to introduce idealized personas to inspire consumers to follow more sustainable consumption patterns? Can the persona of a responsible consumer help consumers make more sustainable decisions in their everyday lives? Can aspirational personas motivate politicians and corporate leaders to make more sustainable decisions?	Good health and well-being (3); clean water and sanitation (6); affordable and clean energy (7); sustainable cities and communities (11); responsible consumption and production (12); climate action (13); life below water (14); life above land (15)

stronger dialogue between HCI and other fields would be mutually beneficial in order to overcome the problem of isolated domains. This dialogue is especially relevant for personas as a design technique, because unlike many other UCD tools that predominantly focus on usability issues, the versatility of personas in particular enables their utilization in any contexts where empathetic end-user understanding that perceives individuals holistically is a source of value. Therefore, we propose a future research question (FRQ), **FRQ1: How can persona use in design be expanded into new areas of social good?**

Second, another crucial factor to address is to overcome the reporting of persona use and their validation but to *truly* shift the

focus on applications. Here, it is vital to distinguish two types of design value from personas, **FRQ2: How do personas actually produce (a) first-party benefits to designers and (b) third-party benefits to end-users?** In other words, future research ought to consider both first-party and third-party value of personas. By first-party value, we refer to the benefits captured by the designer in their work, such as increased user understanding and empathy and facilitating the overall design process. By third-party value, we refer to the benefits realized for end-users, i.e., whether persona-aided design actually results in a higher usability / UX / social impact than if personas had not been part of the design process. This division of value distinguishes between the benefits for designers and the benefits for end-users.

Third, from an empirical standpoint, quantifying the value of persona use for design requires robust methodologies, beyond what the current body of literature entails. Hence, a vital question is **FRQ3: How to isolate the effect of personas as a design instrument relative to other methods?** For addressing this question, we recommend controlled experiments, where design techniques, included those mentioned in Section 4.4, are applied by designers in different combinations, omitting and including personas in the combination. By systematically testing the effect of persona use in isolation and in combination with other UCD techniques on outcome variables such as usability / UX / problem-solving aptitude [73], researchers can begin to dissect the “value added” of personas for design.

6 LIMITATIONS AND CONCLUDING REMARKS

As any research study, also ours comes with some limitations. We discuss the most notable ones in this section. First, while several articles applying personas to product development exist, in order to extract insights, we limited our inclusion criteria to articles that explicitly used personas while designing products and/or services. These strict criteria meant that personas that were applied for general market research purposes and could be used for designs, later on, were excluded, as such articles did not actually discuss an application to design. Second, articles that applied personas to better understand current end-users were excluded on the basis that such studies primarily took place once designs were already finalized and deployed and as such, personas were used to retroactively refine marketing strategies rather than to guide product design. Third, while we identified several articles during screening that employed personas in other diverse domains, such as security systems and autonomous vehicles—these articles were excluded because they did not provide how or evaluations of the impact of personas in their designs. Fourth, possible synonyms for “design task” (e.g., “design brief”) could have been included to expand the literature base. These considerations—while ultimately necessary—somewhat limit the generalizability of our findings to persona applications in design as a whole.

Further research on the applicability of personas in different contexts and stages of development is necessary to gain a more comprehensive understanding of their versatility and efficacy. Particularly important is incorporating practitioners’ views and experiences on using personas; thus, future work is encouraged to involve practitioners. The conclusion from our findings is that while personas intuitively make sense, quantifying their precise impact remains a scientific challenge. This line of inquiry can attempt to measure the experiences of designers (i.e., their assessment of how fluent a design process under different technique combinations was, perceived empathy and design creativity) as well as measuring the design outcomes (e.g., by using evaluation methods outlined in Section 4.3).

Finally, as persona research and use in design is constantly evolving, there is a need to continuously collect an evidence base of articles applying personas for a range of design tasks. We expect to accumulate more evidence and knowledge on persona use going forward, especially regarding societally impactful use cases. The SG use cases presented in this discussion are to be taken as cursory

and further, more principled development of research agenda for persona-aided design in social good use cases is needed. As an example, a practical starting point for this line of work is to consider how HCI, design, and personas specifically can be integrated into broader problem frameworks, such as United Nation’s SDGs, an area where (s)HCI still has a large space to contribute [71]. The examples from previous literature provide encouraging signs on the cross-disciplinary impact that this line of research can have.

