

Cross-Cultural Web Usability Model

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Abstract. Research shows that different user interfaces are needed for successful communication with different cultural groups, yet studies on cross-cultural website usability are limited. This research works towards creating a culturally sensitive world wide web by addressing the gap with a novel cross-cultural website usability model. The authors' prior work evaluated Australian, Chinese, and Saudi Arabian web pages and revealed significant differences in the use of web attributes including: layout, navigation, links, multimedia, visual representation, colour and text. This paper extends those findings by mapping the usage of web attributes with theories of culture to create website design guidelines and a usability measuring instrument. The development of this model includes: evaluation of element use, identification of prominent elements, organisation of cultural factors, organisation of HCI factors, development of design guidelines and development of the usability measuring instrument. This model simplifies the creation of cross-cultural websites, while enabling developers to evaluate page usability for different cultures.

Keywords: Cultural usability · Cross-cultural web communication · Web design guidelines · Intercultural · Cultural differences

1 Introduction

Website localization is a specialized process of adapting web content and applications for regional or local consumption. These adaptations should go beyond simple language translation to tailor the look, feel, and aesthetics of the page.

However, current website cultural adaptation suffers from a narrow and static vision of culture. Most English websites, viewed by users worldwide, are designed based on Western values. These websites are simple, text-heavy, and feature soft colours and deeply structured content and have failed to appeal to users in Asian countries, such as South Korea, Taiwan, and China [1, 2]. It has been suggested that users in many Asian countries prefer transformational, visual-heavy, brightly coloured websites that are less structured [3]. People from Asian cultures efficiently filter dense information [4]. The preferred design of a webpage is strongly influenced by cultural values [3].

Recently, China has published websites reflecting the US website design preferences for their English language versions that significantly differ from the Chinese version. This juxtaposition is shown in Fig. 1. This reinforces the argument that the



Fig. 1. Comparing China’s english and mandarin versions of [6].

look, feel, and aesthetics of a webpage is important and differs between cultures. A failure to account for different cultures may result in usability problems [5].

Cultural usability is the integration of cultural aspects into interaction [2], which allows interfaces to target a user’s culturally specific attributes and values [3]. Prior work suggests that, Hofstede et al.’s [7] and Hall and Hall’s [8] cultural factors are indeed useful to consider how to adapt website design concepts for cultural diversity [9, 10]. Cultural factors were applied, as cultural variables for website design, to study cross-cultural website design interaction, information processing, and communication [3]. Human-Computer Interaction (HCI) researchers, as well as some website designers, have used cultural factors to show that web pages with culturally relevant characteristics are more usable [2, 11], and can increase user satisfaction and work efficiency [3].

To incorporate cultural factors into website design, some website developers and researchers use cross-cultural design guidelines and models. However, the existing guidelines and models are insufficiently detailed [2], and lack usability tests to support their claims [10]. Therefore, a new cross-cultural web usability model is required.

The aim of this research is to create a cross-cultural web usability model that will offer website design guidelines and a usability measuring instrument. Using this model, cross-cultural websites can be easily designed, and web developers and designers may measure the usability of a web page for different cultures.

2 Related Work

Prior research has been conducted to find the relationship between website design elements, which may be unique to a cultural group, and anthropological cultural factors. Better understanding of these relationships may help to design localized websites [2]. Smith, Dunckley, French, Minocha and Chang [12] and Hsieh, Holland and Young [10] developed a model for developing usable cross-cultural websites that incorporated existing cultural factors and Barber and Badre’s [13] cultural markers. Heimgärtner [9] created a model of culturally influenced HCI to cover cultural context in HCI design, which combined cultural factors and HCI factors. HCI factors described

the style of information processing and the interactional characteristics of the user with the web page. However, empirical studies to support these models are lacking.

Some web developers and researchers have demonstrated the limitations of using prior cross-cultural design guidelines and models. They are not sensitive enough [14], usually based only on theoretical research [12]. They also considered limited website design attributes [14], and lack usability tests to support their claims [10]. The validity of these existing cross-cultural design guidelines for cultural usability requires more empirical work. To address these concerns, our wider research began with the first large scale study of cross-cultural web design, which provided the empirical baseline to support the new cross-cultural web usability model described in this paper.

