A Framework for the Study of Customer Interface Design for Mobile Commerce

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ABSTRACT: The rapid growth of mobile telephony has fueled the expansion of the mobile Internet as a foundation for mobile commerce. Proponents claim that mobile commerce will surpass electronic commerce in growth and scope, but there is as yet no commonly accepted framework for the study of interface design for mobile commerce. Using Rayport and Jaworski's 7C's—the seven design elements of a customer interface (context, content, community, customization, communication, connection, and commerce)—as a reference framework, interfaces for mobile commerce and electronic commerce are compared. Two new elements (2M's) are identified: mobile setting and mobile device constraints. These 2M's substantially affect the design of each of the 7C's. Therefore, the 2M's and 7C's are proposed as a new framework for mobile commerce interfaces. Based on this, previous research is analyzed and suggestions for future research are generated.

KEY WORDS AND PHRASES: Customer interface design, human interface, mobile commerce, research framework.

The rapid growth of mobile telephony has fueled the expansion of the mobile Internet as a foundation for mobile commerce (m-commerce). M-commerce refers to "e-commerce activities via mobile devices, such as phones or Personal Digital Assistants (PDA's)" [33]. The mobile Internet has unique strengths over the stationary Internet, because users can connect to the Internet wherever and whenever they want [23]. Given the enhanced features available on the mobile Internet, proponents claim that m-commerce will surpass e-commerce in growth and scale [24]. In Japan, the mobile Internet is already used by more people than the stationary Internet [13]. The market size totals $500 million, and the mobile Internet provider NTT DoCoMo has more than 25 million subscribers [18]. In South Korea, the number of mobile phone owners is 29 million (64% of the population), and there are more than 18 million mobile Internet subscribers (39% of the population) [27].

Despite the sanguine expectations of many observers and the enhanced capabilities of mobile systems, few researchers on information systems (IS) have empirically studied interface designs for m-commerce. Human-computer interaction (HCI) researchers have explored interface designs for mobile devices through which users experience a very different environment than with personal computers. Most IS studies are descriptive, qualitative studies that explore the process of m-commerce acceptance from the perspective of new technology adoption. For instance, Carroll et al. developed an appropriation model that listed the factors that influence users' decisions on whether or not to adopt mobile devices and the extent of their use [12].

Given the early stage of research, commonly accepted prescriptions for the design of m-commerce interfaces have not yet been established. However, the studies to date appear to share the conclusion that principles from the design of e-commerce interfaces should not be directly applied to m-commerce

interfaces, given the substantially different computing environments and device constraints [7, 8, 13, 28, 29, 37]. The principles of designing effective e-commerce interfaces were developed for personal computers equipped with superior and larger output screens and input devices, faster CPUs, and higher-bandwidth access to the Internet than mobile devices. More important, e-commerce interfaces were developed in the absence of a distinct mobile computing environment in which users are often simultaneously engaged in other tasks (e.g., answering a phone call or attending a meeting). Therefore, one must ask whether what is known from e-commerce interfaces can be adopted for m-commerce interfaces, and if not, research is necessary to determine what principles should be developed.

In pursuit of answers to these questions, several studies of m-commerce interface design were analyzed in accordance with Rayport and Jaworski's framework of seven design elements for customer interfaces (the 7C framework) [38]. The 7C framework was developed primarily for analyzing e-commerce interfaces and examines the customer interface based on seven factors: context, content, community, customization, communication, connection, and commerce. This analysis provides two key insights for understanding m-commerce interfaces. First, it verifies that the current perspective on e-commerce is also applicable to m-commerce interfaces. Second, it provides a comprehensive framework for the evaluation of interfaces in that it alerts researchers to major issues in interface design that should be taken into account. The common aspects of e-commerce and m-commerce interfaces make it possible for m-commerce researchers to begin their investigations with the body of knowledge accumulated in e-commerce. On the other hand, the apparent differences highlight what researchers should focus on in seeking an understanding of m-commerce interfaces by identifying what does not apply to them within the existing paradigm of e-commerce. Classifying the interface issues of m-commerce to the 7C framework facilitates the development of an analytical framework with which to organize research so that customer interfaces for m-commerce can be better understood and future research can emerge.

Seven Design Elements of the Customer Interface

Rationale for the 7C Framework

Before the 7C framework is introduced, it would be worthwhile to define "customer interface" with respect to human-computer interaction. HCI is "concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" [2]. In contrast, the user interface for Web-based stores—here designated the "customer interface"—represents "the store's theme, [which should be] easy to navigate, and pleasing to the store's customers" [38]. Hence, while HCI engages all aspects ranging from design to development to evaluation of software/hardware for interactive systems, customer interface issues focus on the components equipped on Web storefronts by e/

m-commerce retailers in order to assist customer navigation, information acquisition, and, ultimately, purchasing. The present discussion is concerned with a comparison of customer interface designs, rather than HCI designs, for e-commerce and m-commerce, and, more specifically, with the customer interface distinctively designed to enable e/m-retailers to communicate with their customers, and vice versa.