REFERENCES

- [1] Tamara Adlin, Holly Jamesen, and Tony Krebs. 2001. Fake People and Sticky Notes: Fostering Communication for Human-Centered Software Design. *Whitepaper, published under: <http://www.jamesen.com/publications/FakePeople-G.pdf>* (2001).
- [2] Tamara Adlin and John Pruitt. 2010. *The Essential Persona Lifecycle: Your Guide to Building and Using Personas* (1st ed.). Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.
- [3] Cheryl Akner-Koler and Parivash Ranjbar. 2016. Integrating Sensitizing Labs in an Educational Design Process for Haptic Interaction. *FormAkademisk-forskningstidsskrift for design og designdidaktikk* 9, 2 (2016).
- [4] Maha AlJohani and James Blustein. 2015. Personas Help Understand Users’ Needs, Goals and Desires in an Online Institutional Repository. *World Academy of Science, Engineering and Technology International Journal of Computer and Information Engineering* 9, 2 (2015), 629–636.
- [5] Mawaddah AlSabban, Arwa Karim, Virginia H. Sun, Jood Hashim, and Osama AlSayed. 2020. Co-design of Color Identification Applications Using Scenario-Based Personas for People with Impaired Color Vision. In *International Conference on Human-Computer Interaction*, Springer, 171–183.
- [6] Jisun An, Haewoon Kwak, Soon-gyo Jung, Joni Salminen, and Bernard J. Jansen. 2018. Customer segmentation using online platforms: isolating behavioral and demographic segments for persona creation via aggregated user data. *Social Network Analysis and Mining* 8, 1 (2018), 54. DOI:<https://doi.org/10.1007/s13278-018-0531-0>
- [7] Jisun An, Haewoon Kwak, Joni Salminen, Soon-gyo Jung, and Bernard J. Jansen. 2018. Imaginary People Representing Real Numbers: Generating Personas from Online Social Media Data. *ACM Transactions on the Web (TWEB)* 12, 4 (2018), 27. DOI:<https://doi.org/10.1145/3265986>
- [8] Alissa Nicole Antle. 2006. Child-personas: fact or fiction? In *Proceedings of the 6th conference on Designing Interactive systems*, ACM, 22–30.
- [9] Farshid Anvari and Deborah Richards. 2015. Using personality traits and a spatial ability test to identify talented aspiring designers in User-Centred Design methodologies. In *2015 International Conference on Evaluation of Novel Approaches to Software Engineering (ENASE)*, IEEE, 90–101.
- [10] Farshid Anvari and Deborah Richards. 2016. A Method to Identify Talented Aspiring Designers in Use of Personas with Personality. In *Evaluation of Novel Approaches to Software Engineering*, Leszek A. Maciaszek and Joaquim Filipe (eds.). Springer International Publishing, Cham, 40–61. DOI:https://doi.org/10.1007/978-3-319-30243-0_3
- [11] Farshid Anvari, Deborah Richards, Michael Hitchens, and Hien Minh Thi Tran. 2019. Teaching user centered conceptual design using cross-cultural personas and peer reviews for a large cohort of students. In *2019 IEEE/ACM 41st International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET)*, IEEE, 62–73.
- [12] Farshid Anvari, Deborah Richards, Michael Hitchens, and Hien Minh Thi Tran. 2019. Teaching User Centered Conceptual Design Using Cross-Cultural Personas and Peer Reviews for a Large Cohort of Students. In *2019 IEEE/ACM 41st International Conference on Software Engineering: Software Engineering Education and Training (ICSE-SEET)*, 62–73. DOI:<https://doi.org/10.1109/ICSE-SEET.2019.00015>
- [13] Farshid Anvari and Hien Minh Tri Tran. 2013. Persona ontology for user centred design professionals. In *The ICIME 4th International Conference on Information Management and Evaluation*, Ho Chi Minh City, Vietnam, 35–44.
- [14] M. Aoyama. 2005. Persona-and-scenario based requirements engineering for software embedded in digital consumer products. In *Proceedings of the 13th IEEE International Conference on Requirements Engineering (RE’05)*, Washington, DC, USA, 85–94. DOI:<https://doi.org/10.1109/RE.2005.50>
- [15] David Archer and Stefan Rahmstorf. 2010. *The climate crisis: An introductory guide to climate change*. Cambridge University Press.
- [16] E. S. Arikoglu, Eric Blanco, Franck Pourroy, and B. J. Hicks. 2010. An empirical study to measure the effectiveness of scenarios to aid shared understanding of functional requirements. In *DS 60: Proceedings of DESIGN 2010, the 11th International Design Conference, Dubrovnik, Croatia*.
- [17] John Armitage. 2003. “And another thing... the current site is in German” the final project in an international digital business consultancy. In *Proceedings of the 2003 conference on Designing for user experiences*, 1–15.