3 Cross-Cultural Web Usability Model

To adapt cultural values into website design, most previous research directly applied theory-based cultural factors into website development. Our work furthers this approach by also incorporating design elements, cultural factors, and HCI factors. Design elements and cultural factors are already the subject of cross-cultural investigation of website design [2, 11]. The HCI factors describe the style of information processing and the user's interaction characteristics are generally linked with time, context, and mental aspects [9]. Therefore, it is believed that richer and more comprehensive cross-cultural web design guidelines may be developed by incorporating HCI factors. To translate these theoretical factors as cross-cultural design guidelines, a detailed literature review was undertaken to map statistically significant design elements with cultural factors and HCI factors. The proposed guidelines are used to create cross-cultural websites that are suitable for the target culture.

A usability measuring instrument is proposed, to measure usability attributes, which in turn may influence the overall satisfaction of a web page. This instrument is suitable to measure both: the effect of culture on website use, and the overall usability between cultures. Finally, the new cross-cultural web usability model may be used to test specific propositions on how web page design could change with cultural factors and the level of cross-cultural usability.

4 Development of a New Cross-Cultural Web Design Guidelines and a Usability Measuring Instrument

4.1 Evaluation of the Usage of Design Elements Between Cultures

To link website design and culture, it was important to determine any differences in the usage of design attributes between cultures. Design attributes are aspects such as Layout, Navigation, Links, Multimedia, Visual Representation, Colour, and Text. Australian, Chinese and Saudi Arabian web pages were evaluated to represent a range of cultural groups, including English speaking, Confucian, and Islamic cultural groups [15]. The results of previous work [16] show significant differences in the design of

Australian, Chinese and Saudi Arabian web pages, providing quantitative evidence that many website design elements are culturally specific.

4.2 Identify Prominent Design Elements

Fraternali and Tisi [11] also found that cultures carry some prominent design elements. These prominent design elements can be used to match the cultural needs, expectations, and preferences of the users from different cultures [2]. To strengthen the proposed model, prominent design elements were derived based on some statistical tests.

In our model, a design element is marked as a prominent design element if the difference, in rate of occurrence, between two cultural groups is greater than or equal to 40%. Table 1 lists the prominent design elements discovered. They are used to directly map to existing cultural factors organised in Sect. 4.3, and HCI factors organised in Sect. 4.4, to create cross-cultural web design guidelines.

Table 1. Prominent design elements

Design attributes	Prominent design elements	Countries		
		A	C	SA
Layout	High use of visible items ⁺ in a web page		✓	
	High display density ⁻		✓	
Navigation	Dynamic type of main menu	✓		✓ *
	More than 10 visible links in the main menu		✓	✓
	Level of 2 choices in the main menu	✓		
	Fat footer	✓		✓
Links	High use of links		✓	
	Links open in a new window		✓	
	External links		✓	
Multimedia	Image/text animation		✓	
	Image/text scrolling		✓	
	Use of images		✓	
Visual representation	Image of young individuals	✓		
	Images of leader			✓
	Image of political		✓	✓
Colour	Bright colours with traditional colours		✓	✓ #
Text	Use of bold		✓	
	Use of headings		✓	

Where: A = Australia, C = China, and SA = Saudi Arabia.

Note 1: + Use of items includes: headings, links, and images.

- Display density = total number of items/web page length.

* For the design attribute navigation, in the Saudi Arabian culture, the usage differences of both: 'Static' and 'Dynamic' were more than 40%. It was then decided to take the highest value.

Moderate use of bright colours.

4.3 Organising Cultural Factors

Hofstede et al.'s [7] cultural model was built on large-scale quantitative data analysis. They distinguished cultures by ranking them mainly along four factors.

- Power Distance: refers to the degree of emotional or tolerance to characterize the hierarchies that exist and are accepted within a society
- Individualism vs. collectivism: the degree to which individuals are integrated into cohesive groups versus being expected to look after themselves.
- Uncertainty avoidance: a society's tolerance for risk and ambiguity versus desire for predictability.
- Long-term vs. short-term orientation: how much society values long-standing as opposed to short-term traditions and values.

Hall and Hall's [8] cultural model consist of two factor such as context and time.

- High-context vs. low-context: The continuum of high- to low-context culture refers to the degree to which communication is implicit and thus requiring an understanding of the context. High-context cultures are those that communicate in ways that are implicit and rely heavily on context. In contrast, low-context cultures rely on explicit verbal communication.
- Monochronic vs. polychronic time perception: This relates to whether time is organised with a single task focus (monochronic) or multi-tasking (polychronic).

As shown in Table 2, the expression of cultural factors in the two models can vary enormously between cultures. This research adopts Hofstede et al.'s [7] and Hall and Hall's [8] seminal work on cultural factors.