The 7C framework is chosen as the reference for comparison, because it emphasizes the specific role of interface elements as a communication channel between retailers and their customers. In other words, the 7C's are the interface components through which retailers communicate with their customers to deliver the core value proposition the company wants to convey [38]. This coincides with the present study's goal of finding out what e/m-retailers should equip their Web sites with in order to communicate with their customers. There are other frameworks, such as Nielsen's ten usability heuristics, Shneiderman's eight golden rules of interface design, and Zhang et al.'s theoretical framework for Web user interface design and evaluation [34, 43, 50]. These frameworks should be acknowledged for their comprehensiveness and their direct applicability to the interface development process, but their focus lies on general design features and formats applicable to all interactive systems, such as "visibility of system status" [34], enabling "frequent users to use shortcuts" [43], and shortening the "length of page loading time or response time" [50]. Consequently, the 7C framework is chosen as the basis of comparison. Each of its design elements will be explained below.

Elements of the 7C Framework

Context captures how the Web site is delivered. It consists of functionality and aesthetics (look and feel). *Functionality* deals with two issues: organizing content into sets of pages (layout) and providing users with a means of navigation (performance). *Layout* refers to three aspects: section breakdown, linking structure, and navigation tools. *Section breakdown* is concerned with how a piece of information is partitioned into sets of pages; *linking structure* with how each page is linked to the others; and *navigation tools* with the means of moving throughout the site. The *aesthetic* nature of sites is established by visual characteristics, including colors used throughout the site (*color scheme*) and *visual themes* that help deliver a message.

While *context* focuses on presentation, *content* focuses on what a site delivers. It comprises offering mix, appeal mix, multimedia mix, and content type. *Offering mix* is the mix of product and service information on a Web site (e.g., collected items for outdoor sports), *appeal mix* refers to promotional and communication messaging (e.g., customer support), *multimedia mix* deals with the choice of media (e.g., pictures of products supported by audio narration), and *content type* refers to the degree of time-sensitivity: *current-content* versus *reference-content* according to high/low time-sensitivity.

Community concerns the interaction between users (i.e., user-to-user communication), including a feeling of membership and a sense of involvement. It is divided into interactive communication and non-interactive communication.

Examples of *interactive communication* tools include instant messaging, message boards, and member-to-member e-mailing lists. On the other hand, some users seek *non-interactive communication* rather than be involved in a direct exchange of responses.

Customization refers to the site's ability to tailor itself (*tailoring*) or to be tailored by each user (*personalization*).

Communication is defined as the dialogue between sites and their users and has three forms: *broadcast,* a one-way information exchange from an organization to users (e.g., e-mail notification), *interactive,* a two-way communication between an organization and a user (e.g., customer service request), and *hybrid,* a combination of broadcast and interactive (e.g., freeware distribution).

Connection refers to the extent of formal linkage from one site to others. It is characterized according to the degree of linkage and the amount of information quoted from other sites: *outsourced content, percent of home site content,* and *pathways of connection.*

Last, *commerce* deals with the interface that supports the diverse facets of business transactions, such as a shopping cart, security, orders through affiliates, order tracking, and delivery options.

Extended Framework for m-Commerce Customer Interface

Comparative analysis of m-commerce customer interfaces against the 7C framework found that a considerable amount of research in m-commerce deals with issues not covered by any of the 7C's. These research issues are grouped under mobile setting and mobile device constraints.

Mobile setting represents the unique environment where mobile users perform their tasks in terms of time, place, and context [23]. Other researchers use different terms to describe mobile setting, but these converge at three points: spatiality, temporality, and contextuality [23, 39]. *Spatiality* concerns the fact that users carry their mobile devices anywhere they go, and therefore includes the mobility of both the device and the user. *Temporality* refers to the ability of mobile users to access the Internet instantly at any time, even while engaged in a peripheral task. Last, *contextuality* is concerned with the nature of the dynamic circumstances in which users employ mobile devices, such as their degree of interaction with others.

The fact that consumers shop in diverse contexts requires attention. A consumer involved in a peripheral task assigns only limited cognitive resources to a mobile transaction. For example, imagine a college student trying to purchase a rock concert ticket while listening to the bus driver announce the name of the next stop. On the other hand, diversity of content provides a new opportunity, because context-aware applications utilize information on the user's mobile setting to adapt the interface to the user's specific circumstances [40, 47].

Mobile device constraints encompass the various issues associated with the inferior performance of mobile devices. To be portable, mobile devices have smaller screens, less convenient input facilities, and lower multimedia processing capabilities than desktop computers. The small screen size has been

a focus of research attention. As technology develops, other mobile device functionalities and features are expected to become equivalent to those of desktop computers, with the exception of screen size.