- [18] Mattias Arvola and Johan Linder. 2018. Know Thy Users by Interpretative Phenomenological Analysis. *The Journal of Interaction Science* 6, (2018), 22–22.
- [19] A. Atzeni, C. Cameroni, S. Faily, J. Lyle, and I. Flechais. 2011. Here's Johnny: A Methodology for Developing Attacker Personas. In *2011 Sixth International Conference on Availability, Reliability and Security*, Vienna, Austria, 722–727. DOI:https://doi.org/10.1109/ARES.2011.115
- [20] Jan C. Aurich, Christian Fuchs, and Christian Wagenknecht. 2006. Life cycle oriented design of technical Product-Service Systems. *Journal of cleaner production* 14, 17 (2006), 1480–1494.
- [21] Ritwik Banerji. 2018. De-instrumentalizing hci: Social psychology, rapport formation, and interactions with artificial social agents. In *New Directions in Third Wave Human-Computer Interaction: Volume 1-Technologies*. Springer, 43–66.
- [22] Oliver Bates, Vanessa Thomas, Christian Remy, Lisa P. Nathan, Samuel Mann, and Adrian Friday. 2018. The Future of HCI and Sustainability: Championing Environmental and Social Justice. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–4.
- [23] Gökçe Elif Baykal, Maarten Van Mechelen, and Eva Eriksson. 2020. Collaborative technologies for children with special needs: A systematic literature review. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–13.
- [24] Stephanie Beene and Katie Greer. 2021. A call to action for librarians: Countering conspiracy theories in the age of QAnon. *The Journal of Academic Librarianship* 47, 1 (2021), 102292.
- [25] Jane Billestrup, Jan Stage, Anders Bruun, Lene Nielsen, and Kira S. Nielsen. 2014. Creating and Using Personas in Software Development: Experiences from Practice. In *Human-Centered Software Engineering* (Lecture Notes in Computer Science), Springer, Berlin, Heidelberg, 251–258. DOI:https://doi.org/10.1007/978-3-662-44811-3_16
- [26] Eric Blanco, Franck Pourroy, and Serap Arikoglu. 2014. Role of personas and scenarios in creating shared understanding of functional requirements: an empirical study. In *Design Computing and Cognition '12*. Springer, 61–78.
- [27] Asa Blomquist and Mattias Arvola. 2002. Personas in action: ethnography in an interaction design team. In *Proceedings of the second Nordic conference on Human-computer interaction*, 197–200.
- [28] Susanne Bødker, Ellen Christiansen, Tom Nyvang, and Pär-Ola Zander. 2012. Personas, people and participation: challenges from the trenches of local government. In *Proceedings of the 12th Participatory Design Conference on Research Papers: Volume 1 - PDC '12*, ACM Press, Roskilde, Denmark, 91. DOI:https://doi.org/10.1145/2347635.2347649
- [29] Nathalie Bonnardel, Mathieu Forens, and Maxime Lefevre. 2015. Enhancing Collective Creative Design? An exploratory study based on a dynamic persona in a virtual environment. In *Communication longue au 11th congress of European Academic of Design*.
- [30] Nathalie Bonnardel and Nicolas Pichot. 2020. Enhancing collaborative creativity with virtual dynamic personas. *Applied Ergonomics* 82, (January 2020), 102949. DOI:https://doi.org/10.1016/j.apergo.2019.102949
- [31] Richard D. Boyce, Isabelle Ragueneau-Majlessi, Jingjing Yu, Jessica Taysontheimer, Chris Kinsella, Eric Chou, Mathias Brochhausen, John Judkins, Brandon T. Gufford, Bruce E. Pinkleton, Rebecca Cooney, Mary F. Paine, and Jeannine S. McCune. 2018. Developing User Personas to Aid in the Design of a User-Centered Natural Product-Drug Interaction Information Resource for Researchers. *AMIA Annu Symp Proc* 2018, (December 2018), 279–287.
- [32] Christopher Brooks and Jim Greer. 2014. Explaining predictive models to learning specialists using personas. In *Proceedings of the Fourth International Conference on Learning Analytics And Knowledge - LAK '14*, ACM Press, Indianapolis, Indiana, 26–30. DOI:https://doi.org/10.1145/2567574.2567612
- [33] Laura Burbach, Patrick Halbach, Martina Ziefle, and André Calero Valdez. 2019. Who Shares Fake News in Online Social Networks? In *Proceedings of the 27th ACM Conference on User Modeling, Adaptation and Personalization* (UMAP '19), Association for Computing Machinery, New York, NY, USA, 234–242. DOI:https://doi.org/10.1145/3320435.3320456
- [34] Joanna M. Burkhardt. 2017. History of fake news. *Library Technology Reports* 53, 8 (2017), 5–9.
- [35] Alessandro Canossa and Anders Drachen. 2009. Play-Personas: Behaviours and Belief Systems in User-Centred Game Design. In *Human-Computer Interaction - INTERACT 2009* (Lecture Notes in Computer Science), Springer Berlin Heidelberg, Berlin, Heidelberg, 510–523. DOI:https://doi.org/10.1007/978-3-642-03658-3_55
- [36] John M. Carroll. 1997. Scenario-based design. In *Handbook of human-computer interaction*. Elsevier, 383–406.
- [37] Robert C. C. Chen, Wen Cing-Yan Nivala, and Chien-Bang Chen. 2011. Modeling the Role of Empathic Design Engaged Personas: An Emotional Design Approach. In *Universal Access in Human-Computer Interaction. Users Diversity*, Constantine Stephanidis (ed.), Springer Berlin Heidelberg, Berlin, Heidelberg, 22–31. DOI:https://doi.org/10.1007/978-3-642-21663-3_3
- [38] Xiantao Chen, Ying Liu, Ning Liu, and Xiaojie Wang. 2011. Can persona facilitate ideation? A comparative study on effects of personas in brainstorming. In *IFIP Conference on Human-Computer Interaction*, Springer, 491–494.
