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## Ergonomics of usability/accessibility-ready websites: Tools and guidelines

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## Abstract

*The 'user-friendliness' of a website indicates to what extent it is easy for all intended users to interact with website to perform their required task(s). Given the explosive growth in the use of computerized systems as well as the World Wide Web for delivering information and services, usability/accessibility becomes an important issue. The purpose of this research is to study the available literature on usability/accessibility ready websites and their tools and guidelines. The research findings will help web engineers to build websites and web services accessible for all the target audience, including people with special needs. People with special needs meet barriers of all types, but computing technology is helping them to overcome these barriers. Accordingly, a great amount of development work has been carried out in the area of designing websites for disabled people, and it is increasingly becoming an important focus for a variety of reasons, legal (due to recent legislation in many countries promoting the rights of disabled people), economic, or ethical. Web engineers are increasingly aware that they need to ensure the usability of mainstream systems for disabled people by developing systems explicitly to meet the needs of disabled users (often referred to as assistive technologies), which also require evaluation to ensure their usability for the target audience. A descriptive/interpretive research method was used for the study of usability, accessibility, globalization, readability and culture differences based on related literatures and on previous studies by academics and industrial institutions.*

## Keywords

*Website accessibility; Cross-cultural usability; Usability guidelines; Usability testing; Readability formulae; User interface design; Local culture; Localized business websites; Globalization*

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## Introduction

Nowadays, many organizations worldwide have recognized the importance of Information and Communication Technology (ICT) to improve the delivery of information and services to customers and potential customers. Moreover, they have started embracing the Web for fast delivery of such information and services and to achieve a competitive advantage. The Web phenomenon has changed the way that people work and communicate. However, while the Web is an exciting technological tool, it does require innovative design to make it accessible to everyone, including people with disabilities ([Al-Badi & Mayhew, 2010](#)). For this reason, the user interface development process focuses its attention on the usability and accessibility in addition to understanding users' requirements and acknowledging demographic diversity.

This paper is organized in the following way: after the brief introduction above, the following section talks about website usability (definitions, guidelines, standards and limitations). Then, we provide an overview of website accessibility (definitions, web accessibility guidelines). After that, we present website usability and accessibility tools. That is followed by a brief account of website readability (writing for the web, readability Formulae (indexes) and limitation of readability Formulae). Another section is about website globalization (definitions of globalization, internationalization and localization). A section on cultural difference issues (definitions, cultural differences and cultural models) follows. Then, finally, the paper is concluded by presenting key conclusions and contributions.

## Website Usability

Many researchers and usability specialists have attempted to define the term "Website usability", hence there are numerous definitions:

[Nielsen](#) (1994) has divided usability into five different attributes. These are learnability, efficiency, memorability, rate of errors and satisfaction. [Preece et al.](#) (1994) defined usability as "a measure of the ease with which a system can be learned or used, its safety, effectiveness and efficiency, and the attitude of its users towards it". [Shneiderman](#) (1998) defined usability as "a combination of characteristics oriented to the user, which are: easiness of learning, high speed of user task performance, low user error rate, subjective user satisfaction and user retention over time" ([Al-Badi & Mayhew](#), 2010). [Keevil](#) (1998) defined it as "how easy it is to find, understand and use the information displayed on a website". According to [Brown](#) (2002), usability can be defined as the degree to which people (users) can perform a set of required tasks, and it is the product of several, sometimes conflicting, design goals including: functionally correct; efficient to use; easy to learn; easy to remember; error tolerant and subjectively pleasing. [Alexander](#) (2011) defined the website usability as the degree of ease with which users can complete various tasks using a website interface with which they are unfamiliar. Some of these tasks include: browsing and general site navigation, locating particular information, purchasing goods and services, submitting data via forms and participating in web-based discussion groups. According to the International standards ([ISO 9241-11](#)), usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" ([Kiviniemi](#), 2000).

Usability is the measure of the quality of a user's experience when interacting with a product or system ([Usability.gov](#), 2011). To encompass all the meanings mentioned in the above definitions, it can be said that Website usability is an indication to what extent it is easy for all users of a website to interact with it in performing the required task(s) ([Al-Badi & Mayhew](#), 2010).

Many usability specialists have emphasized the high importance of website usability, and it has always been accepted as a major contributor to the perceived success of a system. Therefore, website usability is widely recognized as the most important requirement for user acceptance of websites. This requirement is especially critical for some websites, such as e-commerce websites; a customer dissatisfied as a result of poor usability is likely to become a competitor's customer. [Jakob Nielsen](#) (a usability expert) puts this very clearly in the following two quotations:

1) "Usability rules the Web. Simply stated, if the customer cannot find a product, then he or she will not buy it." 2) "The Web is the ultimate customer-empowering environment. He or she who clicks the mouse gets to decide everything. It is so easy to go elsewhere; all the competitors in the world are but a mouse click away" ([Nielsen](#), 1999).

The issues which make the goal of achieving complete usability difficult to some extent are because the user population is expanding in age, expectations, information needs, tasks, and user abilities. However, website designers need to accommodate all these variations over time ([Al-Badi & Mayhew](#), 2010).

Usability is closely related to the flow concept that was initially introduced by [Csikszentmihalyi](#) (1997) to mean the "glue" that holds the consumer and the website. A similar concept is discussed by [Hoffman and Novak](#) (1996) who define flow online as the state occurring during network navigation which is: (1) characterized by a seamless sequence of responses facilitated by machine interactivity, (2) intrinsically enjoyable, (3) accompanied by a loss of self-consciousness, and (4) self-reinforcing ([Hoffman & Novak](#), 1996). The prerequisites for online flow are similar to those offline. On the web, flow "is determined by (1) high levels of skill and control; (2) high levels of challenge and arousal; and (3) focused attention; and (4) is enhanced by interactivity and telepresence" ([Novak et al.](#), 2000). Telepresence is a new dimension unique to online environments where users feel they are part of the action ([Steuer](#), 1992). Users can experience flow only if their trips through "cyberspace" are uneventful, with a fast response, immediate feedback, and minimum distractions.

[Shneiderman](#) (1998) argued that "Universal Usability will be met when affordable, useful, and usable technology accommodates the vast majority of the global population". Despite the recognition of the importance of usability for web-based systems, some would argue that many websites today still fail the most basic tests of usability ([Forrester Research](#), 2011). Appropriate website design and evaluation methods help ensure that websites are usable ([Nielsen & Mack](#), 1994). However, they are numerous methods; it is hard to know which one(s) are best suited for a particular website. Nevertheless, there exist "usability tools" that, when used, can help in simplifying the matter to a great extent and lead to a usable website.

## Web Usability Guidelines

The growing website usability expert community has formulated countless guidelines, and a subset of these is currently in common use. However, none of them sufficiently covers all possible variant constraints ([Becker](#), 2002a).