The importance of these two new categories is that they significantly affect mobile interface design across all 7C's. Each C needs to be redesigned with the influence of these two new factors taken into account. In short, these two distinct facets profoundly affect the fundamentals of m-commerce interfaces. For example, some studies on content suggest providing audio feedback, since mobile users are frequently engaged in other tasks in a mobile setting [8]. A number of studies on context focus on designing a menu structure that effectively segments information on a small screen—a device constraint.

In light of the foregoing discussion, an extended framework of 2M's and 7C's is proposed that comprehensively covers the important issues pertaining to m-commerce interfaces. As depicted in Figure 1, this extended framework suggests that mobile setting fundamentally affects the formation of the 7C's, whereas mobile device constraints define the boundary of the substantiation of the 7C's.

The extension of the 7C framework will broaden the perspectives of IS researchers, enabling them to recognize the uniqueness of m-commerce interface design. The 7C framework was developed for a diverse set of devices, including mobile phones, but is mostly centered on an e-commerce environment (e.g., desktop computers, the stationary Internet, and users who stay in one place when shopping). As the domain changes from the stationary to the mobile Internet, the framework for understanding customer interfaces should be modified accordingly.

Prior research on the 7C's in m-commerce, as reviewed below, clearly shows that the two new elements have been implicitly incorporated into studies of each C. The independent and dependent variables of each study according to the 2M's and 7C's are analyzed in the accompanying tables.

Mobile Setting

A number of studies have focused on m-commerce interfaces designed to support the limited attention span of users due to the multi-tasking that takes place in a mobile setting. For instance, a menu structure requiring minimum attention is recommended by Pascoe et al. [37, 38]. Most research of this type investigates the effect of mobile setting on the 7C's, as will be discussed below separately for each C.

Another stream of research is concerned with the new capabilities that context-aware computing brings about. *Context-awareness computing* provides the user with task-relevant information or services [17]. A mobile device detects the user's setting, including location, people, and resources nearby, and provides this information either to the application, which automatically adapts the interface, or to the user, who chooses whatever interface he or she wishes [9, 14, 41, 45].

Among the many components of context-aware computing is context-aware retrieval, which can be either "interactive, where the user directly issues a
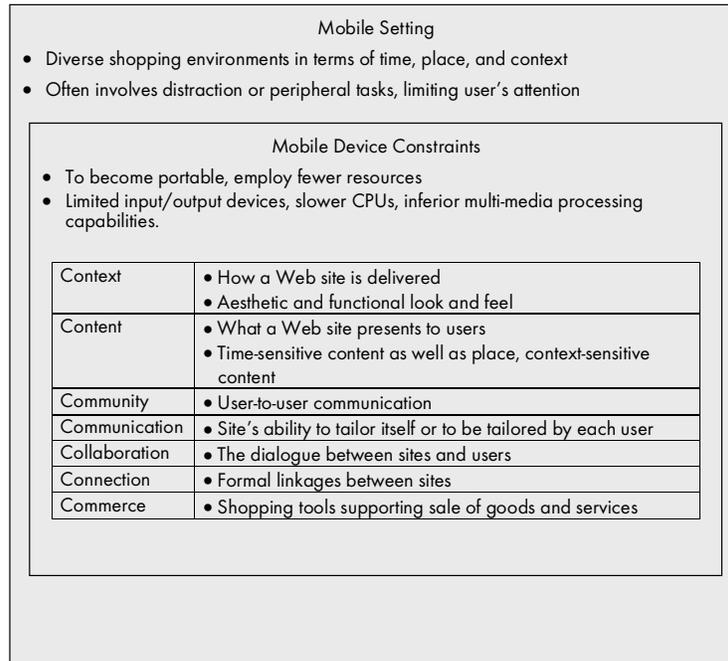
Mobile Setting
- Diverse shopping environments in terms of time, place, and context
- Often involves distraction or peripheral tasks, limiting user's attention

Mobile Device Constraints
- To become portable, employ fewer resources
- Limited input/output devices, slower CPUs, inferior multi-media processing capabilities.

Context	• How a Web site is delivered
	• Aesthetic and functional look and feel
Content	• What a Web site presents to users
	• Time-sensitive content as well as place, context-sensitive content
Community	• User-to-user communication
Communication	• Site's ability to tailor itself or to be tailored by each user
Collaboration	• The dialogue between sites and users
Connection	• Formal linkages between sites
Commerce	• Shopping tools supporting sale of goods and services

Figure 1. The New Framework for the Study of m-Commerce Interface Design

request to retrieve relevant documents, or (more usually) proactive, where documents are presented to the user automatically" [9]. In both cases, a location-aware application (the simplest form of context-aware application) detects the user's location and provides documents, such as a map, relevant to it [9].