- [39] Taridzo Chomutare, Luis Fernandez-Luque, Eirik A. Arsand, and Gunnar Hartvigsen. 2011. Features of mobile diabetes applications: review of the literature and analysis of current applications compared against evidence-based guidelines. *Journal of medical Internet research* 13, 3 (2011), e65.
- [40] Jane Cleland-Huang, Adam Czauderna, and Ed Keenan. 2013. A Persona-Based Approach for Exploring Architecturally Significant Requirements in Agile Projects. In *Requirements Engineering: Foundation for Software Quality* (Lecture Notes in Computer Science), Springer, Berlin, Heidelberg, 18–33. DOI:https://doi.org/10.1007/978-3-642-37422-7_2
- [41] Alan Cooper. 1999. *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity* (1 edition ed.). Sams - Pearson Education, Indianapolis, IN.
- [42] Alan Cooper. 2004. *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity* (2nd Edition). Pearson Higher Education.
- [43] Bernard Crespi, Emma Leach, Natalie Dinsdale, Mikael Mokkonen, and Peter Hurd. 2016. Imagination in human social cognition, autism, and psychotic-affective conditions. *Cognition* 150, (2016), 181–199.
- [44] Abhishek Dahiya and Jyoti Kumar. User centric data shaping designer centric creativity: Observations from experimental study.
- [45] Stefano De Paoli, Nicolò De Uffici, and Vincenzo D'Andrea. 2012. Designing badges for a civic media platform: Reputation and named levels. In *26th Annual BCS Interaction Specialist Group Conference on Human-Computer Interaction*, BCS Learning & Development Ltd., 59–68.
- [46] Michela Del Vicario, Gianna Vivaldo, Alessandro Bessi, Fabiana Zollo, Antonio Scala, Guido Caldarelli, and Walter Quattrociocchi. 2016. Echo Chambers: Emotional Contagion and Group Polarization on Facebook. *Scientific Reports* 6, (December 2016), 37825. DOI:https://doi.org/10.1038/srep37825
- [47] Pallavi Dharwada, Joel S. Greenstein, Anand K. Gramopadhye, and Steve J. Davis. 2007. A Case Study on Use of Personas in Design and Development of an Audit Management System. In *Human Factors and Ergonomics Society Annual Meeting Proceedings*, 469–473.
- [48] Tawanna R. Dillahunt, Xinyi Wang, Earnest Wheeler, Hao Fei Cheng, Brent Hecht, and Haiyi Zhu. 2017. The sharing economy in computing: A systematic literature review. *Proceedings of the ACM on Human-Computer Interaction* 1, CSCW (2017), 38.
- [49] Mark J. Dobrow, Victoria Hagens, Roger Chafe, Terrence Sullivan, and Linda Rabeneck. 2018. Consolidated principles for screening based on a systematic review and consensus process. *Cmaj* 190, 14 (2018), E422–E429.
- [50] Paul Dourish. 2010. HCI and environmental sustainability: the politics of design and the design of politics. In *Proceedings of the 8th ACM conference on designing interactive systems*, 1–10.
- [51] Steven Dow, T. Scott Saponas, Yang Li, and James A. Landay. 2006. External representations in ubiquitous computing design and the implications for design tools. In *Proceedings of the 6th conference on Designing Interactive systems*, 241–250.
- [52] Vidya L. Drego, Moira Dorsey, Megan Burns, and Shelby Catino. 2010. *The ROI Of Personas*. Forrester Research. Retrieved from https://www.forrester.com/report/The+ROI+Of+Personas/-/E-RES55359
- [53] Eve Dubé, Caroline Laberge, Maryse Guay, Paul Bramadat, Réal Roy, and Julie A. Bettinger. 2013. Vaccine hesitancy: an overview. *Human vaccines & immunotherapeutics* 9, 8 (2013), 1763–1773.
- [54] Sabrina Duda. 2018. Personas—Who Owns Them. In *Omnichannel Branding: Digitalisierung als Basis erlebnis- und beziehungsorientierter Markenführung*, Victoria von Gizycki and Carola Anna Elias (eds.). Springer Fachmedien Wiesbaden, Wiesbaden, 173–191. DOI:https://doi.org/10.1007/978-3-658-21450-0_8
- [55] Ezequiel Duque, Guilherme Fonseca, Heitor Vieira, Gustavo Gontijo, and Lucila Ishitani. 2019. A systematic literature review on user centered design and participatory design with older people. In *Proceedings of the 18th Brazilian symposium on human factors in computing systems*, 1–11.
- [56] Matthias Egger, George Davey-Smith, and Douglas Altman. 2008. *Systematic reviews in health care: meta-analysis in context*. John Wiley & Sons.
- [57] Ame Elliott. 2005. Physical Artifacts For Promoting Bilingual Collaborative Design. In *Ethnographic Praxis in Industry Conference Proceedings*, Wiley Online Library, 158–164.
- [58] Nicole M. Else-Quest and Janet Shibley Hyde. 2016. Intersectionality in quantitative psychological research: I. Theoretical and epistemological issues. *Psychology of Women Quarterly* 40, 2 (2016), 155–170.
- [59] Shih-Chen Fan, Ming-Hui Wen, Chun-Tang Hsu, Chung-Hao Hung, Shang-Hwa Hsu, Ming-Chuen Chuang, John K. Zao, and Chin-Teng Lin. 2007. Health pal: a PDA phone that will take care of your health. In *2007 IEEE International Conference on Systems, Man and Cybernetics*, IEEE, 3703–3708.
- [60] Bruna Moraes Ferreira, Simone D. J. Barbosa, and Tayana Conte. 2016. PATHY: Using Empathy with Personas to Design Applications that Meet the Users' Needs. In *Human-Computer Interaction. Theory, Design, Development and Practice* (Lecture Notes in Computer Science), Springer International Publishing, Cham, 153–165. DOI:https://doi.org/10.1007/978-3-319-39510-4_15

