Information Modelling and Knowledge Bases XXXVI
Y. Kiyoki et al. (Eds.)

doi:10.3233/FAIA241575

Exploring Effects of Uncertainty Avoidance in Self-Service Technology User Interface Design in Japan and Finland

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Abstract.

Geert Hofstede famously labelled culture as the "software of the mind", affecting how people cognitively process the world, and how organisations, communities and societies are structured. This lends to explain how culture influences the ways that people, perceive, use and experience technology design, and how within user experience design, cultural logic should be applied to develop user interfaces (UI). This study draws on Hofstede's cultural dimension of 'uncertainty avoidance' (UA) to examine how UA, or the ways in which people within certain cultures cope with uncertainty, unknown and change, to examine the influence of culture on self-service technology (STT) UI design. The authors evaluate a sample of ten UIs from various STTs in Japan, a country of higher UA (N=5), and Finland (N=5) a country of lower UA. The results show that in higher UA cultures design of STT's UI often rely on multimodal interaction, bright colours, and clear progress guidance via illustrations. However, we find also some contradictions in design solutions within the same cultures. It seems that instead of designers' cultural identities playing a role, designers' expertise in usability, company brand, and requirements by context affect how UI components are constructed. We discuss theoretical impacts of these manifestations of UI design on how they relate to accessibility and usability. As an implication to the practice, we propose a UI design assumption that embraces 'Zero Uncertainty', combining clear flow guidance, text and illustrations, with multi-modal guidance and feedback.

Keywords. Cross-cultural research; Cultural dimensions; Uncertainty avoidance; Self-service technologies; User interface design; Zero uncertainty

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1. Introduction

Digital interaction has become a new norm in our societies. The trend is to make public and commercial services digitally available for all [1]. Nowadays, people interact with digital services using self-service technologies (SST) almost everywhere in our daily life [2,3]. SSTs exist online, being accessed via our mobile devices and at home, as much as they exist in public spaces such as automatic teller machines (ATMs), self-service ticket machines and cashiers. The challenge is that while the technology is becoming aggressively uniform in its implementation – that is, SSTs are being implemented across the world regardless of cultural context – the cultures receiving the systems are not necessarily similar in terms of readiness and acceptance to adopt them [4,5]. Not only does technology as a phenomenon impact users' experiences from the perspective of culture, but the logic in which they are designed affects both how the technologies can be used (i.e., match to everyday cultural-linguistic logic), and how this design logic is, in itself, experienced. Thus, successful user interface (UI) engagement is both cognitive and affective [6], which lends them to be highly reliant on cultural context [7–9].

Not only do designers have the challenge of developing UIs for varied national cultural contexts worldwide, but within the nations themselves there is always a variety of cultural backgrounds and combinations of socio-technical acculturations. For instance, aspects such as age, educational background and level, and domain expertise encompass some cultural facets that impact how people understand and are able to use technology [10,11]. Another aspect that is high on the international human-computer interaction (HCI) agenda in terms of addressing issues of equality is neuro-sensory and physical diversity, or in other words, accessibility [12–14]. The idea is that if designs can be used by people who may experience greater challenges in engaging with systems (i.e., user interfacing), then they can be used by anyone [14]. Likewise, the principle behind accessible design is to design for all eventualities (i.e., ability types, language comprehension, expertise levels etc.), thus reducing uncertainty through pre-emptive design in order to maximise the potentialities to cater for all users.

In the case of SSTs and their role in a range of contextual, rapid transactions, there is a basic premise that the machines with be used by all and should be usable by all. Thus, ambiguity regarding users' backgrounds (cultural included) brings both uncertainty and accompanying pressure from the designer perspective. Moreover, from the user perspective, the possible uncertainty induced by UI design, particularly if it does not correspond with expectations of 'ease-of-use' and cultural conventions of information presentation, as well as contextually dependent logic (i.e., match to immediate environment and related systems), may generate states of anxiety. This is especially when considering the characteristics of self-service systems and the urgency of use when engaging with the machines (i.e., purchasing transport tickets, check-out situations, withdrawing money etc.) [6,15].

In the current paper, the authors apply Geert Hofstede's [16,17] cultural dimension of Uncertainty Avoidance (UA – minimizing the level of the unknown) as a concept to both explore the optimization of SST UI design for maximum end user diversity, as well as compare UI design approaches across cultures. The central research question (RQ) of the present study is: *How does uncertainty avoidance affect self-service technologies user interface?* To answer the RQ, we videoed a sample of ten different SSTs in Japan (N=5), and Finland (N=5) including Self-Ordering Kiosks (STK); Self-checkouts (SCO); Vending machines (VM); Ticket vending machines (TVM); and Automatic Teller

Machines (ATM). We evaluated STT user interfaces components, namely, metaphors, mental models, navigation, interaction, and appearance [18,19] to identify effects of UA on the design of SST UIs. Thus, the authors focus on two national cultural contexts – Japan and Finland – to examine whether or not the UA level (from low to high) impacts designers' approach to UI design, and how these potential differences affect the accessibility and interactions of the UIs for all. The paper begins by explaining UA according to Hofstede, then detailing the nature of cultural diversity and its relevance for designing SSTs in context. The HCI-focused UA framework developed by Marcus and Gould [20] is described, and then the context of the study (i.e., SST analysis in Japan and Finland) is outlined. The analysis and results are presented in light of a modified version of Marcus and Gould's UA framework.