Table 2. Cultural distance between countries

Cultural factors	Australia	China	Saudi Arabia
Power distance	Low (36)	High (80)	High (95)
Individualism	High (90)	Low (20)	Low (25)
Uncertainty avoidance	Medium (51)	Low (30)	High (80)
Long-term orientation	Low (21)	High (87)	Low (36)
Context	Low	High	High
Time perception	Monochronic	Polychronic	Polychronic

Note 2: Hofstede et al.'s [7] cultural factors values are derived from [17]. The decimal values are given a range to labels: Low, for 0–40, Medium, for 41–60, and High, for 61–100.

4.4 Organising HCI Factors

HCI factors describe how the nature of information processing, and the interactional style between users and web pages, can differ between cultures [9]. HCI factors are strongly linked with time, context, and mental aspects. To determine the information

processing and interaction style of users from different cultural backgrounds, this research adopts the following definitions, as suggested by Heimgärtner [9].

- Information speed is the duration of information presentation [18].
- Information density is the number of elements at a single point in time [18].
- Information frequency is the number of elements present per time unit [18].
- Information sequentiality is the sequence arrangement of information [18].
- Information redundancy is repetition of information.

4.5 Developing Cross-Cultural Web Design Guidelines

Cultural influence on website design, in HCI, can be connected via relationships across prominent design elements, cultural factors, and HCI factors [19]. With the support of the prior published literature, correlations between prominent design elements, cultural factors, and HCI factors are identified and offered as cross-cultural web design guidelines. Table 3 shows the level of culture and HCI and Table 4 details the web features suitable for the target culture. Together, these tables may help web designers to choose suitable web features for a specific culture.

Table 3. Level of culture and HCI for web design

HCI factors	Cultural factors					
	(L) PDI	(L) IDV	(L) UAI	(L) LTO	(L) CTX	(L) TPC
Information speed	(L)	(H)		(L)	(L)	
Information density				(L)	(L)	
Information frequency	(L)	(H)	(H)	(L)	(L)	(H)
Information redundancy			(H)			
Information sequentiality			(L)			(L)
Interaction sequentiality			(L)			(L)
Interaction exactness			(L)			
Interaction speed	(L)	(H)		(L)	(L)	
Interaction frequency	(L)	(H)	(H)	(L)	(L)	(H)

Where: L: Low, H: High, PDI: Power distance, IDV: Individualism, UAI: Uncertainty avoidance, LTO: Long-term orientation, CTX: Context, and TPC: Time perception.

Navigation and Layout Websites featuring: high use of visible items, display density, more than 10 links in the main menu, and 2 levels of choice in the main menu are identified as prominent design elements in Table 1.

Website structure refers to the breadth and depth in the presentation of content [20]. Breadth is defined as the number of hyperlinks, as options or choices, per level, and depth refers to the number of levels in the navigation hierarchy [21]. Chinese web pages frequently feature high use of visible items and display density, and Chinese and Saudi Arabian web pages feature more than 10 links in the main menu. Comparatively, 2 levels of choice in the main menu, is popular in Australian web pages. Australian, and to a lesser extent Saudi Arabian, main menus are designed with fewer initial links

at first sight, but contain a deeper hierarchical structure. This deeper hierarchical structure reduces the visible items and display density. This is further explained by the fact that short-term orientation cultures prefer less information complexity with a hierarchical navigation structure to accomplish tasks [3].

In short-term orientation cultures, such as Australian and Saudi Arabian, the immediacy of results and the achievement of goals are important issues [22]. When navigating a website, users from short-term orientation countries prefer less information, initially, with fewer links in a main menu [3]. Australian and Saudi Arabian websites favour deep or hierarchical structures, which reduce the information complexity. Reinecke and Bernstein's [3] and Kralisch et al.'s [22] believe that short-term orientation cultures favour deep hierarchical structure, to reduce information complexity.

China is a long-term orientated culture [7]. To process a task, long-term oriented cultures prefer detail [11] and tolerate longer paths [23]. This translates to a greater number of links in main menu with a less deep or flatter hierarchical structure.

The culturally dependent preference for web page structure is supported by HCI research. The deep hierarchical information structure and low information complexity, identified in short-term orientation cultures, reduces the communication overhead by limiting information flow. This further reduces the overall visual complexity of the interface [3]. If the number of first level links in the main menu is low and the hierarchical level in the main menu is high, then the information speed, and frequency, as well as interaction speed and frequency are low. As users from low-context and short-term orientation countries, such as Australia, have inferential-categorical or functional cognitive style [4], the interaction speed and frequency being low may help to them to use functions or investigate page artifacts in a given context.