Rodden et al. emphasized the importance of the context-sensitive nature of mobile devices in their recent research on ubiquitous computing [39]. A number of types of mobile setting can be considered, such as infrastructure, application, system, location, and physical context. Asserting the need to organize related research, they provided a taxonomy of different levels of mobility along three dimensions: the level of mobility within the environment, the extent to which the device is related to other devices, and the cooperative capacity of the mobile application (i.e., the extent to which the device is bound to a particular individual or group) [39].

Mobile Device Constraints

Researchers have studied ways to complement inferior technology so that users will feel less constrained by limited input/output devices. As with the research on mobile setting, many studies on mobile device constraints have been conducted in the context of the 7C's.

Design elements	Ref.	Independent variable	Dependent variable
Mobile setting	[9]	Information retrieval and filtering with the aid of context-aware computing	
Mobile setting	[23]	Spatiality (where) Temporality (when) Contextually (in what way)	
Mobile setting community	[39]	Taxonomy development —Level of mobility (fixed, mobile, autonomous) —Relation to other devices (free, embedded, pervasive) —Cooperation (personal, group, public)	
Mobile device constraints	[1]	Small screen size Text-based interface	Limitations on human short-term memory Limitations on developing mental map Increases in scrolling and clicking Lack of landmarks
Mobile device constraints	[21]	Screen size (1,074 x 768 vs. 640 x 480) Task (focused vs. less directed search)	Navigation activities on site Navigation activities on page

Table 1. Classification of Previous Research by 2M's.

Albers and Kim asserted that the small screen would interfere with navigation because information is too fragmented on separate pages to develop an integrated mental model given the user's limited short-term memory [1]. Jones et al. compared users' navigation activities on small and big screens (640 × 480, 1,074 × 768), and found that navigation activity—the number of scroll up/down and left/right actions—significantly increased on small screens, resulting in low performance [22].

Kamba et al. developed semi-transparent widgets, such as buttons, that overlap with the main body of content in order to make the most of a small screen [25]. This overlapping means that a small screen need not set aside a large portion of its space for infrequently used widgets, thus allowing the user to access more content. Deshe and van Laar proposed the use of a color code that creates the perceptual illusion of different layers to help users read a tabular display on a small screen [16].

Context

The main stream of research with respect to context concerns ways to design a mobile interface that will support the user's limited attention span and over-

come inferior device constraints. Given the early stage of research, studies have more frequently dealt with functional issues than aesthetic issues. A significant number of researchers have attended to section breakdown in layout, especially with respect to menu structures and the separation of the main body of content into individual pages [11, 26, 36, 37, 42].

Kim found that mobile setting moderates the effect of menu structures on user performance [26]. Spatiality (called "movement" in his study) was created in the lab by asking participants to walk on a treadmill while accessing the mobile Internet. Contextuality (termed "visual distraction") was created by asking the participants to press a button whenever they saw something on a screen while navigating the mobile Internet. Finally, the participants' performance was measured (a) according to where the menu item was located in the hierarchy (shallow or deep), and (b) according to whether the menu item was located in a long or a short list.

Pascoe et al. investigated the usage pattern of fieldworkers—a group of ecologists observing giraffes in Kenya—and contended that mobile users have only limited attention capacity when interacting with their mobile devices [36, 37]. They proposed minimal attention user interfaces (MAUIs) that minimize the amount of user attention required to operate a device. MAUIs utilize a sequential layered selection process that employs sub-menus which link to the tasks users are most likely to proceed with. This differs from a field selection process that requires users to return to the main menu to move on to the next process [36, 37].

Dividing a piece of information into an appropriate unit presented on one page is imperative, because a small screen can only contain limited content. Buyukkokten et al. considered how much information should be delivered to users on one page in order to discover an effective way of summarizing an HTML page into a WAP page [11]. They proposed a way of disclosing semantic textual units (STUs), which are "page fragments, such as paragraphs, lists, or ALT tags that describe images." Among four other methods of disclosing methods—incrementally disclosing STUs, providing keywords or summaries, combinations of keywords and summaries, and showing all STUs— participants performed best with the combination of keyword and summary.

Content

Content, one of the most frequently studied areas, has been the subject of diverse research efforts. As in the case of context, most of the studies combine content with the two new elements: mobile setting and mobile device constraints. Moreover, the scope of content in the 7C's is found to be limited in terms of its coverage of new issues in m-commerce interfaces.

