A Holistic Approach: Personalizing Large Semi-Public Displays for Intercultural Groups

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Abstract

Personalizing user interfaces increases usability and user experience. Focusing on large-semi public displays as technology that shares its user interface with diverse people raises the question of whether and how personalization can occur and what kind of user involvement can be expected. Considering cultural design preferences for personalization is especially interesting, as it has been shown to increase usability within single-user applications. Therefore, this paper summarizes and clarifies the potential of personalization and user involvement in combination with large semi-public displays, which should be used by several users, considering cultural design preferences, and describes the challenges in this process. As a result, 15 culturally relevant user interface aspects were identified and assigned to personalization paradigms for a holistic analysis of their potential. This result provides a general basis for cultural adaptations and discussions about user involvement in the design process of large semi-public displays.

CCS Concepts

• **Social and professional topics** → **Cultural characteristics**; • **Human-centered computing** → *Computer supported cooperative work*; *User interface design*; **Displays and imagers**; • **Information systems** → **Personalization**.

Keywords

personalization, user involvement, adaptation, customization, large displays, cultural preferences

1 Introduction

Large semi-public displays with interactivity are an innovative solution to support the collaboration and knowledge exchange in small groups, even sometimes co-located, within a specific physical space [25]. They are wall displays showing content visible from the near and far, enabling direct interaction and passive use from a distance, displaying ambient information that may be helpful and interesting for the people around the display area [24]. For instance, such displays could be positioned in the coffee corner, as a semi-public place within an organization, and show information about colleagues, related departments, current projects running, social events happening, or general company-specific or field-specific news. The example we are working on for such applications are *CommunityMirrors* [27, 38, 46] (figure 1).

The location and purpose of these devices lead to a broad user group as they are supposed to be used by several users consecutively, sometimes even simultaneously. Consequently, the concept of personalization as "a process that changes the functionality, interface, information access, and content, or distinctiveness of a system to increase its personal relevance to an individual or a category of individuals." [13] for increasing the usability and user experience is becoming more challenging. Designing such a large semi-public display to support collaboration requires taking into account design preferences for all employees equally, which also means considering preferences based on their cultural background.

However, discussing the degree of user participation and what kind of personalization may be possible within such scenarios is relevant to ensure a successful personalization process. The anonymity of the actual user and real-time interaction with the system is a major challenge in personalizing large semi-public displays. Due to data privacy, it is often impossible to identify and authenticate single users, especially not in public areas, and thus, connecting their design preferences with the current user interface (UI) becomes ambitious. A promising approach could be to consider the design preferences of users that frequently reside in the display's location. This enables personalization based on group preferences. It would be fascinating to investigate the potentials based on the cultural preferences that deeply impact our perception of technology, providing a sense of like or dislike for the interaction with a UI. This is particularly true as the cultural diversity of employees in organizations continues to increase. As shown in previous work, the cultural adaptation of a UI for one specific user has proven to increase usability and user experience [15, 39–41, 43] and provides promising results as a basis to build upon and further investigate, how this *cultural* personalization can be transferred to *intercultural* personalization: Actively considering various cultural design preferences for a small group of users for the design of a shared UI [17, 44, 45]. However, focusing on the cultural backgrounds requires collecting their cultural experiences beforehand and deriving individual design preferences before aggregating and modeling the group preferences.

In this paper, we elaborate on the degree of user involvement and the personalization potentials regarding intercultural design preferences for the context of large interactive displays in semi-public, collaborative areas.

Therefore, the next section discusses the different potentials of "adaptation" and "customization" to analyze the required user involvement. Afterward, we summarize the personalization potentials by assigning various culturally relevant UI aspects, identified

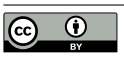

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Figure 1: The UI of the application "CommunityMirrors" for semi-public displays.

based on literature, to the personalization paradigms of Fan and Poole [13], as a holistic approach. Finally, a discussion provokes an overview of the challenges and open questions that still need to be answered.

2 User Involvement

To personalize a UI, it is important to consider the degree of user involvement. This can be distinguished between the two extremes: Adaptation and customization or adaptability [36]. While these terms sound rather similar, their meaning is quite different. Adaptive (adaptation) systems focus on initiating changes without user control, while adaptable (adaptability) describes the changes of a UI a user initiates [36]. Of course, there are some categories in between, but for this paper, we want to discuss which type of user involvement in general is most suitable for large semi-public displays.

Therefore, the following characteristics of large interactive wall displays in comparison to desktop applications by Huang et al. [24] support decide the degree of user involvement:

- Form factor: The physical size enables different interactions, visibility, and multi-user interactions, e.g., content is viewable from a greater distance than desktop applications. This affects the users' perception and interaction with these displays.
- Public audience and location: They are usually located in a common area, leading to different types and amounts of attention. Interacting with these displays is more visible and less private.
- Outside personal workspace: Interactions with these displays differ because they are located outside their personal space. This impacts the user's willingness to explore and discover the usage.
- Group owned: These displays are perceived as a group resource, where users feel less responsibility and personal ownership of the device, its content, and its use. This impacts the usage of the application and the interaction style with content.