In dense, high complexity, websites, Chinese users, have shown to efficiently filter when overloaded with information [4]. If number of items and display density of a web page are high, then the information density, frequency, and speed as well as the interaction frequency and speed are also high. Users from long-term orientation and low-uncertainty, such as China, would be rendered uncertain if only a few pieces of information could be exchanged due to their preference for high-information density pages [9]. Variations in information processing and interaction style have motivated the cross-cultural website design guidelines in Tables 3 and 4.

The type of main menu (dynamic vs. static) varies among cultures. Dynamic menus opens sub menus when the user selects a header, while static menus always displays headers and sub headers. Static menus are more frequently used in Chinese websites than Australian and Saudi Arabian websites. Chinese websites tend to have more hyperlinks in the main menu, and users may only need a single click to reach the target page. This low effort to click to reach the target pages provides navigation freedom, which can be explained with the amount of uncertainty avoidance. Users from low-uncertainty avoidance countries, such as China, tolerate less control in navigation [3] and Chinese websites feature static type main menus.

Users from high-uncertainty avoidance countries, such as Australia and Saudi Arabia, prefer more control in navigation to prevent them from getting lost [3, 23]. These pages generally only show headers at the first level, and sub headers become visible when selected.

Table 4. Web features for culturally specific website design

Cultural factors	Web attributes	Web feature
(L) PDI: Power distance	Visual representation	(L) Human presence in images
(L) IDV: Individualism	Visual representation	(H) Human presence in images
	Links	(L) Focus on the user's goals
		(H) Focus on organisation
(L) UAI: Uncertainty avoidance	Navigation	(L) Guidance and navigation control
		(L) Additional support, in structured way
		(H) Redundant pieces of information
(L) LTO: Long-term orientation	Navigation	(H) Deep, to flat, hierarchical structure
	Layout	(L) Information complexity,
(L) CTX: Context	Multimedia	(L) Visual information
	Colour and Text	(L) Colour-embed information
	Links	(L) Linear navigation

The culturally dependent preference for the dynamic vs. static type main menu is supported by HCI research. In the deep hierarchical structure, dynamic menus provide more navigation control, in which users require high effort to access low level navigation items. Users from high-uncertainty avoidance countries, such as Australia, prefer tasks to be completed in a clear sequential manner [24]. The type of the main menu (dynamic vs. static) has been factored into the cross-cultural design guidelines, shown in Tables 3 and 4.

The use of Fat Footers also varies among cultures. The Fat Footer, provides redundant information at the page bottom [25], and is popular in Australian and Saudi Arabian websites. One possible explanation for this difference is that Australian and Saudi Arabian cultures are associated to high-uncertainty avoidance cultures, that avoid ambiguity [25]. Al-Khalifa and Garcia [25] believe high-uncertainty avoidance cultures use the Fat Footer to prevent information loss.

The culturally dependent preference for the Fat Footer is supported by HCI research. The redundant pieces of information give strong additional support to find information or functionality [26], which is desirable for users from high-uncertainty avoidance countries, such as Australia and Saudi Arabia.

Links The number of external links varies among cultures. Some cultures use more external links to emphasise social and organisational relationship [27]. The use of external links in Chinese websites is higher than Australian and Saudi Arabian websites. In high-power and long-term orientation cultures [7] the strength of the organisational network is important.

The culturally dependent preference for external links is supported by the HCI research. If more external links are presented, the probability of filtering external information and performing external interaction with external websites is high.

The external information frequency and speed as well as the external interaction are high for high-power distance, low-uncertainty avoidance, and long-term orientation countries, such as China. However, users from low-power distance, high-uncertainty avoidance, and short-term orientation countries may get lost with too many external websites; therefore, the external information frequency and speed as well as the external interaction are low for Australia.

The use of Links opening in a new browser window varies between cultures. More links are found in Chinese websites than Australian or Saudi Arabian websites. An explanation can be brought through the work of Hall and Hall's [8] single task focus (monochronic) vs. multi-tasking (polychronic). The Chinese culture is considered polychronic, which uses a parallel problem-solving approach, based on the simultaneous consideration of multiple problems, reasons, and explanations [11]. The multi-tasking ability and the preferences for non-linear navigation mean Chinese websites feature higher number of links opening a new browser window. According to Kralisch et al.'s [22], interpretation polychronic cultures, show non-linear navigation behaviour and tend to switch between several open pages, while monochronic culture, such as Australia, prefer for linear navigation patterns.