2. Theoretical background

The concept of 'uncertainty avoidance' is an interesting one in this context. UA was applied by Geert Hofstede [16] in his research on cultures in organisations, and specifically his cultural dimensions models, which have been revised over the years. Hofstede argued that in relation to culture, UA refers to, "the extent to which the members of a culture feel threatened by uncertain or unknown situations" [16 p. 161]. Uncertainty in itself, alludes to the state of not knowing definite outcomes and progressions. The avoidance of uncertainty means that people will do anything they can to ensure that imminent outcomes and progressions of events are known. And/or, that conditions are established in which risks and surprises are kept to a minimum [21]. This renders the adoption of an UA lens pertinent in the context of cross-cultural HCI. Hofstede [16] applies UA to describe a dimension of cultures that is either likely to be troubled by unaccountable factors of the present and future or is more relaxed about these factors and willing to adapt to change. Even this explanation poses a tone of complexity, as it may be speculated as to whether or not cultures untroubled by uncertainty (i.e., lower on the UA scale) are this way due to their cultural conditions being categorised by imminent and constant change, or whether or not within these cultural groupings there are higher perceptions of stability and safety (i.e., higher standards of living and state supported welfare, and religion) that uncertainty does not present an immediate concern (see e.g., [22–24]. In either case, the more assured that individuals are of something 'higher' taking care of things, the less concerned they seem to be about uncertainty.

2.1. Uncertainty Avoidance and designing for diversity

People in cultures of high UA tend to avoid ambiguous situations and use their actions to make things clearly interpretable and predictable, even if it requires more work in advance, rather than acting and reacting when required [25]. When translating this cultural dimension to the world of user interface design, particularly in that of self-service technology, practitioners and scholars alike understand that there is always a great degree of uncertainty regarding users (user groups), demographics – education levels, cultural backgrounds, areas of expertise, age etc. – and the ways in which the UI designs will be perceived and understood. Regarding culture, cultural backgrounds not only vary between nations, but within nations. SST UI designers may enter paradoxical design solutions when creating UIs due to the range of factors that need to be accounted

for – information presentation, use flow and process guidance, context (ambient sensory environment, signifier-object relevance[2]). In response to user diversity [27–29] proposed the idea of designing culturally adaptive systems. These culturally adaptive systems were intended to automatically generate personalized interfaces that correspond with cultural preferences. One criticism towards this idea is that design patterns for cultural adaptive UIs are not realistic in practice. In addition to the complexity and scope of attempting to adapt to users across cultures, the factors of SST context, location, and cognitively challenging conditions of rapid use with time pressure, render cultural adaptation impractical. Therefore, we argue that the most effective approach to design for UA is to design for accessibility – removing uncertainty and ambiguity within the UIs induced by, i.e., reducing too much information, eliminating inconsistency in information presentation and lack of match to reality, while increasing readability through plain language [30–32] - requiring an integration of solutions [33]. In addition, Liljenberg, Tian, and Yao [34] argued that a single global interface can be deployed to maximize efficiency and experience.

Marcus and Gould [20] introduced general aspects in UI design that high-UA cultures emphasize, and similarly what low-UA cultures emphasize. However, less has been learnt about how the aspects proposed by Marcus and Gould, are applied in practice, particularly regarding what e.g., a high-UA layout entails, and what a low-UA layout entail. From the outset, it can be argued that the idea of designing for either high or low-UA cultures may be riddled with contradictions, as all UIs need to be understood and usable. The present study contributes to knowledge in this area, while exemplifying that to date, UA in the context of STT UA has been sorely understudied.

Previously Marcus and Gould [20] inspected how UA influences user interface and Web design. According to [20], the UA can be seen with certain impressive aspects that can be categorized as more appropriate to either high UA culture or low UA culture preferences. To categorize certain aspects of UA in user interfaces, Marcus [18,19] defined UIs as possessing the following give components: 1) metaphors, 2) mental models, 3) navigation, 4) interaction, and 5) appearance [18,19]. According to [20 p. 41], high UA cultures prefer simplicity in UI design, with clear metaphors, limited choices, and restricted amounts of data. Whereas low UA cultures prefer complexity with maximal content and choices (i.e., in terms of *metaphors*). High UA cultures prefer to see the results of interactions with certainty of the consequences or causal effects, before interacting with a UI. However, in low UA cultures there is a higher acceptance of risk and willingness to explore, with degrees of culture-originated trust that results in willing ignorance of the consequences of HCI-based actions (*mental models*). High UA cultures prefer navigation that clearly guides the user step-by-step, whereas low UA cultures prefer less UI control of *navigation*, allowing the user to do more independently. High UA cultures prefer practices to help reduce the likelihood of users making errors, whereas low UA prefer practices that help them to understand underlying concepts (*interaction*). High UA cultures prefer cues such as colours, typography, and sounds to help reduce ambiguity, whereas low UA cultures hope these cues will maximize information opening up the realm of interpretation (*appearance*).

[2] Refer to Rebekah Rousi's [26] cognitive semiotic model denoting the relationship between the signifying element/ sign / symbol (i.e., the information presented on the SST UI) and the object(s) to which the information refers. In ticket machines this refers to e.g., transport lines, in vending machines concrete products.

2.2. Related work

Faisal and colleagues [35] examined the effect of specific attributes involved in the design of e-commerce websites from the perspective of UA in cultures. Their findings drew attention to the fact that all web design attributes present in the study were observed as important in terms of building user trust and satisfaction for cultures of higher UA. User satisfaction was determined by interactivity, colour, and typography. However, trust was noted as being linked to the content quality and navigation and seemed to be a stronger determinant of loyalty that satisfaction for high UA cultures. Similarly, Ford & Kotzé [36] addressed UI design characteristics in connection with UA. They found that in high UA cultures, UI design characteristics were required to accommodate more usable interfaces for *all* users, regardless of background and capabilities, than those designed for low UA contexts.