Reflecting on these characteristics, some important aspects further indicate the degree of personalization: Firstly, the **duration of interaction**: Interactive Users, single- or multi-users, are not supposed to gather around the display and interact for several hours or longer. The use of the display is usually limited to a short time, especially if it is an application provoking situational awareness and serendipity, showing content that may be interesting for the users but not actively searched after. Secondly, the **individuals commitment**: As the display is a group resource, the responsibility for interacting or contributing to the display is relatively low. It is more convenient for users to consume what others have put on or what the display selected than to proactively contribute content or customize the UI. The display is much more expected to provide proactively relevant ambient information [27].

Considering this contextual situation, we conclude that personalizing a large semi-public display would be best without the users

initiating, discussing, and agreeing on a specific design, specifically when considering the typically very short interaction time and low user commitment. It would be most beneficial to focus on the **adaptation** potentials of such displays rather than their adaptability. Another reason for this becomes apparent when considering the intercultural preferences of a group. It is not necessarily obvious to the designers what design suits the group better, as cultural preferences are more unconscious and hard to express. It is more a feeling of liking or disliking a specific design aspect. Focusing on adaptation can assist in resolving this situation by selecting a design and content that most likely suit the user group's intercultural constellation.

3 Potentials for Intercultural Adaptation

A UI design of large semi-public displays can be personalized based on various user data, e.g., emotions [46]. Multiple studies show that our cultural background impacts the usability and user experience [2, 4, 9, 42], and that cultural adaptation is helpful in positively influencing them [41]. The difference to existing work is that it not only captures the cultural design preferences of individuals but also aggregates them and derive an intercultural adaptive UI for a small group of users. This will mainly involve users in the vicinity of the large semi-public display and who are to be supported by this device through ambient information sharing [44].

However, the questions arise: What are the UI aspects relevant to cultural adaptation? What is their personalization potential?

3.1 Cultural Design Preferences

Based on the literature, there are many insights regarding what design aspects are culturally relevant, which leads to UI aspects that are relevant for adaptation. These cultural design preferences are mainly based on analyzing Hofstede's six cultural dimensions [20, 22, 23] that describe cultural differences on a national level. Each cultural dimension represent societal differences and two extremes which are displayed with a value between 0 and 100. While below 50 is considered a low extent of the cultural dimensions, above 50 represents the opposite. Officially, values for about 119 countries on this scale have been identified [47].

In the adaptation process, we need to conduct **explicit data acquisition** to gather the cultural background from the users most frequently around the display, e.g., assigned to the office area. Trying to capture the cultural background implicitly would mean interpreting a person's nationality based on, for example, pictures or sensor data like speech. This would be ethically highly critical and biased prone. Consequently, it is necessary to gather this information explicitly. It should cover information about the user's cultural experience relevant to our UI design adaptations, e.g., current and previous residences, nationalities of their own and parents, etc. It relies on the work of Reinecke [39] and needs to be adapted to our use case, considering only necessary information for the UI aspects in the focus of adaptation, as they may differ from those mentioned in this work. Based on this information, the cultural profile is calculated, which results in a dataset of numerical values between 0 and 100 for the cultural dimensions of Hofstede. Based on the cultural differences displayed through Hofstede's cultural dimensions, design differences have been identified. Subsequently, this result can be further interpreted into design preferences, e.g., 30 as a low value for the dimension *power distance* leads to a high level of detail (less/low hierarchy).

Based on literature, we identified the following 15 UI aspects as culturally important for adaptation:

(1) **Navigation**: linear (display user's position) or non-linear navigation [5, 10, 21, 26, 28, 30–32, 48], various or strict navigational paths [1]
(2) **Access to functionalities**: high or low access to, or many or reduced choices of functionalities of the UI [5, 21, 31, 48]
(3) **Content structure**: highly structured content in blocks or unstructured, arrangeable content around focus point [29, 31, 35]
(4) **Level of detail**: low or strong hierarchy, most information visible at first sight (complex UI), few details at first sight (strong hierarchy) [5, 7, 8, 19, 28, 31, 32]
(5) **Feedback and error messages**: strict or friendly error messages and feedback [21, 28, 31], personal and kind or encouraging communication [6, 12, 21]
(6) **Support, assistance, and hints**: rare or strong support [31]
(7) **Content type**: focus on leaders or organization, or showing people in daily activities [16, 31], formal content community or product-related or focusing on individuals [31], formal content (work or community-related) or informal, humorous content, user-generated [3, 23, 35]
(8) **Informativeness of colors**: meaningful colors and symbols or colors used to encode information [31], encode colors, typography, sounds with information or increase coding with redundant color use [31, 32]
(9) **Picture-Text-Ratio**: high picture-to-text-ratio or high text-to-picture-ratio [16]
(10) **Multimodality**: high or low multimodality [18]
(11) **Colorfulness**: highly colorful or monotonously colored UI [2]
(12) **Saturation**: pastel colors (low) or bright, high contrast colors (high) [12, 48]
(13) **Density**: low or high content density [30, 31]
(14) **Gender roles**: strict or loose gender roles where applicable [35]
(15) **Joy of use**: formal, explainable interaction or gamification and fun interaction [35]

This overview provides general ideas of UI aspects where usability and user experience are impacted by culture. However, a further question is whether these 15 elements are all relevant for the UI of large semi-public displays and how they relate to personalization potentials.