Saudi Arabia is also a polychronic culture. However, its high-uncertainty avoidance may limit the links opened in the new browser window, to avoid interruptions and information loss.

The culturally dependent preference for the Links opening in a new browser window is supported by the HCI research. If the number of links opening a new browser window is high, then the information and interaction sequentiality are low. Then the probability of conducting sequential action is low. The cognitive style of many East Asians is relational-contextual or thematic [4], which contrasts with many Westerners who are functional. Many Asians prefer to classify on the basis of interdependence and relationship within wholes, and emphasise contexts [28]. The parallel processing may support users from polychronic and low-uncertainty avoidance, country, such as China, to gather information and construct relationships to perform tasks. Therefore, in cross-cultural website design, the information and interaction sequentiality being low is important for polychronic and low-uncertainty avoidance countries, such as China.

Multimedia, Colour, and Text The use of number of images, animations, scrolling objects, colours and bold text varies between cultures. Chinese websites make greater use of images, animations, scrolling objects, bright colours, and bold text. According to Barber and Badre [13], high-context cultures use images, animated objects, traditional as well as bright colours to maximize information as well as to attract user's attention.

Researchers claim that Arabic cultures have an affinity for high-context but low content [29]. Saudi Arabia is a member of the Arabic culture, and its high-context leads Saudi Arabian web pages to use images, animated, scrolling objects, and traditional colours. However, the limited information preferences of high-uncertainty avoidance cultures limit the use of bold text and moderate the use of bright colours.

The direct and explicit communication of formal information [8], often by way of written texts [3], and the low content preferences of medium-uncertainty avoidance means Australian web pages feature less visual information and softer colours.

Reinecke and Bernstein [3] confirmed this in prior work, finding that low-context cultures prefer interfaces that contain high text-to-image ratios, and high-uncertainty avoidance cultures prefer interfaces with soft colours. Cultural preferences for more/less images or animation, bright/soft colours, and bold text are supported by HCI research. The cultural differences of thought pattern and browsing behaviour of users from high-context and low-uncertainty avoidance cultures, such as Chinese, means that users scan the whole web page with non-linear scanning and browsing behaviour [30]. Contents may therefore be placed more freely on Chinese web pages. To highlight useful information and attract attention if information is freely places around the page, animation, graphics, bright colours, and bold text may then be used. The high use of visual and colour embedded information displayed freely around web pages provide fast information flow. Therefore, information speed and frequency, as well as interaction speed and frequency being high are important for high-context and low-uncertainty avoidance country, such as China.

Users from western cultures, which are low-context and high-uncertainty avoidance cultures, favour abstract representation of knowledge with functional interface structure when browsing [4]. For this culture, minimising attention requirements and users working area are important, to minimise error rates and information search time. Since animation, graphics, colours and bold text impact user attention [31], reducing animation, graphics, bright colours, and bold text helps the users, from low-context and high-uncertainty avoidance cultures, to minimise distractions.

Visual Representation Images of young individuals and political leaders were identified as prominent design elements. Images of leaders is higher in Saudi Arabian websites than Australian websites. One possible explanation for this difference is the power-distance among countries. The Saudi Arabian culture is considered as high-power distance culture. The high-power distance is the tolerance of large power distributions among people. Al-Khalifa and Garcia [25] state that high-power distance cultures use images that focus countries leaders or authority, while low-power distance cultures, such as Australia, focus on ordinary citizens [3].

Images of young individuals in Australian websites were more common than Chinese and Saudi Arabian websites, while the political images in Chinese and Saudi Arabian websites were higher than Australian websites. Chinese and Saudi Arabian culture is said to be collectivistic [7], and the preferences to represent human presence on websites [32], means Chinese and Saudi Arabian web pages to use images of political figures that promote characteristics of collectivistic societies. Würtz's [32] believes that collectivistic cultures show more images of groups and political figures, while individualistic cultures, such as Australia, use images of youthful people.

The different use of images shows that culture affects visual perceptions. By creating a sense of warmth or human contact for the user to keep a harmonious relationship with their culture, high-power and collectivistic cultures include both more images and images featuring many people [32]. If more images of people are displayed, then the visual information speed and frequency, as well as interaction speed and frequency are high. The interaction frequency and information speed is important to users from high-power and collectivistic countries, such as China and Saudi Arabia, who generally

place high importance on tradition [33]. In societies that are classified as individualistic, innovation and modern trends, feature more prominently than tradition [33].