It is however noteworthy to emphasise that some of the above-mentioned practices, e.g., the use of colours, are affected by also other cultural dimensions such religious background [20,30]. Additionally, there were more studies investigating how cultural background informs UI design. For instance, according to a study by [34], individuals in Eastern cultures (e.g., Chinese, Korean, Japanese) are more likely to absorb and accept more information content than individuals in Western (e.g., Anglo-American, European etc.) cultures. Conversely, it is suggested that Westerners often prefer to focus on fewer objects and may tend to use only key information [30,34]. It was also argued that while users deriving from Western cultures can use a Chinese-designed site, they often find the experience unpleasant, suggesting that a site with a lower information density is favourable for Westerners. On the other hand, the findings of their study show that Chinese users experienced the design of both types of websites as equally pleasant. The information density did not affect the level of pleasantness for participants deriving from Chinese cultural backgrounds.

Blut, Wang, and Schoefer [37] investigated factors influencing the acceptance of STTs. They found that UA was one cultural moderator that affects how users perceive technological usefulness and ease-of-use. According to [37], the effect of subjective norms (an important referent for individuals to perceive and/or communicate a belief in STT usefulness), and computer playfulness (general perceptions about technology use) is stronger in high UA cultures. Moreover, in high UA cultures, customers tend to prefer external instead of internal cues (experience) to reduce uncertainty. The effect of usefulness, and ease-of-use are stronger in low UA cultures. The need for interaction and more exploratory, interpretative use is stronger in low UA cultures [37]. Similarly, [38] found that when a new product or brand is established it implies some level of uncertainty from the consumer perspective. They found that people within a high UA culture are more sceptical than individuals in low UA cultures when evaluating new products that have high uncertainty. However, the impact of low product uncertainty on user experience, did not produce any significant difference between people in high or low UA cultures. Moreover, for people with more technological experience, and younger people, the effect of UA is reduced [38].

Overall, in their systematic study Lee et al. [2] examined 36 cultural dimensions, from which their research identified 10 critical cultural dimensions that are relevant and important for user experience: uncertainty avoidance, individualism vs. collectivism, masculinity vs. femininity, contextuality, time perception, time orientation, power distance, ascription versus achievement, affective vs. neutral, and controllability. These

resonate with Hofstede's cultural dimensions, yet, while Hofstede posits six dimensions - *power distance*, *uncertainty avoidance*, *individualism versus collectivism*, *masculinity versus femininity*, *long term versus short term orientation*, and *indulgence versus restraint* – Lee et al.'s model argues for time (perception and orientation) ascription versus achievement and controllability. It can be argued that the dimensions of time in Lee et al.'s model are loosely connected to Hofstede's long term versus short term dimension. Furthermore, when applying these dimensions to the logic of UI design, there are apparent overlaps between UA and long term versus short term orientation, as UA implies that design perspectives account for longer term predictive thinking (*mental models* that connect the UI to the real-world context and anticipate of achievement of interaction goals).

According to Reinecke and Bernstein [27,28], the usability and aesthetics of UIs rarely takes into account what users find beautiful and usable, which depends heavily on their cultural background. Admittedly, their studies were conducted over ten years ago and a lot has changed since then (see for instance, [39,40]), yet some of the guiding principles derived from their studies remain. For example, [41] found that Japanese websites use headings frequently and rely on a three-column layout without footer navigation. [27,28] argued that in order to personalise interfaces there was the need to integrate the cultural background of users, in order to appeal to users in an expanding market, to increase satisfaction, income and market share. However, in light of current economic and HCI discourse on trust, the findings of Faisal et al. [35] it is good to keep in mind that *trust* instilled through quality and reliability of information content presents higher competitive advantage over user satisfaction. Moreover, personalization related to UA can be adapted by providing functions to support workflow and process, as well as the provision of support. For example, this applies to whether or not other UI items are still available when the user should or is forced to focus on the current action, as well as the amount of on-site support if and when applicable [29].

According to Alsswey and Al-Samarraie [42], UA in user interface design is heavily related to information architecture. They argue that it influences the avoidance of complex displays and menus, unclear language, unusual icons and symbols, and inconsistent grouping functions. At the same time, designers should also focus on simple design features to avoid confusion among system users. While seemingly straight forward, the recommendations from previous studies may still be challenging to implement, also due to the cultural backgrounds of the designers themselves and how they perceive levels of uncertainty within their UI designs. For this reason, it is imperative to perform third-party evaluations on UIs in order to decipher potential cultural nuances that remain unnoticed by designers operating within their own national cultural contexts.

2.3. Context of the study

The SST UIs under investigation in the present study have been chosen from real-life self-service contexts in Japan and Finland. Both Finland and Japan are known for their comparatively higher standards of living and subjective wellbeing [43,44]. According to the OECD Better Life Index, Finland boasts an overall score of 7/8 while Japan holds a score of 5/8. This means theoretically that the UA should be lower in Finland than in Japan. According to the Hofstede-based Country Comparison Tool (Culture Factor

Group)[3] Finland scored 59 out of 100 for UA, while Japan scored 92 out of 100. Thus, Japan is one of the most uncertainty avoiding countries in the world, whereby the average is 69. In light of these figures, consistency can be observed between the relationship of perceived wellbeing and UA level for each country on average. In Finland, where the quality of living standard is higher, there is lower UA, and in Japan where the quality of living standard is perceived as slightly lower, the UA is higher.