Many of these guidelines have been based on developer expertise, project experiences, and subjective studies. Existing user interface design recommendations were extended to include designing user interfaces for the Web ([Shneiderman](#), 2000; [Nielsen](#), 1999; [Lynch & Horton](#), 1999). Those experienced in designing user interfaces provided heuristics or guidelines for designing web pages, often by identifying design layout, navigation and performance issues associated with particular websites ([Spool et al.](#), 1999; [Hurst](#), 1999; [Flanders & Willis](#), 1998). Many of these guidelines were incomplete or too general to apply to the development of all websites ([Becker](#), 2002a; [Beirekdar et al.](#), 2002).

Numerous online articles were published based on developer experiences, customer feedback, economic and marketing data regarding web use. In addition, there have been many websites that provide help to build a usable website ([University of Rochester](#), 2002; [Lynch & Horton](#), 1999). Many papers ([Borges et al.](#), 1996; [Spool & Scanlon](#), 1997) and many books ([Nielsen & Mack](#), 1994) were published, and some effort was made towards building a Web Usability Assessment Model ([Becker, Roberts & Berkemeyer](#), 2001). Furthermore, a framework and guideline definition language (GDL) for usability (automation) evaluation has been proposed ([Beirekdar et al.](#), 2002).

There are many "usability guidelines" available for web designers. Table 1 below shows some of them, but that is just the tip of the iceberg. This great effort shows the importance placed on producing a usable website for the target users. A brief summary of currently available "usability guidelines" is presented in Table 1.

**Table 1: Website Usability Guidelines**

No	Title/Description	Reference
1	A Framework and a Language for Usability Automatic Evaluation of Websites by Static Analysis of HTML Source Code	(Beirekdar et al., 2002)
2	A Web Usability Assessment Model and Automated Toolset	(Becker et al., 2002)
3	10 Steps To Better Usability	(Nielsen, 1997a)
4	Designing More Usable Websites	(Trace Center, 2011)
5	Designing Web Usability: The Practice Of Simplicity	(Nielsen, 1999)
6	Guidelines For Medical And Health Information Sites On The Internet	(American Medical Association, 2005)
7	Guidelines For Designing Usable World Wide Web Pages	(Borges et al., 1996)
8	Guidelines For Usability Testing With Children	(Hanna et al., 1997)
9	IBM Ease Of Use - Web Design Guidelines	(IBM, 2011)
10	International Web Usability	(Nielsen, 1996)
11	New Zealand Government, Web Guidelines	(New Zealand Government, 2005)
12	Multimedia Guidelines	(Nielsen, 1995)
13	Measuring Website Usability	(Spool and Scanlon, 1997)
14	Research-Based Web Design And Usability Guidelines	(FirstGov.gov, 2011)
15	Top Ten Guidelines For Homepage Usability	(Nielsen, 2005a)
16	UK Cabinet Office, Web Guidelines	(UK Cabinet Office, 2004)
17	Usability Guidelines	(MIT, 2005a)

18	Usability Guidelines	(Bunnyfoot, 2005)
19	Usability Guidelines	(UsabilityNet, 2005)
20	Usability Guidelines	(WEB-it! Interactive Group, 2005)
21	Usability Guidelines	(Wright State University, 2005)
22	Usable Web	(Instone, 2006)
23	Universal Usability	(Shneiderman, 2000)
24	Web Guidelines - Accessibility Information Anytime, Anywhere, For Anyone	(University of Texas at Austin, 2011)
25	Website Usability Style Guidelines	(Design Technologies, 2009)
26	Web Style Guide: Basic Design Principles For Creating Websites	(Lynch and Horton, 1999)
27	Web Usability Guidelines	(University of Rochester, 2002)
28	Web Usability Index	(Usablenet, 2002b)
29	Web Usability, Accessibility & Compatibility	(IML, 2010)
30	World-Wide Web Guidelines	(Kirk, 2005)
31	Web Usability Guidelines	(University of Rochester, 2002)
32	Writing For The Web	(Sun Microsystems, 2011)
33	Writing For The Web	(Nielsen, 2005b)
34	Writing For The Web: Guidelines For MIT Libraries	(MIT, 2005b)
35	Website Usability : A Designer's Guide	(Spool et al., 1999)

The search for a web usability assessment model has been going on for some time. Jakob Nielsen devoted a whole chapter to this topic in his early book on the subject ([Nielsen, 1994](#)). [Becker, Roberts and Berkemeyer](#) (2001) found that none of the existing heuristics or guidelines would satisfy the usability requirements for assessing localized websites, so they developed their own Web Usability model. This web usability assessment model is made up of several key components: strategic goals of the organization in using the web, localized target markets described collectively as a user profile, the computing environment typical of the localized market, and generic usability factors. In this model there are eleven usability factors: navigation, design standards, personalization, design layout, performance, customer satisfaction, design consistency, reliability, security, information content, and accessibility ([Becker, 2002a](#)). It seems that the authors put a great deal of effort into producing their sets of usability guidelines. This work, however, stopped short of reaching the level of being a model, because a model is a representation of the real world. As such, its correctness should be verified. The authors did not show how they verified the completeness and the correctness of the model; hence, it should be regarded as a framework or simply another set of guidelines.

## Usability Standards

The literature shows that there are a number of international standards, for example the ISO standards which discussed/covered "Software Usability"; however, these standards are not necessarily dedicated to web usability. Rather, they focus more on software and graphical user interfaces in general, thus, they require some modification, adaptation, and extension. These standards include:

1. ISO 9241-11: "Guidelines on Usability": defines usability in terms of *effectiveness*, *efficiency*, and *satisfaction*.
2. ISO 9126-1: "Quality Model": is concerned primarily with the definition of quality characteristics to be used in the evaluation of software products. It sets out six quality characteristics, which are intended to be exhaustive. These are: Functionality, Reliability, Usability, Efficiency, Maintainability and Portability ([ISO 9126, 2002](#)).

## Limitations of Guidelines

Although usability guidelines have proved useful, they still suffer from a number of limitations and shortcomings that impede their widespread use and reduce their usefulness. Some researchers have already outlined some of these limitations ([Vanderdonckt](#), 1999; [Nielsen & Mack](#), 1994; [Scapin et al.](#), 2000). The limitations can be summarized as follows:

1. The language used comes from various disciplines (e.g., cognitive modeling, psychology, human factors, ethnography), which may prevent web engineers from easily understanding them and applying them correctly.
2. It is difficult to interpret when and how general guidelines need to be applied during the website lifecycle.
3. Almost all guidelines are based on one natural language (i.e., English) and one culture (i.e., North American).

The following section attempts to clarify the confusion between the terms usability and accessibility by defining and exploring the meaning of website accessibility.