The adaptive supply of content according to the distinct mobile setting has often been investigated. The presentation only of information relevant to the user's mobile setting has been investigated on the basis of three subdimensions: offering mix, appeal mix, and content type. One study of *offering mix* proposes the proximate selection method, a user interface technique in which nearby "located-objects" are emphasized or made easier to choose [40]. Located-objects

Design element	Ref.	Independent variable	Dependent variable
Context	[10]	Summary view that represents link structure	Performance –Browsing speed –Required pen-movement
Context	[17]	Tabular display vs. perceptual layering by color code	Error counts
Context	[25]	Use of semi-transparent widgets with delayed-response technique	
Context	[11]	Ways to convert HTML page to WAP page – User view: page summarization – System view: page summarization process, form summarization process	Completion time Number of selection clicks for completing a required task
Context	[26]	Task – Depth (where an item is located in hierarchy) – Breadth (where an item is located in a long or short list) Context – Movement (walking on a treadmill) – Visual distraction (pressing a button when anything appears on screen)	Verbal and action protocols collected while conducting tasks
Context	[36]	Direct manipulation vs. indirect manipulation – Limited buttons (five buttons) – Touch-sensitive screen – One-handed operation – Layered sequential selection process vs. field selection process – Attachment: microphone Context awareness	
Context Content Mobile setting	[37]	Minimal-attention user interfaces – Touch-sensitive screen – Layered sequential selection process vs. field selection process – One-handed operation with limited keys Context awareness – High-speed interaction	

Table 2 (*continued*)

Design element	Ref.	Independent variable	Dependent variable
Context Customization Mobile device constraints	[42]	– Context-dependency Small screen size – Reduces output by customizing user's needs – Designs chunk of information seen on one page – Horizontal vs. vertical scrolling, etc. Input device (point-and-click vs. button-press) – Uses numbers for input – Uses common abbreviations – Offers choices – Uses standard conventions on buttons (e.g., back), etc.	Task Performance – Number of keystrokes – Average time (sec.) – Average time/key (sec.) – Average error rate – Average error rate/key

Table 2. Classification of Previous Research by Context.

Design elements	Ref.	Independent variable	Dependent variable
Content	[8]	Visual display vs. non-speech sound	
Content	[29]	MOTILE – No visual attention needed – Structured, tactile input Use of audio feedback	
Content	[40]	Categories of context-aware applications – Proximate selection – Automatic contextual reconfiguration – Contextual information and commands Context-triggered actions	
Content	[46]	Visual and 3D audio-display	
Content Context Community	[47]	PARCTAB system – Location-based information access – Communication – Remote control – Local operation	

Table 3. Classification of Previous Research by Content.

include non-physical services routinely accessed from certain locations (e.g., bank accounts, lists of instructions or regulations) and a set of places users want to know about (e.g., restaurants, gas stations, stores). Providing product information relevant to the user's specific mobile setting is a type of *appeal mix,* in that it can be used to attract the user's attention. Since in a mobile setting customers are engaged in other tasks, using their hands for peripheral tasks, Kristoffersen and Ljungberg asserted that direct manipulation which demands a high degree of visual attention is not desirable [29]. Instead, they suggest utilizing audio feedback in order to supplement users' limited visual attention.

To support the limited visual interfaces, *multimedia mix,* especially the use of audio feedback, is recommended. Brewster et al. found that neither speech sounds used to make a phone call nor non-speech sounds used for ringing tones or alarms helped users interact with a mobile device [8]. They recommended the adoption of non-speech sound (e.g., a beeping sound), which is language-independent and faster, in order to overcome the limitations due to the lack of screen space. Substituting non-speech audio cues for visual ones is suggested so that the clutter on the display can be diminished, allowing for the presentation of more information [46].

Meanwhile, *content type,* which mainly refers to the currency of information (time-sensitivity) in the 7C's, cannot contain the diverse content types that emerge from a user's mobile setting. According to Want et al. the most frequently utilized aspects in a user's mobile setting are: (a) the user's current location, (b) the identities of the user and of other people nearby, (c) the status of nearby computer input and output devices, and (d) physical parameters, such as time, temperature, light level, and weather conditions [47]. Accordingly, content type should be extended to contain such information relevant to mobile computing.

Community

Research on community has kept pace with research regarding mobile setting. Context-aware applications enhance the interactive communication of members of a community. For example, they enable users to control a remote display board in virtual space or to vote anonymously [47]. Lamming et al. argued that providing users with an easy method to exchange information appropriate to their setting has enriched communication between users [30].

Commerce

There has been little research on commerce because of the nascent state of m-commerce technology. Despite the importance of an easy and secure checkout process in consumers' actual purchase decisions, little empirical research has been reported due to the fact that the necessary infrastructure is not yet available. One possible approach is to insert a certificate of authentication into mobile phones, so that three parties—consumers, financial service providers, and mobile Web stores—can conduct mutual authentication [24].

Chae and Kim's results open a window on the purchase patterns of m-commerce consumers [13]. Users of the mobile Internet are more frequently concerned with commerce than stationary Internet users. Moreover, the usage patterns for the mobile Internet are different from those for the stationary Internet in three electronic business domains: commerce, communication, and contents.[1] Mobile Internet users purchase more low-risk products (e.g., movie/concert tickets) than high-risk ones (e.g., computer hardware). Also, users tend to subscribe to content with low information intensity (e.g., cartoons, weather) more than to content with high information intensity (e.g., education, travel). These results are consistent with the new characteristics of m-commerce interfaces. Users in mobile settings cannot pay full attention to their interactions with mobile devices and therefore purchase low-risk products. Their mobile devices have inferior visual displays and thus are not suitable for subscribing to high information intensity content.