4.6 Development of a Usability Measuring Instrument

Selection of Usability Attributes Usability is a performance and belief based concept, which is a crucial measure of product quality [34]. Usability has been defined in the existing body of literature in a variety of ways. However, it is now widely accepted that the usability is a socially constructed concept made up of attributes which may not be equally valued across cultures [3].

The usability measuring instrument includes objective measurement of user performance and subjective measurement of user perception. Prior research from Cui, Wang and Teo [21], Lee and Koubek [35], Fraternali and Tisi [11], and Nielsen [34] are reviewed to derive objective and subjective measurements that are suitable to measure effectiveness of communication of the website design. This work focuses on six usability attributes:

- Effectiveness: is defined as the accuracy and completeness with which users achieve specified goals [11]. Effectiveness is measured by whether the users perform a task or answer questions correctly in a given website.
- Efficiency: is the way users use the website in completing their task [34]. Efficiency is measured by the amount of time participants take to complete the given task or answer the questions.
- Errors: are the number of incorrect clicks made by users during the task [34].
- Perceived Navigability: is a user's subjective perception of how easily information is found and the website is navigated [21].
- Perceived Aesthetics: since first impressions are important for web pages [3] aesthetics are important. Perceived aesthetics is a user's subjective judgments of the visual appeal of a website [35].
- Satisfaction: is an important indicator website success [21]. Satisfaction is measured by user's subjective comfort and acceptability of use [34].

Effectiveness, efficiency, and errors can be used to measure user performance. Perceived navigability, perceived aesthetics and satisfaction can be used to measure user perception.

5 Designing Culturally Specific Websites in HCI

The developed cross-cultural web design guidelines, which assumed relationships among prominent design elements, cultural factors, and HCI factors are based on the literature Hofstede et al. [7], Hall and Hall [8], and Alexander et al. [16].

To design websites for a particular culture, website designers should calculate the cultural factor values of the country. Hofstede et al.'s [7] cultural factor values can be calculated from [17]. The decimal values can be given a range to labels: 'L' (low), for 0–40, 'M' (medium), for 41–60, and 'H' (high), for 61–100. The Hall and Hall's [8]

high-context vs. low-context values should be labeled: ‘L’, for low, and ‘H’, for high, and the monochronic vs. polychronic time perception value should be labeled: ‘H’, for monochronic, and ‘L’, for polychronic. In the USA, the calculated cultural factor values are: ‘L’ (40) for Power distance, ‘H’ (91) for Individualism, ‘M’ (46) for Uncertainty avoidance, ‘L’ (26) for Long-term orientation, ‘L’ (low) for Context, and ‘H’ for (monochronic) Time perception.

All calculated cultural factor values should be mapped in Tables 3 and 4. So the USA’s ‘L’ or low for Power distance (PDI) can be used to identify both the HCI factors, in Table 3, and associated web feature, in Table 4. In our example of the USA, the derived HCI factors, in Table 3, are ‘L’ (low) information speed, and frequency, as well as interaction speed and frequency. This gives the appropriate ‘web feature’ in Table 4; for ‘L’ (low) Power distance (PDI), and the ‘L’ (low) information speed, and frequency, as well as interaction speed and frequency, a comparatively lower human presence should be used.

If any cultural factor has value ‘H’, then the values should be changed vice versa for all connections in Tables 3 and 4. For example, USA’s Individualism (IDV), in Table 3. If the IDV value is ‘H’ (high), then the information speed, and frequency, as well as interaction speed and frequency, are ‘L’ (low) and can be used to inform of the appropriate ‘web feature’ in Table 4. Using these design guidelines cultural factors and HCI factors associated with a particular culture may help to inform of the correct web features to be used.

Different cultures will have different cultural factors and HCI factors and the requisite web features will vary. The cultural factors, HCI factors, and web features are not bounded by the border of a nation. A cultural group is determined by the cultural characteristics of group of users and this quantitative and qualitative data has, historically been obtained from, random sampling.