In addition to the demographic facts, Japan offers an interesting field for research, as around the country alone there are approximately 4 million SST units. About half of these are vending machines, and the rest are for instance, ticket vending machines at train stations, and entrance ticket vending machines at public facilities. Considering the size of population and land area, Japan can be said to have the highest actual number of self-service technologies in the world (Japan Vending Systems Manufacturers Association, 2022; Nikkei Compass, 2023). Finland holds first place in the world as a country that enables, utilises, and benefits from digitalisation according to the Digibarometer [47]. In Finland, the use of digital public services is highest among the EU countries [48], due the fact that the digitalisation of public services has been one of the government's flagship projects since 2015 [1]. Therefore, from a technological maturity and experience perspective, both countries exist on a comparatively equal level regarding people's familiarity to both digitalisation and SSTs. This renders the operationalisation of UA as valid in the context of this study as the HCI factors of the studied phenomenon are relatively on par between the countries.

3. Method

This study was conducted via a qualitative expert inspection method performed by the paper's authors, based on a modified heuristic-like criteria established by Marcus and Gould [20]. Marcus and Gould's criteria had been created as an effort to translate the traits of UA into actionable design properties. The criteria represent five dimensions utilized in this study are: 1) *metaphors* (words, images, sounds, touch); 2) *mental models* (organization, functions, tasks, roles); 3) *navigation* (windows, dialogue boxes); 4) *interaction* (input/ feedback); and 5) *multi-sensory design*[4] (visual, verbal, acoustic and tactile). The multi-sensory design component of the UIs addresses the cognitively instrumental properties of aesthetic qualities within the designs (see [49]). With over 10 years of experience in HCI and user experience research and teaching, the authors changed the fifth dimension that was originally 'appearance' into 'multi-sensory design' as the dimension represents the degree of multi-modality in the sensory design of the UIs. The analysis of both experts was written up in an excel spreadsheet, and both were discussed in order to derive a consensus of results.

3.1. Data Collection

In the vein of HCI studies by (51,52) the authors adopted the use of photographs and videos as observational documentation tools to collect data for this study. Although popular among ethnographic and anthropological researchers, the use of photography

[3]https://www.hofstede-insights.com/country-comparison-tool

[4] This was "appearance" in Marcus and Gould's original article, but we have changed it as the criterion comprises multi-modalities.

and videos in data collection is still less used in the field of HCI, even though they are widely used in anthropology, sociology, ecology, geography, medicine, nursing, as well as in marketing research [51]. Photographs and videos have also been used to probe human behaviour, consumption, activities, and responses during interactions [51]. The authors of the current paper employed the method due to its affordances in capturing moments 'in-the-wild' (in ecologically valid contexts) of HCI [50]. It also enabled us to examine and analyse the data by going back and forth in recorded videos and inspecting details of the interactions [51]. The study was scoped to inspect only the UI displayed in a screen (touchscreens). Therefore, excluded from the analysis were interactions related to other parts of the devices, for instance inserting payment cards, and collecting tickets from slots. The data was collected during June 2023 in Tokyo area, Japan, and Finland. A random sample of SSTs was collected by the first author to be recorded from the streets, shops, malls, etc., regardless of their distributors/ companies. Five SSTs were selected from Japan (JP), and five corresponding types of SSTs from Finland (FI). The samples contained: Self-Checkouts (SCO); Ticket vending machines (TVM); Vending machines (VM); Automatic Teller Machines (ATM), and Self-Ordering Kiosks (SOK). The samples were labelled by country code and abbreviation of target SST, for example, self-checkout in Japan is named as "JP SCO". See Figure 1 and Figure 2.

Fig. 1 Sample of Self-Service Technologies in Japan

The images are arranged from self-service check-outs at the left, progressing to the ticket vending machines, vending machines, automatic teller machines and self-service kiosks. It is important to note that while our study focused on the interaction involved with the touchscreens, in Finland there was no virtual self-service vending machine. Thus, the video focused on the interaction between the live products and the keypads.

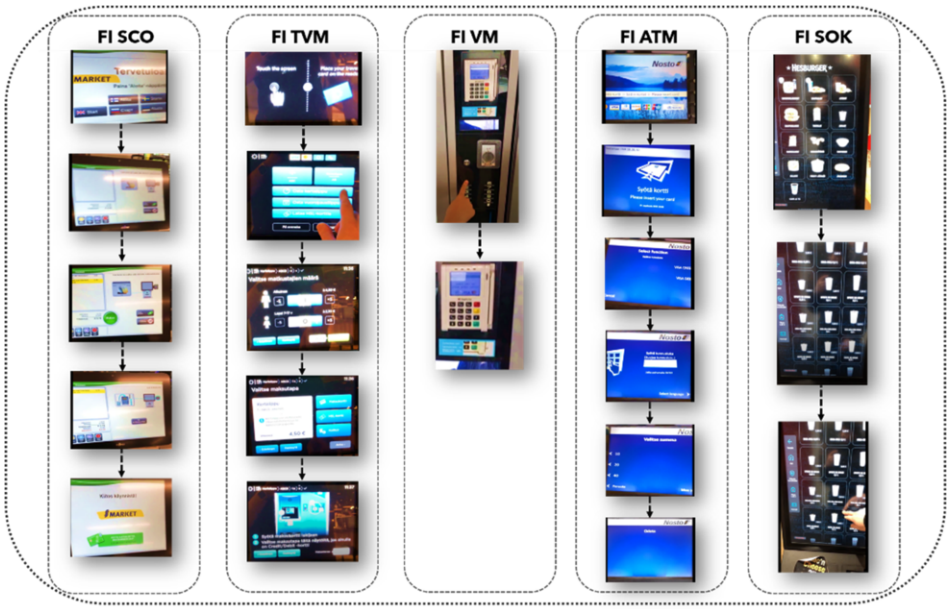

Fig. 2 Sample of Self-Service Technologies in Finland

The SSTs are presented according to the process of workflow that occurs when interacting with the SSTs in actual use. The progress of screens is denoted by the arrows. Thus, the first screen in the interaction series begins at the top of the figures and moves down to the end screen featured at the bottom of the flow images.