## Website Accessibility

Having read about "Usability" in the previous section, the reader might want to compare it with the buzzword "Accessibility". This section aims to shed light on the term "Accessibility" in order to show the relationship between "Usability" and "Accessibility". Generally, web accessibility refers to the degree to which web information is accessible to all human beings (e.g., disabled, able-bodied, old and young). That is, the goal of web accessibility is to allow universal access to information on the Web by all people but especially by people with disabilities (e.g., blindness, low vision, deafness, hard of hearing, physical disabilities or cognitive disabilities). In addition, the information must be accessible by automatic machine tools (e.g., site indexing tools, robots). This information is adequately explained by [Letourneau](#) (2009) who defines web accessibility to mean "anyone using any kind of web browsing technology must be able to visit any site and get a full and complete understanding of the information and must have the full and complete ability to interact with the site if that is necessary".

The term accessible design is used to refer to design intended to maximize the number of potential customers who can readily use a website. Accessible design can impact market size and market share through consideration of the functional needs of all consumers, including those who experience functional limitations as a result of ageing or disabling conditions. A functional limitation describes a reduced sensory, cognitive, or motor capability associated with human ageing, temporary injury, or permanent disability that prevents a person from communicating, working, playing, or simply functioning in an environment where other people in the population can function ([Monterey Technologies Inc.](#), 1996).

Accessible web design entails ensuring that web pages are "user-friendly" in the broadest sense for all those visiting a site. This includes layout, readability, color choice and browser-independence, as well as considering the requirements of those using adaptive or alternative technology ([Forrester Research](#), 2011). It is worth mentioning the relationship between accessibility and usability, which are closely related, as they both improve the satisfaction, effectiveness, and efficiency of users. But while accessibility is aimed at making the website open to a wider user population, usability is aimed at making the target population of the website happier, more efficient, and more effective. Basically, web usability is about making things more intuitive and user-friendly. Therefore, usability implies accessibility ([Brajnik](#), 2000), where accessibility is defined as "the website's ability to be used by someone with disabilities".

The importance of web accessibility can be realized from the following reasons: "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" ([Smillie](#), 2001). "Given the explosive growth in the use of the World Wide Web for publishing, electronic commerce, lifelong learning and the delivery of government services, it is vital that the Web be accessible to everyone" (Bill Clinton, 1997, as quoted in [Paciello](#), 2000).

In addition to the obvious reasons for making commercial and government websites conform to accessibility guidelines, the available statistics highlight the importance of such effort. Exploring these statistics, it was found that there are more than 750 million people worldwide with disabilities ([Towner](#), 2001). In the UK alone, there are 1.7 million blind and partially sighted people ([UK RNIB](#), 2002c). In Saudi Arabia, the total numbers of disabled citizens is 720,000, which represents 4% of Saudi's population. In addition, the rate is expected to increase by 5% annually ([Riyadh city reporter](#), 2004). According to Oman Census 2003 ([Ministry of National Economy](#), 2010) it is estimated that there are

about 41,303 people with different types of disabilities in Oman and they represent 2.3% from total population. However, the W3C estimates that more than 90% of all sites on the WWW are inaccessible to disabled users ([Boldyreff, 2002](#)). These statistics highlight the extent of effort needed in order to allow the disabled people to get the benefit of online information and commercial websites.

"One size does not fit all" - we are not all the same ([Hofstede, 1991](#)), so web engineers have to accommodate the differences. "Since most websites fail to accommodate people with disabilities, these websites have to be re-engineered to achieve accessibility. As we move towards a highly connected world, it is critical that the Web be usable by anyone, regardless of individual capabilities and disabilities" -Tim Berners-Lee, Director of the W3C and inventor of the World Wide Web ([Towner, 2001](#)).

Moreover, making information accessible to all customers is becoming a critical issue for different reasons, some of which include: 1) fairness to people with disabilities demands that they can access the information as everybody else does; 2) it is the law in a number of countries around the world such as Australia, USA, UK and other European Union Countries; 3) taking into account the large number of people with disabilities, it makes good business sense to meet their needs in term of making the online information accessible to them.

Thus, many countries have started putting some effort into this. For example, The Australian Disability Discrimination Act (DDA) of 1992 is a broad piece of legislation that attempts to label and outlaw any form of discrimination against any kind of disability ([Disability Discrimination Act, 1992](#)). In the USA, the accessibility of information on the Web has been well regulated. For example, Section 255 of the Telecommunications Act 1996 regulates the accessibility of Internet Telephony ([Federal Communications Commission, 2008](#)). The 1998 Amendments to the Rehabilitation Act ([US Section 508, 2002](#)), added significant accessibility requirements for the design of electronic and information technology, including accessible web design.

The European Union (EU) countries, working together, have established the EUROPA Web Accessibility Policy ([EUROPA, 2011](#)). Individual member states, for example, the UK, with the "UK Disability and Discrimination Act 1995", are making great efforts to legalize the accessibility of online information resources. The British government is conducting a "Campaign for Good Web Design" ([UK RNIB, 2002b](#)) to further encourage the effort towards web accessibility.

## Web Accessibility Guidelines

Although web accessibility is a relatively new concept, it has started getting serious attention among the professionals in the field. In addition to individual efforts ([Beirekdar et al., 2002](#); [Boldyreff, 2002](#)), [Abanumy et al. \(2005\)](#) divided the participants into four categories: Government, Universities, Institutions and Companies as shown in Table 2. Each category is not an exclusive listing but rather for exemplary purpose. There is no lack of guidelines, standards and legislations but a mechanism for implementing them, in real life, has yet to emerge.

**Table 2: Website Accessibility Guidelines**

<b>Participants</b>	<b>Description</b>	<b>Reference</b>
<b>Government</b>	Section 21 of the UK's 1995 Disability and Discrimination Act	(UK, 1995)
	EUROPA - Web Accessibility Policy	(Commission of the European communities, 2001)
	Section 508 of the U.S. Rehabilitation Act Amendments of 1998	(US Section 508, 2002)
	Section 255 of the U.S. Telecommunications Act 1996	(Federal Communications Commission, 2008)
<b>Universities</b>	The MIT's Web Accessibility Principles	(MIT, 2002)
	The Oregon State University Web Accessibility Guidelines	(Oregon State University, 2004)
	The Santa Rosa Junior College Web Accessibility Checklist	(Santa Rosa Junior College, 2002)
<b>Institutions</b>	IEEE Recommended Practice for Internet Practices	(IEEE, 2001)
	UK Mencap	(UK Mencap, 2002)
	UK RNIB	(UK RNIB, 2002a; UK RNIB, 2004; UK

		RNIB, 2002c; UK, 2011)
	The WAI initiative by the World Wide Web Consortium (W3C)	(W3C, 2011; W3C, 1999)
	DAISY Consortium's Digital Talking Book Standard	(DAISY Consortium, 2011)
<b>Companies</b>	IBM Guidelines for Writing Accessible Applications	(Schwerdtfeger, 2011)
	Microsoft's Guidelines for Accessible Web Pages	(Microsoft, 2004)

The next section discusses tools that implement these guidelines, standards and legislations.

