

# Design of Usable Interface for a Mobile e-Commerce System

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**Abstract**—The development of user interfaces for mobile devices is a challenging research topic as it addresses specific usage of mobile devices—users want rapid responses to their actions while minimizing the amount of information entered. Because of its nature mobile devices face many constraints such as limited size of display and motoric limitations on information input. Good usability is a primary requirement for interface design and is critical to attracting and retaining users, especially in business applications such as mobile e-commerce systems. In this paper, we analyze design principles of user interfaces for mobile devices, formulate requirements for a usable interface of a mobile application, describe model and architecture for interface of a developed PDN (Product Distribution Network) mobile e-commerce system and present its evaluation based on principles of controllability, predictability, unobtrusiveness, privacy and breadth of experience.

## I. INTRODUCTION

Mobile devices impose great challenges on developing user-friendly interfaces for effective browsing of web content. Designing a usable user interface (UI) that is also effective within the constraints of mobile devices and the applied development technology is becoming a hot research topic. Good usability is the primary requirement for interface design [1] that is critical to attracting and retaining users, especially in business applications such as mobile e-commerce systems.

As the user base of mobile devices grows faster than that of desktop computers it is essential to constantly research best principles of effective user interface usable UI and to evaluate their implementations by designing mobile applications according to these principles.

In this paper, we analyze the design principles of user interfaces for mobile devices, formulate the requirements for a usable interface of a mobile application, describe the model and architecture of an interface of a developed mobile e-commerce system and present its evaluation based on a set of functional and non-functional criteria.

## II. REQUIREMENTS FOR USABLE INTERFACES IN MOBILE DEVICES

The ISO 9241-11 standard defines usability as a high level quality objective, i.e., “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”. According to the ISO 9241 standard, usability has three dimensions: efficiency, effectiveness and user satisfaction.

Usability of interface can be evaluated based on the UI usability challenges formulated in [2]:

- Predictability and transparency: users must be capable of predicting the repercussion of their actions.
- Controllability: user must have control over his actions.
- Unobtrusiveness: messages must not cause confusion and distract the user from current activities.
- Privacy: information that is collected about users implicitly.
- Breadth of experience: learning curve needed to start using an interface fully and effectively.

Differences in user needs require that an interface will be effectively used by novice and as expert users. A set of criteria for evaluating UIs based on user needs was formulated in [3]:

- Efficiency: ability to complete transactions quickly in a minimal number of steps or amount of time, while clarity implies immediate learnability of efficient user usage of UI.
- Simplicity: avoiding presentation of UI elements unnecessary for performing the required tasks (minimalistic design).
- Symbiosis: seamless and ergonomic use of UI.
- Cognitive and motor limits: interface should not overload the user’s cognitive, visual, auditory, tactile, or motor limits.

Gong and Tarasewich [4] formulated interface design guidelines for mobile devices as follows:

- Consistency: elements of mobile interfaces such as names, colour schemes, and dialog appearances should be device independent;
- Reversal of actions: mobile applications should rely network connectivity as little as possible;
- Design for multiple and dynamic contexts: allow users to configure output to their needs and preferences (e.g., text size, brightness);
- Design for small devices: provide word selection instead of requiring text input;
- Design for speed and recovery: allow applications to be stopped, started, and resumed with little or no effort;

- Design for top-down interaction: present high levels of information and let users decide whether or not to retrieve details;
- Allow for personalization: provide users the ability to change settings to their needs or liking;
- Design for enjoyment: applications should be visually pleasing and fun as well as usable.

General design principles or guidelines for mobile interface include (according to [5, 6]):

- Learnability: an interface should be easy to use from the first time the user interacts with it. Amount of functionality presented to the user should be limited to exactly what the user requires to get to their goal.
- Efficiency: number of steps it takes for a user to complete a task. Key tasks should be made as efficient as possible.
- Memorability: interface should be easier to use each time the user interacts with it.
- Error recovery: users should not be allowed to make a mistake.
- Simplicity: avoid unnecessary functionality and keep the visual design and layout uncluttered.
- Mapping: users get exactly what they expect to happen when they interact with the interface.
- Visibility: important information should be more visible than less important information.
- Feedback: user should always be in control of the UI.
- Satisfaction: user should enjoy of using the UI.
- Consistency: UI elements should always be displayed and act the same way across the application.

Of these design principles learnability [9, 10] can be considered as the most important one that facilitates user engagement and rapid adoption of the product.

### III. ARCHITECTURE OF A MOBILE E-COMMERCE SYSTEM

PDN mobile e-commerce platform is an electronic shopping network for mobile devices that we developed for the evaluation and implementation of UI design principles for mobile devices. We think it is essential to line up functional and non-functional requirements for user interface to reach high user satisfaction.

PDN platform has a goal—to sell products and services on mobile devices and save time for buyer and seller.

PDN is software-as-a-service [7] solution that runs on number of servers and mobile user interface to deliver shopping experience to mobile devices. System architecture is presented in Fig. 1.

We use a taxonomy of Rich-User-Interface Components [8] to model the interface and implemented it with Model-View-Controller architectural pattern (Fig. 2).