3.2. Data analysis framework

An analysis framework was composed by adapting the UI components including metaphors, mental models, navigation, interaction, and appearance [19,20,52] as a lens to retrieve information. The description of the information retrieved is presented in Table 1.

Table 1. User Interface Components Adopted From [19,52], and Information Retrieved in the Expert Review.

UI Component	**Information retrieved**	**Options**
Metaphors	Metaphors in words, images, sounds, or touch	Yes (What? How?)/No
Mental Models	Organization of data, functions, tasks, roles	Yes (What? How?)/No
Navigation	Movement through mental models	Yes (What? How?)/No
Interaction	Input/output techniques, and feedback	Yes (What? How?)/No
Appearance	Visual, verbal, acoustic, tactile information	Yes (What? How?)/No

The essential metaphorical items that appeared either in words, images, sounds, or touch were retrieved. A typical example of a metaphor is the desktop metaphor with a computer screen masked by documents and folders. In the case of SSTs, often used metaphors include ‘home’ icons (house images), left-facing (backwards in Western countries) and right-facing (forwards in Western countries) arrows. Items relating to mental models such as the organization of data, functions, tasks, and roles were also

reviewed in the data. Navigation items such as windows, dialogue boxes, breadcrumb, slider, search field, pagination, slider, tags, icons etc. were noted. Subsequently, items relating to the interaction were also isolated. These are input/output techniques, and feedback including checkboxes, radio buttons, dropdown lists, list boxes, buttons, toggles, text fields, date field etc. Lastly, we reviewed the appearance of the UI designs, paying close attention to the visual, verbal (human voice-like speech instructions), acoustic (audio-feedback), and tactile information. Other details within the scope of the analysis included forms (if any), charts, maps, and diagrams, tooltips, icons, progress bar, notifications, message or dialogue boxes, modal windows, and one-page layout scroll screens. The data was analysed according to these dimensions in an excel spreadsheet by both researchers. The results were compared and then synthesised by consensus for the purposes of this paper.

4. Findings

Similarly to in the studies of [19,52], the findings are organised according to the five UI design components mentioned above. First, the detailed interpretation of the target UI functions, and appearance of related components is provided followed by an overall evaluation per valuation of the component in question.

4.1. Metaphors

We collated our findings to metaphors in relation to words, images, sounds and touch. First, all of the inspected UIs (both from Japan and Finland) provided text in descriptions, functions, and notifications. The text is prescriptive text in the form of directions, instructions, rules, and/or interventions. An exceptional font size (i.e., larger), bolding or colour was used in some of the UI We collated our findings to metaphors in relation to words, images, sounds and touch. First, all of the inspected UIs (both from Japan and Finland) provided text in descriptions, functions, and notifications. The text is prescriptive text in the form of directions, instructions, rules, and/or interventions. An exceptional font size (i.e., larger), bolding or colour was used in two of the UIs (JP SCO, JP ATM), to emphasise critical questions against other options displayed in less pronounced representation (i.e., normal non-bolded font, or black colour). This strategy was also used in JP SCO, FI SCO, JP TVM, FI TVM to indicate the total sum of costs (money) for the selected products. The bolding and emphasising of text were used for illustrating main tasks (FI ATM), as well to welcome and express thanks for the use of the service (JP SCO, JP TVM, JP VM, JP ATM, JP SOK, FI SCO) (see Table 2.).

Table 2. Emphasising critical text according to cue, function and action

	JP SCO	JP TVM	JP VM	JP ATM	JP SOK	FI SCO	FI TVM	FI VM	FI ATM	FI SOK
Critical questions	X			X						
Main tasks									X	
Total sums	X	X				X	X			
Welcome / thanks	X	X	X	X	X	X				

Pictorial metaphors were used for a range of purposes. Icons were used to assist navigation, i.e., by displaying various pages (home, bonus, payment), ‘next buttons’ and

directions via arrows (JP SCO, JP ATM, JP SOK, FI SOK), products (JP VM, JP SOK, FI SOK), demonstrating required actions (JP SCO, JP TVM, JP ATM, FI SCO, FI TVM, FI ATM), and social-emotional interaction (JP SOK) (see Table 3.).

Table 3. Icons, directional (arrows and process flow), flags (language), images

	JP SCO	JP TVM	JP VM	JP ATM	JP SOK	FI SCO	FI TVM	FI VM	FI ATM	FI SOK
Navigation	X			X	X					X
Product			X		X					X
Action	X	X		X		X	X		X	
Interaction (Emot)					X					

Sounds were used in most of the SST UIs (eight out of 10), with verbal instructions given in JP SCO, JP ATM, FI SCO, FI TVM, and FI SOK. Acoustic sound effects were present to indicate required action and action feedback in JP VM, JP ATM, SP SOK, FI TVM, and FI VM (see Table 4.).