## Website Usability and Accessibility Tools

Numerous tools exist to determine whether or not a website adheres to various web usability/accessibility guidelines. These tools can provide useful feedback to the Web engineers, designers and maintainers. In addition, these tools can assist in the repair and enhancement process of a website. There are websites that provide a selection of these tools with a description of the functionality of each tool ([Accessibility Monitor](#), 2002; [Government Computer News - Check sites for 508 with audit-edit tools](#), 2001; [NIST, WebMetric Tools](#), 2002; [Web Accessibility for Ethnic older adults](#), 2002; [WEBAIM](#), 2004; [Brown](#), 2002; [Thatcher](#), 2002; [Graves](#), 2001; [NIST](#), 2011; [Becker et al.](#), 2002; [Hower](#), 2011; [W3C](#), 2002). Some of the better-known tools are listed in an internal technical report for School of Computing Sciences, University of East Anglia ([Al-Badi](#), 2002). Some of the better-known tools are listed in Table 3.

**Table 3: Website Usability and Accessibility Tools**

<b>Tool</b>	<b>Company/Ref</b>	<b>Description</b>
508 Accessibility Suite	(UsableNet, 2002a)	Off-line identify potential accessibility problems.
AccessEnable	(Brown, 2002)	Web-based; A tool for evaluating compliance with accessibility standards.
AccVerify, AccRepairand AccMonitor	(HiSoftware, 2002)	Web based; in addition to other services, the hosted service solution allows the user to monitor Accessibility & Usability: Section 508, WCAG 1.0 (Priority 1-3), WCAG 2.0, XAG; AccVerify checks HTML for compliance verification and reports all errors/non-compliance with the standards while AccRepair guides user through steps to achieve accessibility for Web content.
A-Prompt Tool Kit	(University of Toronto, 2002)	Off-line; a utility developed by the University of Toronto (the ATRC) for checking for access barriers and making repairs to correct any problems; free download.
AskAlice	(SSB Technologies, 2002a)	Web-based; provide online report containing: a thorough assessment of your site's accessibility; an analysis of the opportunities accessibility offers your organization; and information on how you can make your site accessible.
BBC's text-only Betsie system	(BBC, 2002)	Web-based; a filter program used by the BBC to create an automatic text-only version of its website. Betsie will only work with BBC sites.
Bobby	(Watchfire, 2002)	Web-based and off-line; a comprehensive website accessibility software tool designed to help expose barriers to accessibility and encourage compliance with existing guidelines; recently WatchFire acquired Bobby from CAST.
CORDA Technologies - PopChart (D)	(CORDA Technologies, 2002)	Data-Driven Charts compliant with Section 508, Corda's software can create and descriptive text that can be read by a screen reader.
Crunchy Technologies Accessibility Solutions	(Crunchy eBusiness Network, 2002)	Web content accessibility software products including PageScreamer, Page Screamer Central and PageScreamer Spider. This latest product claims "non-compliant text or images are identified, reported and corrected, and recurring images in the main website and its links can be corrected with one change".
Delorie Lynx viewer	(Delorie, 2004)	Web-based; simulates a Lynx browser in an online environment. Deals with frames, but doesn't render the menu of the ALT text or

		URL's of the areas.
Doctor HTML	(Imagiware, 2003)	Web-based and off-line; Available from Imagiware; a Web page analysis tool which retrieves an HTML page and reports on any problems that it finds.
HTML TIDY	(Raggett, 2002)	A free utility that allows one to fix HTML coding mistakes automatically and tidy up sloppy editing into nicely laid out markup.
LIFT	(UsableNet.com, 2002)	Web-based and off-line; available from UsableNet.com; it is for testing usability and repairing accessibility and usability.
LinkBot	(Watchfire, 2002)	Off-line, with ranking; fault analysis and repair tool; the next generation is WebQA™ 2.0.
MacroBot	(Watchfire, 2002)	Off-line; failure identifier
Macromedia Dreamweaver Accessibility Extension	(Macromedia, 2002)	Free downloadable extension that integrates accessibility reviews into your Dreamweaver U.I. Checks for WAI compliance or 508 and generates a report.
Magpie	(NCAM, 2002)	Media Access Generator is available in several formats. This tool adds captions to three multimedia formats: QuickTime, SMIL and Microsoft's Synchronized Accessible Media Interchange (SAMI) format.
MetaBot	(Watchfire, 2002)	Off-line; fault analyzer and repair tool.
Metrics for Usability Standards in Computing (MUSIC)	(Bevan, 1995; Macleod et al., 1998)	Provide valid and reliable means for specifying and measuring usability. Diagnostic Recorder for Usability Measurement (DRUM) supports the MUSIC performance measurement method, and also has wider applicability.
NetMechanic	(Netmechanic, 2002)	Web-based; available from Netmechanic; fault analyzer and repair tool.
Office 2000 HTML Filter	(Microsoft, 2002)	This tool, provided by Microsoft, removes Office-specific markup tags embedded in Office 2000 documents such as Word documents when saved as Web pages.
PDF to HTML Converter	(Adobe, 2002)	Web-based; developed by Adobe, converts PDF file to accessible HTML file.
Powerpoint Accessibility Wizard	(University of Illinois, 2003)	Off-line; from Division of Rehabilitation - Education Services, University of Illinois, this tool converts PowerPoint presentations to plain HTML.
RetroAccess	(RetroAccess, 2002)	Web-based; a website evaluation and repair package that automatically evaluates your website for accessibility. Uses checklists to guide you through the repair of those problems.
SSB Technology	(SSB Technologies, 2002b)	Web-based; a set of tools for evaluation and repair including site monitoring and report generation regarding Section 508 compliance issues. For either desktop or server applications.
Usability Enforcer	(Becker, 2002b)	Web-based; An ActiveX control that transforms a web page according to a set of usability rules. These rules are based on various sources including the National Institute on Aging guidelines, Usability.gov guidelines.
Vischeck	(Vischeck, 2002)	Web-based or offline; tool for simulation of appearance of graphical elements to people with various sorts of colour deficiency.
W3C HTML validation tools	(W3C, 2002)	Web-based; and off-line; checker for W3C recommendations and standards, including HTML, XHTML and CSS.
Wave	(Pennsylvania's Initiative on Assistive Technology (PIAT), 2003; Kasday, 2000)	Web-based free utility that checks for common accessibility issues, and generates a report with user friendly icons showing key issues. Good for checking linearization of table cells, missing ALT, etc.
Web Page Backward	(Delorie software, 2002)	Web-based; see what your page looks like without support for various features.