6 Discussion

This research has drawn from large scale empirical results of website design preferences [16], and integrated these with design guidelines. These guidelines are appropriate for various cultural groups. The guidelines presented in this paper describe the relationship among prominent design elements, cultural factors, and HCI factors. Since identifying prominent design elements or cultural markers, that are universally valid for web pages, is necessary [14], prior work [16] that investigated the use of the design attributes in website design was used as a starting point to determine the relationship among prominent design elements, cultural factors, and HCI factors. Cross-cultural differences including different cognitive styles, reading and scanning patterns, or color meanings are used to consider the implications of the identified differences in designing cross-cultural websites. Relevant Hofstede et al.’s [7] and Hall and Hall’s [8] cultural factors are used for cross-cultural website design to explain the reason for the observed preferences. The values of cultural factors show that culture-dependent variations can be used to design websites for different cultures. Much research effort is still necessary to validate, refine, and optimize the guidelines and a large-scale user test to investigate cross-cultural website usability is an important next step. The usability measuring

instrument, presented in this paper, derived objective and subjective measurements that are suitable to measure effectiveness of communication of the website design. Findings from this subsequent work will facilitate the optimization of the design guidelines and ultimately yield a usability model which is the model is generic enough to tailor the look, feel and aesthetics of the web page to arbitrary cultural groups.

7 Conclusion and Future Work

A new cross-cultural web usability model has been proposed. This work describes how prior work in cultural theory, and the measurement of web elements used by different cultures, can be used to design websites for different cultures. The guidelines advise web developers on design attributes including: layout, navigation, links, multimedia, visual representation, colour, and text. Every design guideline contains cultural factors and HCI factors, which relates to the level of cultural adaptation necessary. By using these guidelines, a cross-cultural website can be constructed for each culture.

In the future, we plan to carry out a user test to investigate the cross-cultural web design guidelines. We will design cross-cultural websites, and perform a cross-cultural usability study to evaluate the efficacy of real cross-cultural websites. The goal of user testing is to acquire behavioural data including: effectiveness (task success rate), efficiency (average time on task), and errors (average number of clicks for a task), and attitudinal data including perceived navigability, perceived aesthetics, and satisfaction based on completion of specified tasks. From the behavioural and attitudinal data, user performance and user perception will be measured.

It is hoped that these advances in cross-cultural web usability will support a new generation of effective web content. For effective communication with diverse cultural groups and a global audience, simple language translation is not sufficient. The work described in this paper is a step toward the provision of tailored, accessible and effective communication for all cultural groups and regions.

References

1. Bernstein, A., Reinecke, K.: Knowing what a user likes: a design science approach to interfaces that automatically adapt to culture. *Manage. Inf. Syst.* **37**(2), 427–453 (2013)
2. Hsieh, H.C.L.: Evaluating the effects of cultural preferences on website use. In: Rau, P.L.P. (ed.) CCD 2014. LNCS, vol. 8528, pp. 162–173. Springer, Cham (2014). doi:[10.1007/978-3-319-07308-8_16](https://doi.org/10.1007/978-3-319-07308-8_16)
3. Reinecke, K., Bernstein, A.: Improving performance, perceived usability, and aesthetics with culturally adaptive user interfaces. *ACM Trans. Comput.-Hum. Interact.* **18**(2), 1–29 (2011)
4. Nisbett, R.E.: *Geography of Thought: How Asians and Westerners Think Differently...and Why*. Free Press, New York (2003)
5. Sun, H.: Expanding the scope of localization: a cultural usability perspective on mobile text messaging use in American and Chinese contexts (2004)
6. MEP. Ministry of environmental protection of the People's Republic of China, 17 August 2017. <http://www.mep.gov.cn/>