Table 4. Metaphors via sound – verbal (prescriptive) and acoustic (chimes, beeps, tones)

	JP SCO	JP TVM	JP VM	JP ATM	JP SOK	FI SCO	FI TVM	FI VM	FI ATM	FI SOK
Verbal	X			X		X	X			X
Acoustic	X	X	X	X	X		X	X		

There was a relatively equal distribution of metaphor elements in the SST UIs from both countries. Interestingly, the most remarkable difference rests in attention to social-emotional interaction observed in the Japanese UIs, emphasising the need to maintain a level of interpersonal exchange, even when a machine is in question when providing a service. Product purchasing and cash withdrawal services rely heavily in both countries on the pictorial demonstration of action (pictorial and animated instructions) to illustrate how to undertake tasks correctly, and the sequence of actions needed. Acoustic effects were more prominent in the Japanese UIs.

4.2. Mental Models

Exploring the mental models (an explanation of how UI works), we concentrated the inspection on the organization of data, functions, and tasks. For example, JP SCO and FI SCO UIs are organized in three sections: Company logo, sound button, cancel button as a header. Content is presented in solo sections that are directly related to the current task. The footer is used for the back and forward buttons (navigation). The FI SCO had three sections on left: list of products, summary of products scanned into the system, and functions for settings. On the right-side of the screen were instructions (demonstration images of task) and prompts.

Overall, the UIs were task-driven, organising the available options, information, content (products, quantities, amounts etc.). The core task is presented in the middle of the UI in order to capture user focus. The conduction of the core task is helped with the instructional illustration. For example, JP SCO, JP TVM, JP ATM, JP SOK, FI SCO, FI TVM, and FI ATM displayed the instructional illustration of the task (e.g. insert money) to help user understand the task to be conducted or act. Moreover, minimal information content was used to de-clutter and direct attention in the designs of JP SCO, JP SOK, FI SCO, and FI ATM. An abundance of options and information content are evidenced in

JP TVM, JP ATM, and FI SOK. Thus, the use contexts of shop cashiers in which there is the assumption of long queues and fast action needed, emphasise minimal designs in both countries. The ordering of food in the Japanese example is more focused by de-cluttering, while in the Finnish context the ATM machine is most minimal.

4.3. Navigation

Overall, all sampled SSTs demonstrated a simple "card grid" type of navigation, while the FI SOK additionally comprised a screen scroll function in the one-page grid layout. JP TVM, JP VM, JP ATM, FI SCO did not provide an opportunity to explore the UI but guides the user forward in the process. JP SCO and FI TVM's navigation were only based on "back" and "forward" buttons that are indicated with the icon and text. JP SOK provided breadcrumbs in the presentation of the payment procedure (separate device). JP SOK featured two similar menu bar side by side that may confuse the main menu with the secondary menu. The FI SOK UI was the most pronounced with navigation anchoring instilled by constant page icons (i.e., home, sign-in, bonus, coupon, checkout) on lining the left-hand side of the screen. This feature aided in grounding the screen scroll feature necessary for navigating the products.

4.4. Interaction

As the interaction of all sample SSTs is based on the user's selection of options and function i.e. clicking buttons, UI feedback is addressed in two ways: button click effect of highlighted and/or colour-changing (JP TVM, JP VM, JP ATM, JP SOK, FI SCO, FI TVM, and FI SOK), button sound effects and tones (JP SCO, JP TVM, JP VM, JP ATM, JP SOK, FI TVM, and FI VM). As mentioned above, social-emotional interaction in the form of the vector of a bowing waiter only occurred in JP SOK. With greetings and salutations ('thank you') being prominent in the Japanese UIs.

4.5. Multi-sensory [Appearance in the original model]

Drawing on the importance of multi-sensory design for cognitive fluency in interaction, and aesthetic usability specified by [50]. The original component of 'appearance' was modified. Thus, here we focused on the aspects of visual, verbal, acoustic, and tactile information. These are all integrated into the above-mentioned UI components, yet here we focus specifically on the aesthetic quality of the multi-sensory design. Related to the interaction with UI buttons, 'buttonization' as a visual effect is used widely. Icons are used in buttons (JP SCO, JP ATM, FI SCO, FI TVM, FI SOK). Some of the samples follow the colour theme of the distributor's brand when each button is coloured according to the brand (JP SCO, JP ATM, FI SCO, FI TVM, FI ATM) (see Table 4.).

Table 4. Metaphors via sound – verbal (prescriptive) and acoustic (chimes, beeps, tones)

	JP SCO	JP TVM	JP VM	JP ATM	JP SOK	FI SCO	FI TVM	FI VM	FI ATM	FI SOK
Buttonization	X			X		X	X			X
Brand	X			X		X	X			X
Colour coding		X		X	X	X	X			

Colour coding in buttons is used to indicate functions. However, we did not identify universal standards. Instead, some contradictions were found. For example, red button in JP ATM indicated "cancel", in FI SCO "call staff", and in JP SOK "place order". Green button was found to indicate "ok" in JP ATM, "back" in JP SOK, and "pay" in FI SCO. Yellow button indicated "delete purchases" in FI SCO, and "continue" in FI TVM. Even though all of the sample UIs except FI VM are based on touchscreen, we did not identify any SST providing tactile modality for the interaction.

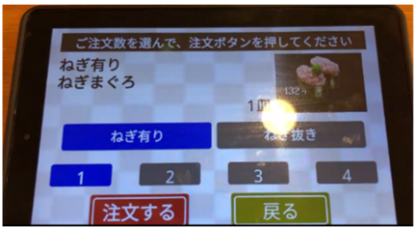

Fig. 3 Close-up of JP SOK – pay attention to the red 'order' button (left), and green 'back' button at right

In Figure 3, we observe interesting design choices in terms of the fact that firstly, the colour-coding appears inconsistent – red button placed on left for 'order', and the green button positioned at the right for 'back'. Thus, the logic reflects a more traditional Japanese reading style – right to left. Yet, the rest of the menu complies with Western reading conventions from left to right.