Compatibility Viewer		
Website Analysis and Measurement Inventory (WAMMI)	(WAMMI, 2002)	Web-based; An evaluation tool for websites. It is based on a questionnaire that visitors fill out, and which gives website managers a measure of how useful and easy they found the website.
Web Usability Index	(Usablenet, 2002b)	A measure, expressed as a percentage (%), of how closely the features of a website match generally accepted usability guidelines.
WebCriteria	(WebCriteria, 2002)	Web-based; available from WebCriteria; comparative evaluation of a website with respect to a benchmark derived from similar well-established websites; failure identifier.
WebGarage	(Netscape, 2002)	Web-based; available from Netscape; fault analyzer; for measuring the website performance (speed and download).
WebQual	(WebQual, 2002; Barnes and Vidgen, 2002)	A method for assessing the quality of websites.
WebQuilt	(University of California, 2002; Hong et al., 2004)	A web logging and visualization system that helps web design teams run usability tests (both local and remote) and analyze the collected data.
WebSAT	(NIST, 2004)	Web-based and off-line; available from NIST; fault analyzer.

There are a number of studies on automating the Web usability/accessibility evaluation process, which aim at examining the usefulness and effectiveness of the existing tools. For example, [Brajnik \(2000\)](#) presented a survey of automatic usability evaluation tools for websites. These tools consider a large set of properties depending on attributes and not on the context of websites. He concluded that, in particular, those tools supporting repair actions have the potential to reduce dramatically the time and effort needed to perform maintenance activities. Another study ([Ivory & Chevalier, 2002](#)) examined the effectiveness of the [WatchFire Bobby \(2002\)](#), [W3C HTML Validator \(2002\)](#), and UsableNet LIFT automated evaluation tools ([UsableNet.com, 2002](#)). They concluded that although the tools helped designers to identify a larger number of potential problems, designers were not effective in interpreting and applying the guidelines. Furthermore, the modifications that designers made based on the tools did not improve user performance or ratings.

## Website Readability

Readability on websites is a very critical factor and should be given high priority. It was found by many researchers that Web documents have very different characteristics from newspaper articles or pages in a textbook ([Al-Badi et al., 2005](#)). Web designers are required to design web pages that attract surfers, retain and convert them to loyal customers. Readability is concerned with the extent to which piece of text is easy for the target readers to read. A proficient reader is likely to be bored by simple repetitive texts. An incompetent reader will soon become discouraged by texts which he/she finds too difficult to read. This is likely to happen when the text contains complex sentence structures, long words, or too much material with entirely new ideas. The term readability refers to all the factors that affect reading and understanding a piece of text. These factors include: the interest and motivation, page layout (e.g., foreground/background color, spacing between lines and objects), text affects (e.g., font typefaces, size and styles), among others, the quality of user's monitor as well as the actual composition of the website content ([Lee, 1999](#)).

Readability Formulae (also called readability indices or metrics) were first developed in the 1920s in the United States. For many years, readability Formulae has helped teachers, librarians, and parents match books to students in that country. They are used to analyze text and predict which materials can be comprehended by individual readers ([Al-Badi et al., 2005](#)). As far as the researchers are aware, there is no equivalent to such Formulae for the Arabic language.

## Writing for the Web

Most websites use text as a common way of communication, because it downloads quickly and is reads well ([Allen, 2002](#)). Previous researchers and practitioners in the fields of "web usability" and "writing for

the Web" have found that writing for the Web is different from writing for hardcopy (print). This is due to the fact that people rarely read web pages word by word; instead, they scan the page content. It was found that 79% of users always scan any new page they come across and only 16% read word by word (Thomason, 2011; Nielsen, 2005b; Nielsen, 1997b; Morkes & Nielsen, 1997). Reading from computer screens is 25% slower than from paper. It is advised that Web content should have 50% of the word count of its paper equivalent (Nielsen, 1997b; Morkes & Nielsen, 1997).

Many studies highlighted the difference between writing for the Web and writing for hardcopy, for example, Dillon et al. (1992) stated that reading on a screen is substantially slower than reading print and accuracy is lessened for cognitively demanding tasks. They also suggested that visual fatigue and reduced levels of comprehension is more likely to result from reading from a screen and readers preferred good hard copy to screen displays. There was almost consensus among the usability experts regarding the need for different styles of writing when composing a web document. Online documents need to be concise, scan-able and objective (Morkes & Nielsen, 1997). Therefore, experts in the field formulated a set of guidelines for writing for the Web.

## Readability Formulae (indexes)

A readability formula is a method of testing the level of reading skill needed to be able to read a particular piece of text. Readability formulae are mathematical equations that correlate various document features with a standard measure of reading comprehension. The document features can include the number of letters and syllables per word and the number of words per sentence. Most of the current readability formulae express the readability level as a grade level or as years of education. However, many researchers believe that the way readability formulae predict the readability of a document is inadequate (Al-Badi et al., 2005). As a matter of fact, readability formulae might be counterproductive, because they focus the writer's attention on words and sentences and draw attention away from other readability issues. Hundreds of readability indexes/formulae exist; and many online resources describe the different kinds of readability formulae (Hill, 1997; Nielsen, 1997b; Weitzel, 2003; Miller, 2004). A detailed report is presented in (Al-Badi et al., 2005).

## Limitation of Readability Formulae

Many researchers have highlighted the limitations of readability formulae (Courtis, 1995). Redish and Selzer (2005) stated five main problems with readability formulae and the way they are used. These problems are summarized as follows:

It is not clear what a readability score means in writing for adults. The assumptions the developers of these formulae made at design time are based on an old American system for children at school. This may not be applicable to the current system in America let alone other parts of the world.

Studies have shown that readability formulae are not reliable and valid predictors of the difficulty of documents. Researchers found that the ability to recall information from different paragraphs that had the same readability scores was not the readability score but that each passage had fewer ideas in each sentence and that the connections between the ideas were clearer. Furthermore, they found simplifying the vocabulary in order to improve reading comprehension was not always successful.

Short sentences are not necessarily clearer than long sentences. Readability formulae pressure writers to write short, simple sentences but sentences can be difficult to read because they are too short. Similarly, short words are not always easier words. The important point is not that the words are short, but that the readers know the words that are being used.

People are not text-processing machines. The underlying assumption of readability formulae is that any text for any reader for any purpose can be measured with the same formula. The formulae ignore motivation but reading researchers have found that readability scores are unimportant if adult readers are motivated to read the text.