Customization

Customization is a major contributor to m-commerce success [24]. Mobile Internet devices are usually more personal and individualized than stationary Internet devices because people rarely share mobile phones in the same way that they share desktop computers [13, 29]. Consequently, the mobile device always carries its user's identity, an essential condition for customization [35]. Schmidt and Schroder enabled mobile Internet users to choose the interface design they want from the stationary Internet site, and their mobile Interfaces are adapted accordingly [42].

Information on mobile settings also plays an important role in customization because it is another important clue for filtering the information the user needs in specific circumstances [31]. For instance, Davis et al. provided a context-

Design elements	Ref.	Independent variable	Dependent variable
Community	[30]	Exchanges of documents and other materials. – Easy access to document services – Timely document access – Streamlined user interface – Ubiquity – Compliance with security policies	Ease of use
Customization	[31]	Personal Service Environment (PSE)	
Customization	[15]	Context-sensitive tourist guide – Limited visual output – Tailored to meet needs of end-users – Context-awareness to react to changes in user's environment	
Commerce Community Content	[13]	Media (mobile vs. stationary Internet)	Commerce (high/low risk product) Communication (synchronous/asynchronous) Content (high/low information intensity content)

Table 4. Classification of Previous Research by Community, Customization, and Commerce.

sensitive tourist guide that tailors geographical information according to a user's specific location (i.e., mobile setting) [15].

Communication and Connection

The mobile Internet and m-commerce are still in an early stage. As a result, no research on communication and connection has been found.

Suggestions for Future Research

The preceding research review demonstrates that 2M's have exerted substantial influence on the study of each of the 7C's. Research questions upon which future research can be built are provided next.

Mobile Setting

Mobile setting requires special attention in that consumers often perform more than one task and thus limit their cognitive resources for a mobile transaction. This leads to a number of interesting research topics:

- To what extent does the mobile setting influence users' attention capacity, and, in turn how does this affect a customer's ability to process a piece of information or learn from it?

- Does the importance of the outcome or the user's commitment to a mobile transaction moderate this relationship?

The amount of information that must be processed to make a purchase decision varies across product types. More specifically, for purchases of utilitarian goods, which are primarily bought for informational reasons, including instrumental and utilitarian reasons, consumers need to process more information than for hedonic goods, which are mainly purchased for transformational reasons, including consummatory affective gratification [4]. The consumer's attention capacity is constrained under a *mobile setting* and thus may not reach the level required for the purchase of a utilitarian good. Therefore, one can explore whether consumers will find it less easy to acquire information about utilitarian goods than hedonic goods, and whether such perceived difficulty makes purchase decisions less accurate.

- Does the product type, such as utilitarian vs. hedonic goods, moderate the effect of the consumer's limited attention on the quality of the purchase decision?

Mobile Device Constraints

The negative impact of the limited resources of mobile devices necessitates the creation of appropriate input/output mechanisms. Visual representations of objects, mostly through graphic icons, are easier to retain and manipulate than textual representations [43]. Whether direct manipulation is as effective on a small screen with a limited input device as it is on a PC needs be examined. While visualization of objects that require high-quality visual support is central to direct manipulation, mobile devices can supply only small display screens with relatively low resolution.

- Is direct manipulation applicable to m-commerce as effectively as to e-commerce?

Meanwhile, consumers establish their preferences by means of two types of tasks: choice tasks (choosing one alternative from a set) and judgment tasks (constructing an overall evaluation of an alternative) [21]. When users perform these tasks with limited devices, their performance will be challenged and the quality of their choices will be lowered.

- Which types of task performance will be more seriously challenged by the use of limited devices?

- How will consumers' preferences be influenced as a consequence of performing these tasks while using limited devices?

	Mobile setting	Mobile device constraints
	• To what extent does this *mobile setting* influence users' attention capacity, and, in turn, how does this affect users' ability to process a piece of information or learn from it? • Does the importance of the outcome or the users' commitment to a mobile transaction moderate this relationship? • Does the product type (e.g., utilitarian vs. hedonic goods) moderate the effect of users' limited attention on the quality of the purchase decision?	• Is direct manipulation applicable to m-commerce as effectively as it is to e-commerce? • Which types of task performance will be more seriously challenged by the use of limited devices? • How will consumers' preferences be influenced as a consequence of performing these tasks while using limited devices?
Context	• How should information be structured so that it appears natural and logical to users and enables them to save cognitive effort for combining information? • How does this structure affect navigation errors and the total number of clicks or scrolls required to complete a task?	• What interface aids can assist consumers to accurately process multi-alternative/multi-attribute information with minimum effort, and eventually find the product that best fits their needs?
Content	• Among diverse cues from users' *mobile* setting, which cue should be selected to trigger content retrieval?	• Does the use of multi-media also promote the flow state of m-commerce consumers who want to keep in touch with their surrounding environment? • If so, does the deepened flow state increase consumers' satisfaction with the Web site as much as it does in e-commerce?
Community	• Do consumers feel supported and assured of their choice when the interface aid enables them to communicate with fellow shoppers who experience a similar mobile setting?	• What methods support interactive information exchange between consumers despite inferior input/output devices, and as a result, increase users' intention to revisit the Web stores?
Customization	• Do inquiries on personal preferences negatively influence customers' satisfaction towards customized Web sites?	• Do consumers feel sufficiently informed if less, albeit customized, information is delivered? • If so, do consumers find the customized Web stores more useful as their needs for information are satisfied?