5. Discussion

In this paper, we evaluated how 'uncertainty avoidance' defined by Geert Hofstede (2001) may influence the UI design of SSTs in two national contexts – Japan and Finland. Our sample contained SSTs in Japan (*N*=5), a country of higher UA (92/100), and Finland (*N*=5) a country of lower UA (59/100). As a lens in the evaluation, we adapted Marcus and Gould's five UI components: metaphors, mental models, navigation, interaction, and appearance [18,19] that was transformed into *multi-sensory* based on Rousi and Silvennoinen's [49] observations on the organisation of complex information into simplicity and processing fluency. The results demonstrate that several typical characteristics in UI components are present in the SSTs from both national contexts, that reflect the suggested UA components of UI design. These are:

- Metaphors: Prescriptive text is utilized in buttons, descriptions, and notifications, in addition to images, animations, and arrows.
- Mental Models: UIs possess task and process-driven focus. Tasks are presented one step per screen, and the core task is presented in the middle of the UI to capture and maintain user focus.
- Navigation: Linear navigation structure. UIs provide less options to freely explore the UI to avoid confusion.
- Interaction: Multimodal feedback (acoustic and visual) is utilized in the buttons.

- Appearance: Prescriptive text is emphasised by variance in font size, text bolding, and colours. Voice guidance is utilized, and demonstrations images of the tasks are provided to help users to understand needed action.

Interestingly, there are various aspects that drew the authors' attention during the analysis. Firstly, the minimal design, icon presence, consistency and brand uniformity of the SSTs in Finland. Although Finland is said to have a higher tolerance for uncertainty, the UIs are designed in such a way – both informationally, workflow-wise and aesthetically – that uncertainty is less likely to arise. There is some form of continuity from one screen to the next that minimises surprises and maintains user experience uniformity. This may appeal to diverse user groups as the predictability is maintained through the minimal consistent design ethos of most SSTs (with the FI VM as an exception due to its analogue nature). More acoustics and verbal instructions were given in the Japanese SST UIs. This provided higher levels of multi-sensory input that are effective: a) when understanding the use context in which the SST exists; and b) the language of instructions. Language could be selected in most of the cases, Japanese UIs possessed a language option for English. Finnish UIs for two or more languages. Language could be selected in FI SOC, FI TVM, and FI ATM most obviously. Thus, once more, non-context specific understandability was important within the Finnish SST UI designs.

Fig. 4. Bowing image of JP SOK (centre) may resemble without the context and/or additional information (text) both the 'You're welcome' bow and 'Sincere apologies'

However, a point to note was the emphasis on social-emotional design in the Japanese examples (see Figure 4). In the tradition of Kansei engineering [53], the emphasis on emotions to support usability and ergonomics is important. Social-emotional response not only indicates respect for the customer but affirms a successful transaction and instils a sense of safety [54] a dimension of cultural experience that may not only be lacking from the UI design in Finnish SSTs, but perhaps also live human-to-human customer service. Thus, the social-emotional dimension of service provision is somewhat understated from a utilitarian perspective and should be investigated more in future SST UI design studies.

5.1. Theoretical contributions

In a light of this study, we argue that design aspects of web design presented by [20] accommodating for uncertainty avoidance in cultures do not necessarily apply uniformly to SST design. This is perhaps due to the fact that the UI elements and their characteristics proposed by Marcus and Gould [20] have not been systematically considered as main-stay in interaction design education and are not standardised within international design guidelines. With this said, regulations such as the European Accessibility Act [55] can be considered a strive towards designing for UA, in as far as if design can be used by diverse groups within populations, then it can be assumed that

the designers (and guidelines) are pre-empting uncertainty. Yet, as this study demonstrates, high UA does not necessarily mean consistent, ease-to-use, and minimalistic UIs – if returning to the traditions, they may be highly complex due the large amount of text in buttons, descriptions, and notifications as well as complex colour coding. By reducing choices, restricting the number of options, and decreasing the information amount on the screens, simplicity is increased. In a case the of STTs, the context of use is a significant driver for the UI design. Thus, navigation for instance, needs to be easy and fast to use, while metaphors are semantically close to the functions and actions they indicate. High UA cultures are said to prefer controlled navigation that do not allow user to become confused or lost [20]. It can be agreed that the designs of the sample UIs follow simple navigation principles (one screen per action, back and forward arrows, icons indicating home page). Although most of the sample UIs provided linear navigation structures with few options to explore, the navigation of SOKs in both countries is based on hierarchical product categories allowing the user to explore the content freely. Samples included practices that help users to focus on the task at hand and help them understand how to use the SST. As an example, demonstrative illustrations of the tasks are utilized to help the users focus and understand the interaction process. In addition, colours, typography, and sounds [20,35] are utilized to provide cues in order to help users' understanding.

Prior studies such as [36] found that in high UA cultures, UI design characteristics were required to accommodate more usable interfaces for *all* users. In the case of the present study, the authors are left wondering whether or not the cultural experience of UA originates from innate uncertainty within cultural practice, thus, establishing different points of departure in terms of what people within a culture may experience as UA. Perhaps, the UI designs observed in the Finnish context indicate that within the Finnish culture and associated cultural products, there are indeed high levels of certainty and predictability via uniformity. That is, within the Finnish cultural context perceptions of UA are low because there are the expectations that uncertainty and the likelihood of the unknown are not in fact high. Whereas, within the Japanese context there may be more variation, i.e., in design approaches, cultural practices, and even living conditions that may be induced by factors such as geographic circumstances (likelihood of natural disasters), higher population rates, with more people per square kilometre, that brace people towards an expectation of uncertainty. Contextual knowledge within Japan, and assumed language knowledge (i.e., more people speaking Japanese than people speaking Finnish) may also be interpreted by Japanese SST users as intuitive elements of the UI design.