- [61] Asbjørn Følstad, Petter Bae Brandtzaeg, Tom Feltwell, Effie LC Law, Manfred Tscheligi, and Ewa A. Luger. 2018. SIG: chatbots for social good. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–4.
- [62] Christopher Frauenberger, Judith Good, Wendy Keay-Bright, and Helen Pain. 2012. Interpreting input from children: a designerly approach. In *Proceedings of the SIGCHI conference on human factors in computing systems*, 2377–2386.
- [63] Diane Gal and Mark Lewis. 2018. Designing a programmatic digital learning environment: Lessons from prototyping. *Journal of Educational Technology Systems* 46, 3 (2018), 315–328.
- [64] Simson Garfinkel, Jeanna Matthews, Stuart S. Shapiro, and Jonathan M. Smith. 2017. Toward Algorithmic Transparency and Accountability. *Commun. ACM* 60, 9 (August 2017), 5–5. DOI:https://doi.org/10.1145/3125780
- [65] Chu Hiang Goh, Narayanan Kulathuramaiyer, and Tariq Zaman. 2017. Riding Waves of Change: A Review of Personas Research Landscape Based on the Three Waves of HCI. In *Information and Communication Technologies for Development (IFIP Advances in Information and Communication Technology)*, Springer International Publishing, Cham, 605–616. DOI:https://doi.org/10.1007/978-3-319-59111-7_49
- [66] A. Gonzalez De Heredia, J. Goodman-Deane, S. Waller, P. J. Clarkson, D. Justel, I. Iriarte, and J. Hernández. 2018. Personas for policy-making and healthcare design. In *Proceedings of International Design Conference, DESIGN*, 2645–2656. Retrieved October 24, 2019 from <http://publications.eng.cam.ac.uk/1037918/>
- [67] Joy Goodman-Deane, Sam Waller, Dana Demin, Arantxa González-de-Heredia, Mike Bradley, and John P. Clarkson. 2018. Evaluating Inclusivity using Quantitative Personas. In *In the Proceedings of Design Research Society Conference 2018*, Limerick, Ireland. DOI:https://doi.org/10.21606/drs.2018.400
- [68] Trisha Greenhalgh and Richard Peacock. 2005. Effectiveness and efficiency of search methods in systematic reviews of complex evidence: audit of primary sources. *BMJ* 331, 7524 (November 2005), 1064–1065. DOI:https://doi.org/10.1136/bmj.38636.593461.68
- [69] Jonathan Grudin. 2006. Why Personas Work: The Psychological Evidence. In *The Persona Lifecycle*, John Pruitt and Tamara Adlin (eds.). Elsevier, 642–663. DOI:https://doi.org/10.1016/B978-012566251-2/50013-7
- [70] Kathleen W. Guan, Joni Salminen, Lene Nielsen, Soon-Gyo Jung, and Bernard J. Jansen. 2021. Information Design for Personas in Four Professional Domains of User Experience Design, Healthcare, Market Research, and Social Media Strategy. In *Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS'21)*, Virtual conference, 10. DOI:https://doi.org/10.24251/HICSS.2021.540
- [71] Lon Åke Erni Johannes Hansson, Teresa Cerratto Pargman, and Daniel Sapiens Pargman. 2021. A Decade of Sustainable HCI: Connecting SHCI to the Sustainable Development Goals. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–19.
- [72] Nick Haslam. 2006. Dehumanization: An integrative review. *Personality and social psychology review* 10, 3 (2006), 252–264.
- [73] Gillian R. Hayes. 2014. Knowing by Doing: Action Research as an Approach to HCI. In *Ways of Knowing in HCI*, Judith S. Olson and Wendy A. Kellogg (eds.). Springer New York, New York, NY, 49–68. DOI:https://doi.org/10.1007/978-1-4939-0378-8_3
- [74] Niels Hendriks, Frederik Truyen, and Erik Duval. 2013. Designing with Dementia: Guidelines for Participatory Design together with Persons with Dementia. In *Human-Computer Interaction – INTERACT 2013 (Lecture Notes in Computer Science)*, Springer, Berlin, Heidelberg, 649–666. DOI:https://doi.org/10.1007/978-3-642-40483-2_46
- [75] Susanne Hensely-Schinking, Aparecido Fabiano Pinatti de Carvalho, Michael Glanznig, and Hilda Tellioglu. 2015. The Definition and Use of Personas in the Design of Technologies for Informal Caregivers. In *Human-Computer Interaction: Design and Evaluation*, Masaaki Kurosu (ed.). Springer International Publishing, Cham, 202–213. DOI:https://doi.org/10.1007/978-3-319-20901-2_19
- [76] Ilyena Hirskiy-Douglas, Janet C Read, and Matthew Horton. 2017. Animal Personas: Representing Dog Stakeholders in Interaction Design. In *Proceedings of the 31st British Computer Society Human Computer Interaction Conference (HCI '17)*, BCS Learning & Development Ltd., Swindon, UK, 37:1–37:13. DOI:https://doi.org/10.14236/ewic/HCI2017.37
- [77] Dan Högberg, Lars Hanson, Daniel Lundström, Maria Jönsson, and Dan Lämkuull. 2008. Representing the elderly in digital human modeling. In *Proceedings of the 40th Annual Nordic Ergonomic Society Conference, Reykjavik, Iceland*.
- [78] Richard J. Holden, Carly N. Daley, Robin S. Mickelson, Davide Bolchini, Tammy Toscos, Victor P. Cornet, Amy Miller, and Michael J. Mirro. 2020. Patient decision-making personas: An application of a patient-centered cognitive task analysis (P-CTA). *Applied Ergonomics* 87, (September 2020), 103107. DOI:https://doi.org/10.1016/j.apergo.2020.103107
- [79] Richard J. Holden, Anand Kulanthaivel, Saptarshi Purkayastha, Kathryn M. Goggins, and Sunil Kripalani. 2017. Know thy eHealth user: Development of biopsychosocial personas from a study of older adults with heart failure. *International Journal of Medical Informatics* 108, December (December 2017), 158–167. DOI:https://doi.org/10.1016/j.ijmedinf.2017.10.006