(continues)

Table 5 (*continued*)

	Mobile setting	Mobile device constraints
Communication	• Do retailers' messages that are adapted to potential consumers' mobile setting increase the customers' intention to visit the Web store?	• What methods can overcome the inconvenience of text-typing and encourage consumers to provide feedback?
Connection	• Do pathways that present Web sites relevant to users' mobile setting enhance the perceived usefulness of the sites, or do they simply impose more confusion on navigation?	• What features prevent consumers from feeling "lost" among the pathways provided on a limited-display device?
Commerce	• What payment methods will require minimal cognitive attention from consumers in a multi-tasking environment while maintaining security?	• How can the checkout process be condensed so that it does not need to be separated on a number of pages?

Table 5. Suggestions for Future Study.

Context

Context needs to be structured in a way that helps consumers in a mobile setting navigate easily. One way of assessing how easily a page is organized is to measure the number of clicks/scrolls that hampers users' performance [22].

- How should information be structured so that users see it as natural and logical, and are able to save cognitive effort for combining information?
- How does this structure affect navigation errors and the total number of clicks or scrolls required to complete a task?

Research to date shows that information presentation format (e.g., information organized by attributes or by brand) exerts a significant effect on consumers' encoding of information and memory, and this, in turn, is related to their decision-making [5, 44]. Researchers may want to investigate how to present content on a small screen in order to support decision-making. Especially in an m-commerce context, it is sometimes necessary to present a number of alternative product choices with many attributes on a small screen. Consider a mobile Web store that sells many different digital cameras, each of which has distinct features (e.g., number of pixels, LCD monitor size, zoom feature). When this abundant information is displayed on a small screen, it will require too many pages for ordinary customers to navigate around.

- What interface aids can help consumers to accurately process multi-alternative/multi-attribute information with minimum effort, and then to find the product that best fits their needs?

Content

Extended content type supplies more clues for adapting interfaces in a mobile setting. In e-commerce, given the users' static environment, only the currency of content is considered. In contrast, m-commerce makes it possible to reflect the users' dynamic environment into its content by virtue of context-aware applications. Therefore, more diverse variables should be included for research on m-commerce interfaces.

For example, which cue suggests the most effective point when/where promotional messages should be sent to consumers in an m-commerce context?

- Which of the diverse cues from the user's mobile setting should be selected to trigger content retrieval?

Given the limited display space, the use of multi-media is recommended so that display space can be conserved [8, 29]. The use of multi-media, such as audio, furthers the state of flow, a subjective psychological experience that characterizes the human-computer experience as playful and exploratory [20, 48]. The Web page is presented not only through a visual channel but also

through an auditory channel that provides users with a more enjoyable experience, hence engaging them more deeply in the interaction. However, unlike e-commerce consumers, who are relatively more devoted to their transactions, m-commerce consumers should be kept alert to situational cues (e.g., identifying the bus to catch).

- Does the use of multi-media promote the flow state of m-commerce consumers who want to keep in touch with their surrounding environment?
- If so, does the deepened flow state increase consumers' satisfaction with the Web sites as much as it does in e-commerce?

Community

Mobile devices are inherently communication devices. Thus opportunities exist for locating users and facilitating interactive communication between them. When consumers are provided with an interface aid that facilitates interactive communication with others in a similar setting, their satisfaction can be increased, because some of them may want to consult others before making a decision. Consider a member of a winter sports community who checks another member's report on snow quality in local ski resorts before going skiing.

- Do consumers feel supported and assured of their choice when the interface aid enables them to communicate with fellow shoppers who experience a similar mobile setting?

Consumers will find the exchange of opinions more helpful when the obstacles to communicating with other members (e.g., typing or reading long reports on a bulletin board) are eliminated by using alternative methods, such as posting pictures of products. Strongly established membership in a community will build stickiness to Web sites [49].

- What methods support interactive information exchange between consumers despite inferior input/output devices, and, as a result, increase their intention to revisit a Web store?

Customization

Dynamic adaptation of content is also closely related to customization. In order to customize the interface, one must determine exactly what the user wants. Consumers want to receive customized support with minimum intrusion from service providers.

- Do inquiries about personal preferences negatively influence the customers' satisfaction with a customized Web site?