With this said, from a multi-cultural perspective, we may also consider the expertise of UI designers and their familiarity in designing for people in respect to a) uncertainty avoidance; and b) diversity. Globally, Finland has a relatively small population, and an assumed disposition towards limited numbers of people being either familiar with Finnish culture, or fluent in the language. There is a mind-set that not all immigrants learn the language. There are also pressures that accompany European Union membership towards designing for accessibility as seen in the European Accessibility Act [55,56]. These are all factors that should be taken into account when endeavouring upon a comparative study of UI design.

5.2. Implications for practice

As an implication for SST UI design practice, we propose overall SST UI design assumptions that embrace 'Zero Uncertainty'. A step toward *Zero Uncertainty* can be achieved by combining clear flow guidance, consistency in iconography, colours and layout, text and illustrations (including simple animations), with multi-modal guidance and feedback. Clear flow guidance such as use of arrows that follow colour conventions (e.g., red for cancel, green for continue), and limiting the information according to that which is necessary for the workflow. Whenever possible, language selection increases the potential user pool of the SSTs. Likewise, consistency in the location of buttons and functions should be maintained on each progressive screen. Stable icon selections that repeat on each screen allowing the user to navigate directly to a desired location can enhance the experience of usability. Following a zero uncertainty approach would have further reaching effects on a societal level, due to the extent to which societies continually rely on automated and self-service technologies. This approach would be reinforced by a rigorous large-scale study of the user interfaces in situ - accounting for the multi-sensory experience of these devices i.e., in train stations, restaurants, shopping malls. Interference generated by environmental conditions would indicate the types of design properties the user interfaces would need to support understanding regardless of the context.

6. Limitations and future research directions

The results of this study have been obtained by analysing limited amount of different STTs. The sample comprised 10 UIs, five from two different countries. Thus, the first obvious limitation pertains to the lack of generalizability enabled by such a small sample of both SST UIs as well as country samples. Moreover, the samples were analysed by two researchers living in Finland, possessing a Finnish and Australian (also related to North-Western European perspectives) viewpoints towards design experience as well as the subject in general.

The authors additionally identified some contradictions, which require more research:

- UI layout is simple (one step in one view) >< sometimes all functions are presented in one view, and abundant text is presented inducing complexity
- Navigation is complex in light of menu design >< no particular navigation, the user is guided step-by-step
- Use of colours: red button is indication cancel / remove / delete >< order. Yellow is indicating 'clear' in JP AMT >< 'continue' in FI TVM

There are indications that designs in high UA cultures should theoretically be close to design aspects in accessibility design. Yet, within this study our results are contradictory to this observation. This warrants more investigation, and potentially indicates that there is a need to develop more advanced and applicable tools or principles to assist UI design for UA that incorporates intentionality towards diverse user groups.

7. Conclusion

In respect to technology adoption, Japan provides an interesting viewpoint for UX research, as fundamental interaction patterns have some differences compared to Nordic countries. Cross-cultural research between Japan and Nordic countries can provide an in-depth understanding of interaction design patterns, as well as with closer analysis, reveal deeper cultural understandings and interaction conventions. Research, as with the practical UI design itself, calls for more attention to be placed on how cross-cultural contexts challenge UI design practice, and how various cultural elements should be considered in UX design. The decision to engage in UA as the analytic framework for the study relates to the challenge of studying for diversity in general. Yet, future work would benefit a) by a revision of all cultural dimensions (Hofstede's and otherwise) in respect to current changes in international cultural climates; and b) in-depth study of all the cultural dimensions with close attention to how these can be witnessed in a large sample of UIs.

Furthermore, knowledge of diverse cultural backgrounds can aid in the development of UX in general. The benefits of a user-centered approach to information technology (IT) artifact design have been identified and recognized as essential for capturing users' needs related to human factors and contexts. However, factors affecting UX in different cultures may conflict with the IT artifacts when encountered in various cultural settings, by a range of audiences. Yet, we acknowledge that these differences are challenging to address, both from design in addition to *designer* standpoints. The comparison of any cultural product should always be done with care, particularly in light of ethical and critical cultural studies practice, as all decisions made within a culture are relative and relevant for that culture, connecting with deeper socio-political and technical frameworks [57]. This renders the topic as complexly sensitive for researchers, practitioners and educators alike. Moreover, the understanding of the cross-cultural factors affecting products' accessibility and usability remains vague. The realization of accessibility still requires design patterns that emphasize the broadest range of users' abilities, actual needs, and the context of use.

Accessible and culturally adaptive IT artifacts such as websites, user interfaces, and mobile applications can increase the autonomy of use and satisfaction [28,33]. The context of use of these IT artifacts may however vary due to user-internal and external factors, including users' emotional state, socio-cultural factors, and socio-technical factors, whereby the cultural, political, sociological, and historical aspects of the context influence the users [58–62]. The context of use also influences users' abilities. Moreover, users' expectations based on past experiences, prejudices, evoked memories, unmet expectations, and confidence strongly affect how users perceive and experience the accessibility of IT artifacts [63]. The balance between user specific, and culturally specific factors remains territory for examination in the near future.

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