- [80] Kai Holländer, Mark Colley, Enrico Rukzio, and Andreas Butz. 2021. A Taxonomy of Vulnerable Road Users for HCI Based On A Systematic Literature Review. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–13.
- [81] Daniel J. Isenberg. 1986. Group polarization: A critical review and meta-analysis. *Journal of personality and social psychology* 50, 6 (1986), 1141.
- [82] Bernard J. Jansen, Soon-gyo Jung, Joni Salminen, Kathleen Guan, and Lene Nielsen. 2021. Strengths and Weaknesses of Persona Creation Methods: Outlining Guidelines for Novice and Experienced Users and Opportunities for Digital Innovations. In *Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS 2021)*, Virtual conference, 4971–4980. Retrieved from <http://hdl.handle.net/10125/71222>
- [83] Bernard Jansen, Joni Salminen, Soon-gyo Jung, and Kathleen Guan. 2021. *Data-Driven Personas* (1st ed.). Morgan & Claypool Publishers. Retrieved February 10, 2021 from <https://www.morganclaypool.com/doi/abs/10.2200/S01072ED1V01Y202101HCI048>
- [84] Angus Jenkinson. 1994. Beyond segmentation. *Journal of targeting, measurement and analysis for marketing* 3, 1 (1994), 60–72.
- [85] Matilde B. Jensen, Christer W. Elverum, and Martin Steinert. 2017. Eliciting unknown unknowns with prototypes: Introducing prototrials and prototrial-driven cultures. *Design Studies* 49, (2017), 1–31.
- [86] Martin Johansson and Jörn Messeter. 2005. Present-ing the user: constructing the persona. *Digital Creativity* 16, 04 (2005), 231–243.
- [87] Peter Jones. 2013. *Design for care: Innovating healthcare experience*. Rosenfeld Media.
- [88] Soon-gyo Jung, Joni Salminen, and Bernard J. Jansen. 2021. Persona Analytics: Implementing Mouse-tracking for an Interactive Persona System. In *Extended Abstracts of ACM Human Factors in Computing Systems - CHI EA '21*, ACM, Virtual conference. DOI:https://doi.org/10.1145/3411763.3451773
- [89] Kaho Kagohashi, Yuki Taoka, Takehiko Ohno, Nana Hamaguchi, Xinlei Chen, Kenta Amano, and Shigeki Saito. 2019. Doll Based Design Tool in Corporate Contexts: A Qualitative Comparison with Storyboard in a New Product Development Project. In *Proceedings of the Design Society: International Conference on Engineering Design*, Cambridge University Press, 1473–1482.
- [90] Laewoo Kang. 2016. Breaking andywall: Transgressive and playful exploration on the dynamic role of users in art and design. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 3855–3858.
- [91] Sami Kauppinen, Satu Luojus, and Janne Lahti. 2016. Involving citizens in open innovation process by means of gamification: The case of WeLive. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction*, 1–4.
- [92] Robert B. Kelly, Stephen J. Zyzanski, and Sonia A. Alemagno. 1991. Prediction of motivation and behavior change following health promotion: Role of health beliefs, social support, and self-efficacy. *Social science & medicine* 32, 3 (1991), 311–320.
- [93] Pramod Khambete, Debjani Roy, and Sujit Devkar. 2015. Validation of a Service Design Pattern Language as an Effective Framework for Multidisciplinary Design. In *Proceedings of the 7th International Conference on HCI, IndiaHCI 2015 - IndiaHCI'15*, ACM Press, Guwahati, India, 1–9. DOI:https://doi.org/10.1145/2835966.2835967
- [94] Euiyoung Kim, JungKyoonyoon Yoon, Jieun Kwon, Tiffany Liaw, and Alice M. Agogino. 2019. From Innocent Irene to Parental Patrick: Framing User Characteristics and Personas to Design for Cybersecurity. In *Proceedings of the Design Society: International Conference on Engineering Design*, Cambridge University Press, 1773–1782.
- [95] Euiyoung Kim, JungKyoonyoon Yoon, Jieun Kwon, Tiffany Liaw, and Alice M. Agogino. 2019. From Innocent Irene to Parental Patrick: Framing User Characteristics and Personas to Design for Cybersecurity. In *Proceedings of the Design Society: International Conference on Engineering Design*, Cambridge University Press, 1773–1782.
- [96] Erle Krøger, Frode Guribye, and Tor Gjørseter. 2015. Logging and visualizing affective interaction for mental health therapy. In *Norsk konferanse for organisasjoners bruk av IT*.
- [97] Sze Yin Kwok, David Harrison, and Alessio Malizia. 2017. Designing individualisation of eco information: A conceptual framework and design toolkit. *International Journal of Sustainable Engineering* 10, 6 (2017), 302–312.
- [98] Teemu H. Laine, Jörgen Normark, Helena Lindvall, Anna-Karin Lindqvist, and Stina Rutberg. 2020. A Distributed Multiplayer Game to Promote Active Transport at Workplaces: User-Centered Design, Implementation, and Lessons Learned. *IEEE Transactions on Games* 12, 4 (2020), 386–397.
- [99] Nicole Lazzaro. 2004. Why we play games: Four keys to more emotion in player experiences. In *Proceedings of GDC*, 1–8.
- [100] Brian Lee, Savil Srivastava, Ranjitha Kumar, Ronen Brafman, and Scott R. Klemmer. 2010. Designing with interactive example galleries. In *Proceedings of the SIGCHI conference on human factors in computing systems*, 2257–2266.
- [101] Frank Long. 2009. Real or imaginary: The effectiveness of using personas in product design. In *Proceedings of the Irish Ergonomics Society Annual Conference*, Irish Ergonomics Society Dublin.