Given the device constraints, m-commerce Web stores cannot deliver as much content as e-commerce Web stores, so they may decide to filter unnecessary

information and only deliver information that users appreciate. This way, consumers will feel sufficiently informed about products they are interested in despite the limited information delivered by a restricted display device.

- Do consumers feel sufficiently informed if less, albeit customized, information is delivered?
- If so, do consumers find customized Web stores more useful as their needs for information are satisfied?

Communication

Communication and connection will form the new arena for m-commerce research because they are the aspects that have been least explored. Although few studies have examined communication, it exhibits the potential to build links between mobile retailers and their customers because retailers can utilize this link to promote their offerings [32]. Moreover, retailers can utilize information about consumers' mobile setting in order to catch the right moment to send their promotional messages.

- Do retailers' messages that are adapted to potential customers' mobile setting increase the customers' intention to visit the Web store?

Consumer feedback to retailers is a valuable asset for the improvement of the store [32]. Consumers can be encouraged to supply feedback by providing them with an easy means to do it.

- What methods can overcome the inconvenience of text-typing and encourage consumers to provide feedback?

Connection

In e-commerce, the provision of links to other Web sites enriches users' navigation experiences because they can find diverse information on the other sites [38]. In m-commerce, such links can be used to provide timely information as users' mobile settings change, as is evident in the case of adaptive hypermedia that provide information about a city tailored to tourists' interests and locations [15]. On the other hand, m-commerce consumers whose attention span is substantially restricted may not welcome these additional links because they cannot afford more surfing than is absolutely required to achieve their goals.

- Do pathways that present Web sites relevant to users' mobile settings enhance the perceived usefulness of the sites, or do they simply impose more confusion on users' navigation?

On a small monitor, it is not easy to employ a design feature that prevents users from getting "lost" in the chain of Web pages. For instance, a map that indicates where users are now in a hierarchy of chained Web pages (e.g., home → furniture → living room) is not easily implemented on a tiny screen.

- What features can prevent consumers from feeling "lost" among the many pathways provided on a limited display device?

Commerce

According to BizRate.com, 75 percent of on-line consumers are abandoning the "shopping cart" [6]. This shows the importance of providing secure payment methods and easy checkout processes. A secure payment method that calls for only minimal attention is required in the distracting mobile setting [32].

- What payment methods will require minimal cognitive attention from consumers in a multi-tasking environment while maintaining security?

In order to make the checkout process less cumbersome on a small display device, a set of processes across several steps should be condensed into a "one-click" checkout process

- How can the checkout process be condensed so that it does not need to be separated on a number of pages?

Conclusion

Despite the rapid growth of mobile telephony and the mobile Internet, research concerning m-commerce interfaces is still in the early stages. In an effort to propose a research framework that would help researchers perceive upcoming changes, the existing research on m-commerce interfaces was analyzed according to Rayport and Jaworski's 7C's. This analysis found two elements of m-commerce interfaces that are not embedded in the 7C's: mobile setting and mobile device constraints. The 2M's influence the formation of every one of the 7C elements. Mobile setting suggests that m-commerce interfaces should be designed to support the users' limited attention. Mobile device constraints call for supplementation of insufficient displays and awkward input devices. A new framework that embraces and highlights the importance of the 2M's is proposed for the study of customer interface design for m-commerce: the 2M's and the 7C's.

This provides m-commerce researchers with a blueprint for reinterpreting existing studies and a basis on which to conduct future studies. Combining the 2M's and the 7C's generates many intriguing research topics with focal points different from what is found in e-commerce interface studies. For example, while e-commerce interface research concentrates on the effectiveness and thoroughness of the consumers' shopping experience (e.g., the presentation format that makes it possible to examine products to the last detail), m-commerce interface studies emphasize efficiency and convenience (e.g., the context structure that enables customers to locate the desired product quickly and conveniently).

On a practical plane, this study should alert developers to the unique principles of design for m-commerce. It may seem obvious to suggest that the usage environment and device constraints should be taken into account in developing interfaces. However, the design of many mobile interfaces ignores these principles. For example, some PDA browsers unnecessarily employ graphical icons that consume most of the screen but make little sense to users. Some mobile Web stores show only their brand logo accompanied by a background picture on the title page, leaving the actual content on the next page. The use of too many pages causes an increase in the number of clicks and scrolls, which hampers consumers' navigation performance.

This paper has several limitations derived mainly from the fact that customer interface studies are still in an early stage. Thus there has been no research on communication and connections. In addition, the framework presented in the paper is not elaborated across different types of mobile devices (e.g., cellular phones vs. PDAs) because it would have been very complicated to monitor all the mobile devices whose features have been developing so rapidly. Instead, an attempt was made to provide a generic framework that will continue to be relevant no matter how devices are changed and under every conceivable advance in communication networks.

NOTE

1. Their usage of the terms "commerce," "communication," and "contents" differs from our definitions.

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