Readability formulae do not measure the most important features of a document but only the features that can be counted. Yet many factors for which we have no objective measures also influence how understandable and useful a document is. These features may be as important as the length of the sentences and the words. Three critical factors that readability formulae ignore are content, organization, and layout. Document Content: readability formulae do not measure the appropriateness or accuracy of the content. Even for well-educated adults, not all content is equally easy to understand. Document Organization: Readability formulae do not consider how well a document is organized. Sometimes the information is hidden under uninformative headings which the readability formulas do not discover.

Document layout: readability formulae cannot be used on text that is not straight prose or for a document with forms nor with text that relies heavily on charts, tables, graphs, or illustrations. Typically, the layout of a website document with colors and hyperlinks is not considered in the current readability Formulae.

## Website Globalization

Some companies compete globally with English-only websites; many others require that their websites present content in local languages. Leading research firms arrived at various growth rate predictions, but one trend is very clear: non-English speaking Internet audiences today comprise the majority. In 2001, the International Data Corporation (IDC) estimated that by the year 2004, non-English speaking users will make up over 70% of the total online population ([IDC](#), 2011).

So, the question is: when the site audience is the whole world, how can its content be made accessible to the non-American, non-English-speaking people who have different cultural values and expectations? Does the translation of a website from one language to another solve the problem? Becker and Crespo argued that the basis of support for multicultural websites is quite complex and cannot be viewed as a direct translation of textual content from one language to another ([Becker & Crespo](#), 2001). In addition to the inadequacy of the translation, it is also a very expensive process. This is because any changes to the home language site will require that related changes are made to the foreign language sites, so that the translation issues never end. It can involve many types of materials, including technical documents, marketing materials, market research, sales information, product literature, price lists, and even competitor information. Moreover, application server and content management software were initially developed for the monolingual US market and often do not work smoothly with non-English character sets. Such issues are obstacles for international web designers in producing usable localized websites. Therefore, it is not only because translation is expensive and inadequate but also because there are other issues that need to be considered. These relate to culture, real-world experience, and language. Such realization led to the emergence of the term "Globalization."

## Definitions of Globalization

Globalization is when "a website serves every visitor with the same quality experience regardless of location, language, business practices, or cultural issues" ([Izar.com](#), 2002). The term globalization encompasses the whole process of creating a product with versions for users in different countries, from the first specification through adaptation to local markets ([Al-Badi & Naqvi](#), 2009). However, some software engineers use the term interchangeably with the word "Internationalization" ([Hars](#), 1996). Today's e-business requires an infrastructure that will accelerate globalization and provide a standard platform that all parties can use to manage and streamline the process ([Uniscape](#), 2002).

## Internationalization (i18n)

Nielsen defines the term internationalization as "a single design that can be used worldwide" ([Nielsen](#), 1999). That is, the website must be technically and culturally neutral. It is the process and philosophy of making software/website portable to other locales. Effective internationalization reduces the time and resources required for localization. In other words, internationalization abstracts out local details, localization specifies those details for a particular locale ([Al-Badi & Naqvi](#), 2009). Although logically it is the first step in the globalization process, internationalization is often done after the company has done a localized version. Internationalization involves designing an e-business framework or web architecture that is culturally neutral. The creation of a linguistic and culturally neutral framework is the first critical step in the globalization process ([Al-Badi & Naqvi](#), 2009). Internationalization, then, prepares a website to function seamlessly across diverse cultural backgrounds and business rules, which can be loaded as needed for appropriate audiences ([Uniscape](#), 2002).

## Localization (L10n)

Localization involves the process of adapting linguistic and cultural content to specific target audiences in specific "locales" ([Al-Badi & Naqvi](#), 2009). Nielsen defines localization as "making an adapted version of the Internationalized design for a specific locale" ([Nielsen](#), 1999). "Locale" is the name for specific linguistic, cultural and business rules for a given target audience. For example, the Spanish language in Mexico some different features than Spanish in Spain, and the same conditions apply for the currency and other business rules. This include the text translation process of the user interface, on-line help and documentation, as well as making sure that the graphics, colors, and sound effects are culturally appropriate, and things like dates, calendars, measurement units and monetary notations are in the correct format ([Hars](#), 1996). In other words, localization is the design for a locale by taking into account

language, culture, religion, laws, currency, and text and number formats i.e. creating culturally biased website ([Al-Badi & Naqvi, 2009](#)).

## Global Content Management

Localizing content for the first time is actually easier than the challenge of keeping it continually updated on an on-going basis. With the Web, content is continually changing, on a weekly, daily or even hourly basis. Often, changes that occur in one language must be rippled across other target languages. This process of constantly changing content must be efficiently managed.

## Cultural Difference Issues

Does the culture have any stake in website usability? This section tries to answer this question.

### Definitions of Culture

Different definitions of culture have been formulated by different scholars, for example, [Henderson](#) (1996) defined culture as a "manifestation of the patterns of thinking and behavior that result through a group adaptation to its changing environment which includes other cultural groups". Hence, culture can be defined as behavior typical of a group or class (of people). Similarly, ([Martin et al.](#), 1997) assert that culture "consists of traditional ways of doing things, traditional objects, oral traditions and belief systems that are taken for granted". [Livonen et al.](#) (1998) defined culture to be "more than art, it is a framework to our lives. It affects our values, attitudes and behaviors. In other words, we are actors in our culture and affect it". Culture has also been defined by [Martin et al.](#) (1997) as a way of living, thinking and learning, and as an individual dialectic. They further explained how pervasive the effect of culture is on individual perceptions, cognition and behavior: "Each culture operates according to its own internal dynamic, its own principles, and its own written and unwritten laws. Even time and space are unique to each culture". Similarly, [Hofstede](#) (1997) defined culture as "the learned pattern of thinking, feeling, acting and values, which are specific to a group or category of people". [Rice](#) (1999) believes that there are individual differences within the range of the generalization of a culture. She mentions that "within a given culture there is a range of individual variations created by preferences, religion and innate differences such as gender and disabilities". [Sheridan](#) (2001) defines culture as "how people from certain cultural orientations view and interpret specific images and messages".

### Cultural Differences

The World Wide Web by its nature is global; therefore an important question is whether the "one-size-fits-all" approach is appropriate for websites? That is, can one website be usable by everybody across different culture, different countries?

Obviously, there are differences among cultures across the globe that dictate the way content should be presented and adapted accordingly. In other words, the manner in which the Web is designed, written, and the way the information is organized may affect the users' understanding or interpretation of, or receptiveness to, the information presented. That is, many factors need to be considered when designing for an international audience; [Alvin Yeo](#) (1996) categorized them into overt (objective) and covert (subjective) factors. The overt factors consider tangible, straightforward and publicly observable elements. They are said to include date, time, calendars, telephone number and address formats, weekends, day turnovers, character sets, collating order sequence, reading and writing direction, punctuation, translation, units of measures and currency. Covert factors deal with the elements that are intangible and depend on culture or "special knowledge". Graphics/visuals, colors, sound, metaphors, functionality and mental models are all covert factors. Covert symbols usually have the same meaning to members of a particular culture. Thus, communication within these cultures using artifacts and symbols would be possible. There is less likelihood of misinterpretation of covert factors within a single culture.