- [102] M. Macdonald, R. Martin Misener, L. Weeks, and M. Helwig. 2016. Covidence vs Excel for the title and abstract review stage of a systematic review. *International Journal of Evidence-based Healthcare* 14, 4 (2016), 200–201.
- [103] Sabine Madsen and Lene Nielsen. 2010. Exploring Persona-Scenarios - Using Storytelling to Create Design Ideas. In *Human Work Interaction Design: Usability in Social, Cultural and Organizational Contexts*. Springer, Berlin, Heidelberg, 57–66. DOI:https://doi.org/10.1007/978-3-642-11762-6_5
- [104] Ronald Maier and Stefan Thalmann. 2010. Using personas for designing knowledge and learning services: results of an ethnographically informed study. *IJTEL* 2, 1/2 (2010), 58. DOI:https://doi.org/10.1504/IJTEL.2010.031260
- [105] Raghvendra Mall, Mridul Nagpal, Joni Salminen, Hind Almerekhi, Soon-Gyo Jung, and Bernard J. Jansen. 2020. Four Types of Toxic People: Characterizing Online Users' Toxicity over Time. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*, Association for Computing Machinery, New York, NY, USA, 1–11. Retrieved January 17, 2021 from https://doi.org/10.1145/3419249.3420142
- [106] Nicola Marsden and Maren Haag. 2016. Stereotypes and politics: reflections on personas. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 4017–4031.
- [107] Nicola Marsden and Maren Haag. 2016. Evaluation of GenderMag personas based on persona attributes and persona gender. In *International Conference on Human-Computer Interaction*, Springer, 122–127.
- [108] Tara Matthews, Tejinder Judge, and Steve Whittaker. 2012. How Do Designers and User Experience Professionals Actually Perceive and Use Personas? In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12)*, ACM, New York, NY, USA, 1219–1228. DOI:https://doi.org/10.1145/2207676.2208573
- [109] Karen McNally. 2021. Library Guides: Literature Review: Systematic literature reviews. Retrieved December 12, 2021 from https://libguides.csu.edu.au/review/Systematic
- [110] Allen E. Milewski, F. Cemile Serce, and K. Swigger. 2013. Quantitative and qualitative analysis of globally distributed team collaboration in design and development of software. In *2013 6th International Conference on Human System Interactions (HSI)*, IEEE, 443–450.
- [111] Laura Millen, Sue Cobb, and Harshada Patel. 2011. A method for involving children with autism in design. In *Proceedings of the 10th international conference on interaction design and children*, 185–188.
- [112] Florian Floyd Mueller, Pedro Lopes, Paul Strohmeier, Wendy Ju, Caitlyn Seim, Martin Weigel, Suranga Nanayakkara, Marianna Obrist, Zhuying Li, and Joseph Delfa. 2020. Next steps for human-computer integration. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–15.
- [113] Steve Mulder and Ziv Yaar. 2006. *The User is Always Right: A Practical Guide to Creating and Using Personas for the Web*. New Riders.
- [114] Enid Mumford. 2000. A socio-technical approach to systems design. *Requirements Engineering* 5, 2 (2000), 125–133.
- [115] Mekhail Mustak, Elina Jaakkola, and Aino Halinen. 2013. Customer participation and value creation: a systematic review and research implications. *Managing Service Quality: An International Journal* 23, 4 (2013), 341–359.
- [116] Preslav Nakov. 2020. Can We Spot the "Fake News" Before It Was Even Written? *arXiv preprint arXiv:2008.04374* (2020).
- [117] Jakob Nielsen. 1994. Enhancing the explanatory power of usability heuristics. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 152–158.
- [118] Lene Nielsen. 2019. Going Global—International Personas. In *Personas - User Focused Design*, Lene Nielsen (ed.). Springer, London, 123–133. DOI:https://doi.org/10.1007/978-1-4471-7427-1_7
- [119] Lene Nielsen. 2019. *Personas - User Focused Design* (2nd ed. 2019 edition ed.). Springer, New York, NY, USA.
- [120] Lene Nielsen, Kira Storgaard Hansen, Jan Stage, and Jane Billestrup. 2015. A Template for Design Personas: Analysis of 47 Persona Descriptions from Danish Industries and Organizations. *International Journal of Sociotechnology and Knowledge Development* 7, 1 (2015), 45–61. DOI:https://doi.org/10.4018/ijksd.2015010104
- [121] Lene Nielsen and Kira Storgaard Hansen. 2014. Personas is applicable: a study on the use of personas in Denmark. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, Toronto, Ontario, Canada, 1665–1674.
- [122] Naomi Oreskes. 2004. The scientific consensus on climate change. *Science* 306, 5702 (2004), 1686–1686.
- [123] Dean Ornish, Shirley E. Brown, J. H. Billings, L. W. Scherwitz, William T. Armstrong, Thomas A. Ports, Sandra M. McLanahan, Richard L. Kirkeede, K. L. Gould, and R. J. Brand. 1990. Can lifestyle changes reverse coronary heart disease?: The Lifestyle Heart Trial. *The Lancet* 336, 8708 (1990), 129–133.
- [124] Desen Sevi Ozkan, David Reeping, Lisa D. McNair, Tom L. Martin, Steve Harrison, Luke Lester, Ben Knapp, Matthew Wisnioski, Annie Patrick, and Liesl Baum. 2019. Using personas as curricular design tools: Engaging the boundaries of engineering culture. In *2019 IEEE Frontiers in Education Conference (FIE)*, IEEE, 1–7.
- [125] Jessica Pater, Amanda Coupe, Rachel Pfafman, Chanda Phelan, Tammy Toscos, and Maia Jacobs. 2021. Standardizing Reporting of Participant Compensation in HCI: A Systematic Literature Review and Recommendations for the Field. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–16.
- [126] John Pruitt and Jonathan Grudin. 2003. Personas: Practice and Theory. In *Proceedings of the 2003 Conference on Designing for User Experiences (DUX '03)*, ACM, San Francisco, California, USA, 1–15. DOI:https://doi.org/10.1145/997078.997089
- [127] Daniel J. Rea and James E. Young. 2019. Backseat teleoperator: affective feedback with on-screen agents to influence teleoperation. In *2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, IEEE, 19–28.
- [128] Blaine Reeder, Rebecca A. Hills, Anne M. Turner, and George Demiris. 2014. Participatory design of an integrated information system design to support public health nurses and nurse managers. *Public Health Nurs* 31, 2 (April 2014), 183–192. DOI:https://doi.org/10.1111/phn.12081
- [129] Valeria Righi, Sergio Sayago, and Josep Blat. 2017. When we talk about older people in HCI, who are we talking about? Towards a 'turn to community' in the design of technologies for a growing ageing population. *International Journal of Human-Computer Studies* 108, (2017), 15–31.
- [130] Kari Rönkkö. 2005. An Empirical Study Demonstrating How Different Design Constraints, Project Organization and Contexts Limited the Utility of Personas. In *Proceedings of the Proceedings of the 38th Annual Hawaii International Conference on System Sciences - Volume 08 (HICSS '05)*, IEEE Computer Society, Washington, DC, USA. DOI:https://doi.org/10.1109/HICSS.2005.85
- [131] Kari Rönkkö, Mats Hellman, Britta Kilander, and Yvonne Dittrich. 2004. Personas is Not Applicable: Local Remedies Interpreted in a Wider Context. In *Proceedings of the Eighth Conference on Participatory Design: Artful Integration: Interweaving Media, Materials and Practices - Volume 1 (PDC 04)*, ACM, Toronto, Ontario, Canada, 112–120. DOI:https://doi.org/10.1145/1011870.1011884
- [132] Bo Rundh. 2009. Packaging design: creating competitive advantage with product packaging. *British Food Journal* (2009).
- [133] Joni Salminen, Kathleen Guan, Soon-gyo Jung, Shammur Absar Chowdhury, and Bernard J. Jansen. 2020. A Literature Review of Quantitative Persona Creation. In *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, ACM, Honolulu, Hawaii, USA, 1–14. DOI:https://doi.org/10.1145/3313831.3376502
- [134] Joni Salminen, Kathleen Guan, Soon-Gyo Jung, and Bernard J. Jansen. 2021. A Survey of 15 Years of Data-Driven Persona Development. *International Journal of Human-Computer Interaction* 0, 0 (April 2021), 1–24. DOI:https://doi.org/10.1080/10447318.2021.1908670
- [135] Joni Salminen, Bernard J. Jansen, Jisun An, Haewoon Kwak, and Soon-gyo Jung. 2018. Are personas done? Evaluating their usefulness in the age of digital analytics. *Persona Studies* 4, 2 (November 2018), 47–65. DOI:https://doi.org/10.21153/psj2018vol4no2art737
- [136] Joni Salminen, Soon-Gyo Jung, Kamal Chhirang, and Bernard Jansen. 2021. Instilling Knowledge Claims of Personas from 346 Research Articles. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–9. Retrieved August 19, 2021 from https://doi.org/10.1145/3411763.3451619
- [137] Joni Salminen, Ilkka Kaate, Ahmed Mohamed Sayed Kamel, Soon-gyo Jung, and Bernard J. Jansen. 2020. How Does Personification Impact Ad Performance and Empathy? An Experiment with Online Advertising. *International Journal of Human-Computer Interaction* 0, 0 (August 2020), 1–15. DOI:https://doi.org/10.1080/10447318.2020.1809246
- [138] Joni Salminen, Sercan Şengün, Haewoon Kwak, Bernard J. Jansen, Jisun An, Soon-gyo Jung, Sarah Vieweg, and D. Fox Harrell. 2018. From 2,772 segments to five personas: Summarizing a diverse online audience by generating culturally adapted personas. *FM* 23, 6 (June 2018). DOI:https://doi.org/10.5210/fm.v23i6.8415
- [139] Thiago Freitas dos Santos, Danilo Gouveia de Castro, Andrey Araujo Masiero, and Plinio Thomaz Aquino Junior. 2014. Behavioral persona for human-robot interaction: a study based on pet robot. In *International Conference on Human-Computer Interaction*, Springer, 687–696.
- [140] Ari Schlesinger, W. Keith Edwards, and Rebecca E. Grinter. 2017. Intersectional HCI: Engaging identity through gender, race, and class. In *Proceedings of the 2017 CHI conference on human factors in computing systems*, 5412–5427.
- [141] Ingrid Konstane Ledel Solem, Cecilie Varsi, Hilde Eide, Olöf Birna Kristjansdóttir, Elin Børøund, Karlein MG Schreurs, Lori B. Waxenberg, Karen E. Weiss, Eleshia J. Morrison, and Mette Haaland-Øverby. 2020. A user-centered approach to an evidence-based electronic health pain management intervention for people with chronic pain: design and development of EPIO. *Journal of medical Internet research* 22, 1 (2020), e15889.
- [142] Marc Steen and Ibo Van de Poel. 2012. Making values explicit during the design process. *IEEE Technology and Society Magazine* 31, 4 (2012), 63–72.
- [143] Robert J. Sternberg and Lawrence J. Soriano. 1984. Styles of conflict resolution. *Journal of Personality and Social Psychology* 47, 1 (1984), 115.