7. Hofstede, G., Hofstede, G.J., Minkov, M.: *Cultures and Organizations: Software of the Mind*, 3rd edn. McGraw-Hill Education, New York (2010)
8. Hall, E.T., Hall, M.R.: *Understanding Cultural Differences*. Intercultural Press, London (1990)
9. Heimgärtner, R.: Reflections on a model of culturally influenced human–computer interaction to cover cultural contexts in HCI design. *Int. J. Hum.-Comput. Interact.* **29**, 205–219 (2013)
10. Hsieh, H.C., Holland, R., Young, M.: A theoretical model for cross-cultural web design. In: Kurosu, M. (ed.) *HCD 2009*. LNCS, vol. 5619, pp. 712–721. Springer, Heidelberg (2009). doi:[10.1007/978-3-642-02806-9_83](https://doi.org/10.1007/978-3-642-02806-9_83)
11. Fraternali, P., Tisi, M.: Identifying cultural markers for web application design targeted to a multi-cultural audience, pp. 231–239
12. Smith, A., Dunckley, L., French, T., Minocha, S., Chang, Y.: A process model for developing usable cross-cultural websites. *Interact. Comput.* **16**(1), 63–91 (2004)
13. Barber, W., Badre, A.: *Culturability: the merging of culture and usability*
14. Mushtaha, A.: *Towards designing localized websites*, Department of Computer Science Vrije University Brussel, Belgium, Faculty of Science and Bio-Engineering Sciences (2012)
15. Inglehart, R., Welzel, C.: Changing mass priorities: the link between modernization and democracy. *Perspect. Polit.* **8**, 551–567 (2010)
16. Alexander, R., Thompson, N., Murray, D.: Towards cultural translation of websites: a large-scale study of Australian, Chinese, and Saudi Arabian design preferences. *Behav. Inf. Technol.* **36**(4), 351–363 (2016)
17. The-hofstede-centre. Country comparison, 1 August 2014. <http://geert-hofstede.com/countries.html>
18. Hall, E.T.: *The Silent Language*. Anchor Books, USA (1956)
19. Alexander, R., Thompson, N., Murray, D.: *Cross-Cultural Web Design Guidelines*
20. Galletta, D.F., Henry, R.M., McCoy, S., Polak, P.: When the wait isn't so bad: the interacting effects of website delay, familiarity, and breadth. *Inf. Syst. Res.* **17**(1), 20–37 (2006)
21. Cui, T., Wang, X., Teo, H.: Building a culturally-competent web site: a cross-cultural analysis of web site structure. *J. Glob. Inf. Manage. (JGIM)* **23**(4), 1–25 (2015)
22. Kralisch, A., Eisend, M., Berendt, B.: The impact of culture on website navigation behaviour
23. Marcus, A., Gould, E.W.: Crosscurrents: cultural dimensions and global web user-interface design. *Interactions* **7**(4), 32–46 (2000)
24. Heimgärtner, R.: *Cultural Differences in Human-Computer Interaction: Towards Culturally Adaptive Human-Machine Interaction*. R Oldenbourg Verlag GmbH, Munich (2012)
25. Al-Khalifa, H.S., Garcia, R.A.: Website design based on cultures: an investigation of saudis, filipinos, and indians government websites' attributes. In: Marcus, A. (ed.) *DUXU 2014*. LNCS, vol. 8518, pp. 15–27. Springer, Cham (2014). doi:[10.1007/978-3-319-07626-3_2](https://doi.org/10.1007/978-3-319-07626-3_2)
26. Chapman, C.: Navigation patterns for ten common types of websites, 21 May 2015. <https://www.webdesignerdepot.com/2011/11/navigation-patterns-for-ten-common-types-of-websites/>
27. Gould, E.W., Zakaria, N., Yusof, S.A.M.: Applying culture to website design: a comparison of Malaysian and US websites, pp. 161–171
28. Rau, P.-L.P., Choong, Y.-Y., Gavriel, S.: A cross cultural study on knowledge representation and structure in human computer interfaces. *Int. J. Ind. Ergon.* **34**, 117–129 (2004)
29. Liginlal, D., Rushdi, M., Meeds, R., Ahmad, R.: *Localization for a High Context Culture: An Exploratory Study of Cultural Markers and Metaphors in Arabic E-Commerce Websites, E-Commerce, E-Business and E-Service*. Taylor & Francis Group, London (2014)

30. Dong, Y., Lee, K.P.: A cross-cultural comparative study of users' perceptions of a webpage: with a focus on the cognitive styles of Chinese, Koreans and Americans. *Int. J. Des.* **2**(2), 19–30 (2008)
31. Noiwan, J., Norcio, A.F.: Cultural differences on attention and perceived usability: investigating color combinations of animated graphics. *Int. J. Hum. Comput. Stud.* **64**, 103–122 (2006)
32. Würtz, E.: Intercultural communication on web sites: a cross-cultural analysis of web sites from high-context cultures and low-context cultures. *J. Comput.-Mediated Commun.* **11**(1), 274–299 (2005)
33. Kyriakoullis, L., Zaphiris, P.: Culture and HCI: a review of recent cultural studies in HCI and social networks. *Univ. Access Inf. Soc.* **15**(4), 629–642 (2016)
34. Nielsen, J.: *Usability Engineering*. Academic Press, New York (1993)
35. Lee, S., Koubek, R.J.: The impact of cognitive style on user preference based on usability and aesthetics for computer-based systems. *Int. J. Hum.-Comput. Interact.* **27**(11), 1083–1114 (2011)