Different cultures may have different meanings, perceptions or metaphors for the same thing, which may depend on the context of the thing in hand. It is important to note that a users' interpretation of metaphors is based largely on the users' past and current knowledge ([Murrell](#), 1998).

Screen metaphors are an example of an area where misinterpretation may occur. For example, the "trash can", would not be understood by Thai users, because in Thailand, a "trash can" is a wicker basket ([Sukaviriya & Moran](#), 1990). In the United States, the owl is a symbol of knowledge but in Central America, the owl is a symbol of witchcraft and black magic ([Apple-Computer Inc.](#), 1992). A black cat is considered bad luck in the US but good luck in the UK ([Del Galdo & Nielsen](#), 1996).

Certain covert elements may be inoffensive in one culture, but offensive in another. In most English-speaking countries, images of the ring or OK hand gesture may be understandable, but in France the same gesture means "zero", "nothing" or "worthless". In some Mediterranean countries, the gesture implies a man is a homosexual. Covert factors will only work if the message intended in those covert factors is comprehended in the target culture. To use any of the covert factors on a website, the website developers need to make sure that they know their users in the target cultures.

[Evers and Day](#) (1997) have also addressed the role of culture in user interface acceptance. For example, Asians prefer soft colors, fixed menus and explicit text (character)-based interfaces; while the mouse is considered the best input-device, and sound is very important. Even in Asia, there are differences in interface preferences: Indonesians like soft colors, black and white displays, pop-up menus and new input technologies more than Chinese people do ([Evers & Day](#), 1997). [Barber and Badre](#) (1998) gave an example of the color-culture of different countries. For example, the color red means different things to different people: for the Chinese it means happiness; for the Japanese, anger/danger; for Egyptians, death; for the French, aristocracy; and for Americans, danger/stop. The use of color can also be associated with religion. For example the Judeo-Christian tradition is associated with red, blue, white, and gold; Buddhism with saffron yellow and Islam with green.

Graphic literacy (semiotics) may also affect navigation. Symbols that may be assumed to be universal may in fact not even be known to others, or may have an opposite meaning; [Andrews](#) (1994) points out that to an illiterate Zulu-speaking person, the "No smoking" sign means "you can smoke half a cigarette", and the "Emergency Exit" sign is interpreted as "don't run that way or you will get head, hands and feet chopped off". A research conducted by [Amory and Mars](#) (1994) shows that South Africans tend to represent the word "picture" with an icon of a drawing in a picture frame, while Americans are likely to draw a camera. Murrell in ([Apple Macintosh](#), 1997) has discussed a number of highly important cultural aspects in relation to the South African user community. Also, as indicated by ([Hars](#), 1996) some cultures around the globe associate the pointing-finger cursor with thieves. The use of certain symbols, icons, or images may be offensive or even against the law in certain regions. In some parts of the world (e.g., Saudi Arabia), the celebration of Valentine's Day is punishable by law. In other parts (e.g., some parts of India), it is deemed as obscene and is boycotted. Celebration of the 5<sup>th</sup> of November in Ireland is viewed as anti-Roman Catholic.

## Cultural Models

Researchers and scholars have attempted to define the various dimensions of culture. For example, [Hall](#) (1999) distinguished cultures on the basis of a way of communicating along a dimension from "high-context" to "low-context". A high-context communication is one in which little has to be said or written because most of the information is either in the physical environment or within the person, while very little is in the coded, explicit part of the message. [Trompenaars and Hampden-Turner](#) (1997) conducted research on cultural dimensions (30,000 interviews and questionnaires in 20 countries representing 47 national cultures). They distinguish culture along a number of interesting axes, including relationships and rules, group versus individual, feelings, personal involvement, status, the approach to time and attitude toward the external environment. However, it is Hofstede's dimensions of culture that are the most often quoted theories in relation to cross-cultural usability ([Hofstede](#), 1991). He conceptualized culture as 'programming of the mind', in the sense that certain reactions were more likely in certain cultures than in others, based on differences between basic values of the members of different cultures. Hofstede carried out a study of 116,000 IBM employees distributed through 72 countries using 20 languages in 1968 and 1972. The study was based on a rigorous research design and systematic data collection ([Hofstede](#), 1991). He proposed that all cultures could be defined through five dimensions:

**Power Distance (PD):** The degree of emotional dependence between the boss and the subordinate.

**Individualism/Collectivism (IC):** Integration into cohesive groups versus being expected to look after himself/herself.

**Masculinity/Femininity (MF):** This could be interpreted as toughness versus tenderness.

**Uncertainty Avoidance (UA):** The extent to which members feel threatened by uncertain or unknown situations.

**Long/Short Term Orientation (LTO):** This represented a philosophy of life that was prepared to sacrifice short-term results for long-term gain. This dimension does not discriminate across all cultures in the same way as the dimensions given above. It has been suggested that it discriminates between environment-centric cultures and human-centric cultures.

Hofstede recognized that UA was an important dimension for western cultures and LTO for eastern cultures. A closely-related concept to Hofstede's individualism-collectivism dimension is [Rotter's](#) "Locus of Control" (1966) which refers to whether individuals tend to feel that events are the result of their own

actions (i.e., internal locus) or the effect of the external environment and powerful others (i.e., external locus). It has been suggested that LC influences information-seeking behavior so that 'internals' seek more information in problem solving, although the strength of this behavior depends very much on the situation. By contrast, when individuals adopt an 'external' approach they might not generalize or learn effectively. They learn less because they believe they do not control the relationship between their behavior and reinforcement. In Western cultures the making of plans and having them work is frequently endorsed, while in collectivist societies the focus is less on having plans work well, but more upon personal relationships. This can have many effects, including the belief a person has in his/her ability to accomplish computer tasks ([Langford & Reeves, 1998](#)).

Most of the above theories were formed long ago, and were not related to website usability but to organizational change. Therefore, the applicability of such theories to website usability is questionable. To explore the applicability of the cultural models in web design, many researchers conducted theoretical and empirical studies that use the existing cultural models. For example, [Marcus and Gould \(2000\)](#) address Hofstede findings and present guidance for each of Hofstede's dimensions based on a theoretical analysis of websites. They attempted to provide guidelines for designing a website based on Hofstede's dimensions. Another advocate for designing sites according to Hofstede's dimensions is [Sheridan \(2001\)](#). Similar to Marcus and Gould, [Sheridan \(2001\)](#) provides guidelines for website design based on each of the cultural dimensions. Experimental work has also been conducted using dimensions of existing cultural models as a means of choosing and identifying samples and fitting them into a cultural category. ([Smith et al., 2001](#)) carried out one such study. They use Hofstede's study on generic cultural differences, which included UK and China, to build up on their work. They adapt the Taguchi method (partial factorial experimental design method) to explore differences between British and Chinese satisfaction and preferences for websites. They claimed to find significant differences between British and Chinese users in their preference for detailed e-finance product information.