3.2 Personalization Potentials

The identified 15 UI aspects can further be assigned to the design paradigms for personalization of Fan and Poole [13], which illustrates the personalization potentials systematically. The result is displayed in figure 2, which allocates the UI aspect 7 (content type) to the paradigm *commercial*. Assigned to the paradigm *architectural* are the UI aspects: 1 (navigation), 3 (structure), 4 (level of detail), 9 (picture-text-ratio), 11 (colorfulness), 12 (saturation), and 13 (density). The UI aspects for the paradigm *relational* are 5 (feedback,

error messages), 6 (support, assistance, hints), 8 (informativeness of colors), and 14 (gender roles). To the final paradigm *instrumental*, the UI aspects 2 (access to functionalities), 10 (multimodality), and 15 (joy of use) can be assigned.

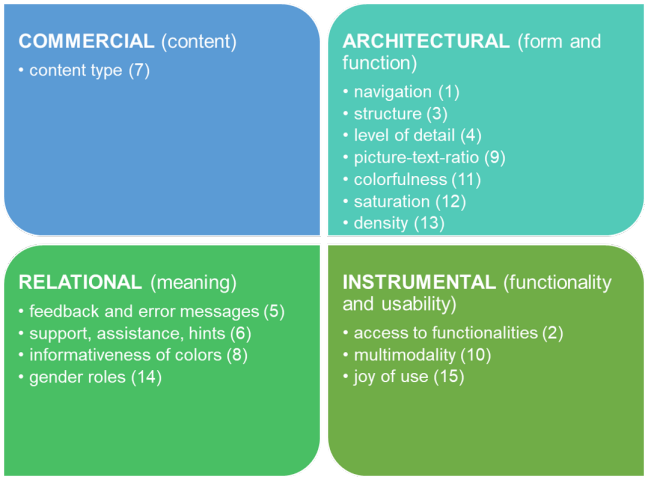

Figure 2: Design paradims by Fan and Poole [13] matching with culturally relevant UI design aspects.

Ensuring a holistic approach requires further inspection of at least one UI aspect for each design paradigm. For a more focused UI aspect selection of each paradigm, the most common ones for large interactive displays should be investigated as most applications would benefit from the adaptation analysis of such.

4 Challenges

Additionally, to the already mentioned challenges of identifying UI adaptations most relevant for large interactive displays, the question arises of how to decide on a design that should be usable and create a great user experience for a **group of users**. This means the personalization of such a UI requires considering diverse cultural preferences. The contextual use of this UI leads to intercultural situations, as several users are supposed to use the display, and thus to intercultural preferences: How can we bridge these cultural design preferences within a small group so that it increases the overall user experience? This major challenge of adapting a multi-user application, a "shared reality" [17], is to consider and consensually agree on the final design decisions or recommendations, especially when the preferences differ. This means to focus on a small group, including up to ten people, and on aggregating their design preferences. Within the research of group recommender systems [11, 14], various group modeling strategies [33, 34], based on the Social Choice Theory, are discussed and provide a great starting point to investigate the aggregation of cultural design preferences. Our future approach will focus on groups of about six people to represent an intercultural small group, as there are six Hofstede's cultural dimensions, each representing design preferences, and some of the group modeling approaches consider selecting at least one design preference that is most important for each group member. The number of six would ensure at least one preferred design choice. An interesting aspect would also be the homogeneity of a group as a factor that influences the success of aggregation strategies. Therefore, it is necessary to explore and discuss what is meant by homogeneity in the context of the intercultural group preferences. Initially, we think it is important to focus on the homogeneity of preferences within the cultural dimensions as it shows the differences and relations between users. One idea could be to use similarity metrics or k-medoid clustering to identify more of a "degree of design preference homogeneity" rather than a clear separation of homogeneous and heterogeneous groups. The factor of *homogeneity degree* could impact the success and selection of aggregation strategies and will be part of our future work.

5 Outlook and Conclusion

Based on the identified personalization potentials for large semi-public displays focusing on personalization using individual cultural design preferences, the next step will include demonstrating and evaluating two aggregation strategies and resulting adaptations for a sample application. Therefore, a systematic literature review will reveal UI aspects that are mostly relevant for large interactive displays based on their occurrence and lead to final general adaptation rules for UIs. Based on this result, we will transform the general adaptation rules into application-specific ones for the sample application *CommunityMirrors* [37, 38], an example of the UI is displayed in figure 1, conducting an expert workshop.

A *qualitative* evaluation of the individual's design preference aggregation will occur within four small groups of six participants to identify a group modeling approach suitable for this context and type of preference. This evaluation will also investigate whether and how the intercultural adaptation of such a UI impacts user experience. In conclusion, the evaluation will also consider the challenges mentioned in the previous sections and hopefully derive new insights on how to handle them.

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