- [144] Jennifer Stoll, David McColgin, Michelle Gregory, Vern Crow, and W. Keith Edwards. 2007. Exploiting the user: Adapting personas for use in security visualization design. In *Proceedings of the Fourth Workshop on Visualization for Computer Security*, Citeseer.
- [145] Neeraja Subrahmaniyan, D. Jeffery Higginbotham, and Ann M. Bisantz. 2018. Using Personas to Support Augmentative Alternative Communication Device Design: A Validation and Evaluation Study. *International Journal of Human-Computer Interaction* 34, 1 (2018), 84–97.
- [146] Simone Taffe. 2017. Who's in charge? End-users challenge graphic designers' intuition through visual verbal co-design. *The Design Journal* 20, sup1 (2017), S390–S400.
- [147] Anthony L. Threatt, Jessica Merino, Johnell O. Brooks, Stan Healy, Constance Truesdail, Joseph Manganelli, Ian Walker, and Keith Evan Green. 2017. The design, prototyping, and formative evaluation of an assistive robotic table (art) for stroke patients. *HERD: Health Environments Research & Design Journal* 10, 3 (2017), 152–169.
- [148] Phil Topham, Praminda Caleb-Solly, Paul Matthews, Andy Farmer, and Chris Mash. 2015. Mental health app design: A journey from concept to completion. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct*, 582–591.
- [149] Carole Torgerson. 2003. *Systematic Reviews*. A&C Black.
- [150] Nicholas True, Shad Gross, Chelsea Linder, Amber McAlpine, and Sri Putrevu. 2017. Bifurcating the User. In *International Conference of Design, User Experience, and Usability*, Springer, 313–329.
- [151] Phil Turner and Susan Turner. 2011. Is stereotyping inevitable when designing with personas? *Design studies* 32, 1 (2011), 30–44.
- [152] Ester Van Laar, Alexander JAM Van Deursen, Jan AGM Van Dijk, and Jos De Haan. 2017. The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in human behavior* 72, (2017), 577–588.
- [153] Gerrit C. van der Veer, Teresa Consiglio, and Laura Benvenuti. 2012. Service Design-a Structure for Learning before Teaching. *IxD&A* 13, (2012), 27–46.
- [154] Lise Vestergaard, Bettina Hauge, and Claus Thorp Hansen. 2016. Almost like being there; the power of personas when designing for foreign cultures. *CoDesign* 12, 4 (2016), 257–274.
- [155] Froukje Sleswijk Visser and Pieter Jan Stappers. 2007. Mind the face. In *Proceedings of the 2007 conference on Designing pleasurable products and interfaces*, 119–134.
- [156] Henriette C. van Vugt, Elly A. Konijn, Johan F. Hoorn, I. Keur, and Anton Eliéns. 2007. Realism is not all! User engagement with task-related interface characters. *Interacting with Computers* 19, 2 (2007), 267–280.
- [157] Anna Wilson, Stefano De Paoli, Paula Forbes, and Marco Sachy. 2018. Creating personas for political and social consciousness in HCI design. *Persona Studies* 4, 2 (2018), 25–46.
- [158] Peter Wright and John McCarthy. 2015. The politics and aesthetics of participatory HCI. *Interactions* 22, 6 (2015), 26–31.
- [159] Yu Xiao and Maria Watson. 2019. Guidance on Conducting a Systematic Literature Review. *Journal of Planning Education and Research* 39, 1 (March 2019), 93–112. DOI:<https://doi.org/10.1177/0739456X17723971>
- [160] Robert K. Yin. 2003. *Case Study Research: Design and Methods*. SAGE Publications.
- [161] John K. Zao, Shih-Chen Fan, Ming-Hui Wen, Chun-Tang Hsu, Chung-Hoo Hung, Shang-Hwa Hsu, and Ming-Chuen Chuang. 2007. Activity-oriented design of Health Pal: A smart phone for elders' healthcare support. *EURASIP Journal on Wireless Communications and Networking* 2008, (2007), 1–10.
- [162] Ping Zhang and Andrew Dillon. 2003. HCI and MIS: shared concerns. *International Journal of Human-Computer Studies* 59, 4 (2003), 397–402.
- [163] John Zimmerman, Anthony Tomasic, Charles Garrod, Daisy Yoo, Chaya Hiruncharoenvate, Rafae Aziz, Nikhil Ravi Thiruvengadam, Yun Huang, and Aaron Steinfeld. 2011. Field trial of tiramisu: crowd-sourcing bus arrival times to spur co-design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1677–1686.