[Zahedi et al. \(2001\)](#) employed the cultural dimensions to build a conceptual model for international web design. They claimed that their model is the first attempt to identify the influence of cultural and individual differences in the perceived effectiveness of and satisfaction with various web designs, as can be seen in the Figure 1.

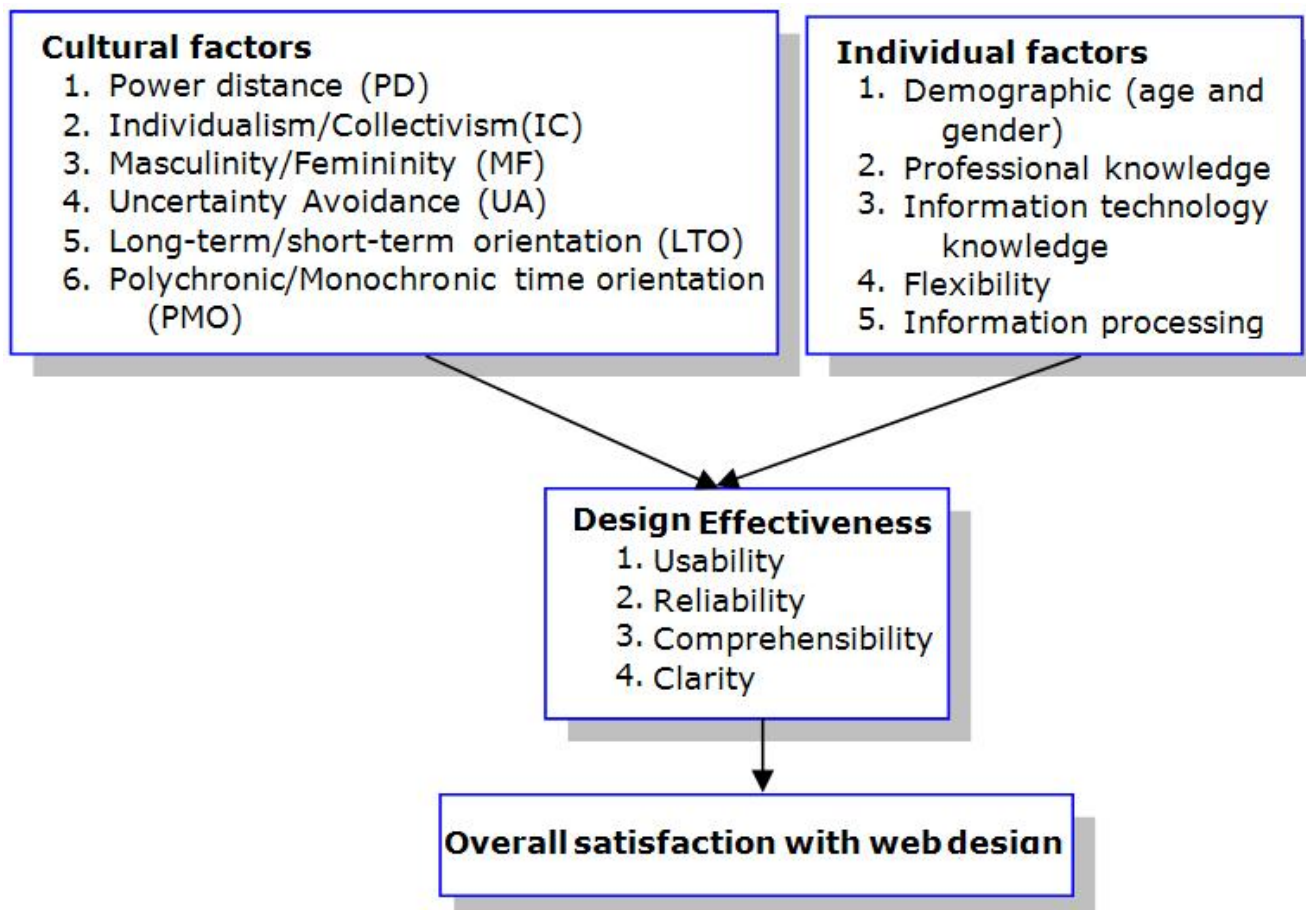


Figure 1. A Conceptual Framework for Web Design

Adopted from: ([Zahedi et al.](#), 2001)

They adopted the cultural factors of [Hofstede](#) (1997), and they added polychronic/monochronic time orientation from [Hall](#) (1983). Hall argues that the structure of time is formulated, used, and patterned differently in different cultures and these culturally dependent temporal structures are unconsciously and invisibly woven into our everyday activities, deeply influencing how we work and think. Polychronic cultures prefer doing many things at a time, stress involvement with people and completion of transactions rather than adherence to schedules, emphasize commitments to people and lifetime relationships, and rely on the situational context of the message ([Hall](#), 1983). Monochronic cultures prefer doing one thing at a time, compartmentalize relationships and tasks according to strict time schedules, value promptness and adherence to plans, and rely on communications in which most of the information must be included in the message itself with details clearly spelled out ([Hall](#), 1983). There are also other attempts in this regard, however, in all these cases the results were not that encouraging ([Smith et al.](#), 2001; [Simon](#), 2001; [Bourges-Waldegg & Scrivener](#), 1998; [Sun](#), 2001). The researchers are interested, therefore, in conducting studies with target users to determine the extent to which cultural factors do actually affect the international website usability and accessibility.

## Conclusion

This exploratory study provided a broad overview of previous research and the literature related to website usability, accessibility, readability culture differences and globalization. Obviously, that "one-size-fits-all" approach is not appropriate in terms of websites for the reasons outlined in this research.

The existing usability, accessibility guidelines, methods and tools are steps in the right direction; however, most studies of usability have taken place within North America and, to a lesser extent, in Western Europe. Hence they need to be broadened to meet the challenge of a global environment. What is needed is a framework to help web engineers, designers, developers and/or evaluators to assess the usability/accessibility of a website and web services. This framework must consider all the factors (challenges) that are involved in the process of localizing websites. Moreover, the challenges brought forward by the invention of Web 2.0 and its related social networking sites obviously were not considered during the writing up of the existing guidelines and their associated tools.

Having reviewed the literature on the accessibility/usability, the next step is to develop an accessibility aware e-content framework where people with special needs will be able to access all electronic contents based on their disability levels. This e-content framework can be used for developing accessible websites and electronic services for these people.

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