MVC (Model-View-Controller) enables clear separation of data, logic and user interface. By using this software design pattern we can inject any user interface as a new view independently from any component in the system. We are also able to create any number of views. This design pattern is

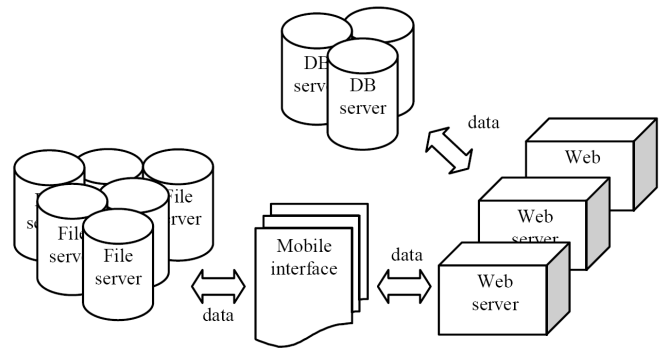


Fig. 1. Architecture of a system

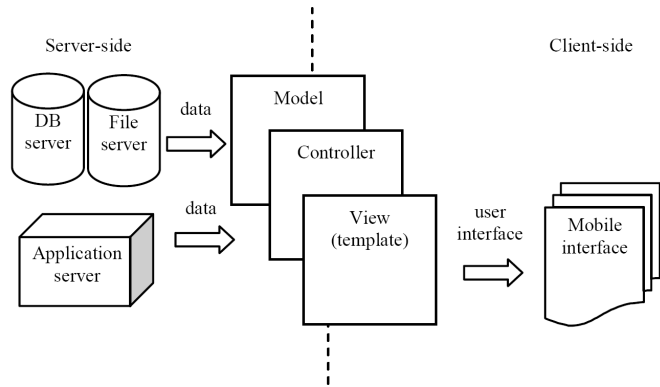


Fig. 2. Interface model of a system

widely used, and alongside it other modularity issues can be tackled according to recent advances [13], [14], [15].

To reach mobile users we developed front-end application for mobile devices (PDN Store) that addresses major UI usability challenges formulated in [2]:

- Predictability: minimal number of UI elements; fast to read UI elements (ex. images vs. text) [11];
- Controllability: consistent and always available navigation; consistent colour schemes for key actions;
- Unobtrusiveness: avoid entering duplicate information; do not limit user input format; (e.g., use special controls for sophisticated input);
- Privacy: do not collect unnecessary private information in advance (e.g., phone number, address, etc.) [12];
- Breadth of experience: use well known symbols for representing user actions.

The UI is also build on set of criteria for evaluating interfaces based on user needs formulated in [3]: efficiency, simplicity, symbiosis and motor limits.

### IV. IMPLEMENTATION OF USABLE INTERFACE FOR E-COMMERCE SYSTEM

A typical workflow for the PDN Store mobile application user is to browse goods catalog and to buy items. It is clear that by helping customer to reach a goal of buying faster and easier, platform achieves higher customer satisfaction. First mobile

Navigation Step 1	Navigation Step 2	Navigation Step 3	...	Navigation Step N
Information				
Picture 1	Item title 1			Action 1
Picture 2	Item title 2			Action 2
Picture ...	Item title ...			Action ...
Picture N	Item title N			Action N

View 1	View 2	View 3	View ...	View N
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Fig. 3. Usable interface of category list and product list

Navigation Step 1	Navigation Step 2	Navigation Step 3	...	Navigation Step N
Information				
Picture 1	Item title			Action 1
Item information				
View 1	View 2	View 3	View ...	View N

Fig. 4. Usable interface of product description and gallery

application screen displays product categories and product lists (Fig. 3). Application views are divided into areas for user navigation, category (product) information (picture, title, etc.), user action and user view.

Selecting product in the product list triggers product description and media gallery interface. The product description follows the same pattern of representation giving the user the feel of familiarity and the ease of use, while avoiding the need to learn another interface (Fig. 4).

## V. EVALUATION OF DEVELOPED USER INTERFACE

To evaluate the design principles formulated by [2] we compare our developed PDN Store mobile web application with another popular PDN Store mobile native application Magento Mobile. Both applications are recent implementations mobile applications for e-commerce and suggest resourceful examples of good principles in mobile user interfaces.

- **Controllability.** It is essential to assure that user always have control over his actions. One way to ensure it is to use bidirectional navigation. In PDN Store mobile



Fig. 5. Controllability in PDN. Bidirectional navigation

application where user moves through number of steps to reach the goal of buying the product or service it enables user to switch from one view to another (Fig. 5 shows ability to go back from product gallery to product details, product list or category list).

Magento Mobile uses controllability principle to switch between different mobile application areas (home, store, search, cart, profile).

Magento Mobile also uses controllability for “sort by” functionality to allow user to sort products in ascending or descending order. See Fig. 6:

The other important controllability aspect is to persist input values and do not ask user to re-enter data in case of information reload (ex. required field empty or incorrect data).

- **Predictability.** User must be capable of predicting the repercussion of interface actions. The main factor disrupting it is complex interface with many active UI components (buttons, text boxes, etc.). First and most important option to avoid this complexity is to use less UI controls as possible. This reduces functionality but increases user predictability.

Using images instead of text can be a key to more predictable interface worldwide by removing a need for translation addressing multi-language problems and will help to recognize interface faster. It is easier to interpret one symbol (image) than a group of two or more symbols (text). The PDN Store uses image controls extensively to simplify navigation interface (Fig. 7).

Implementation of predictability principle by using images instead of text is well recognizable on Magento Mobile as well. To reach high predictability Magento

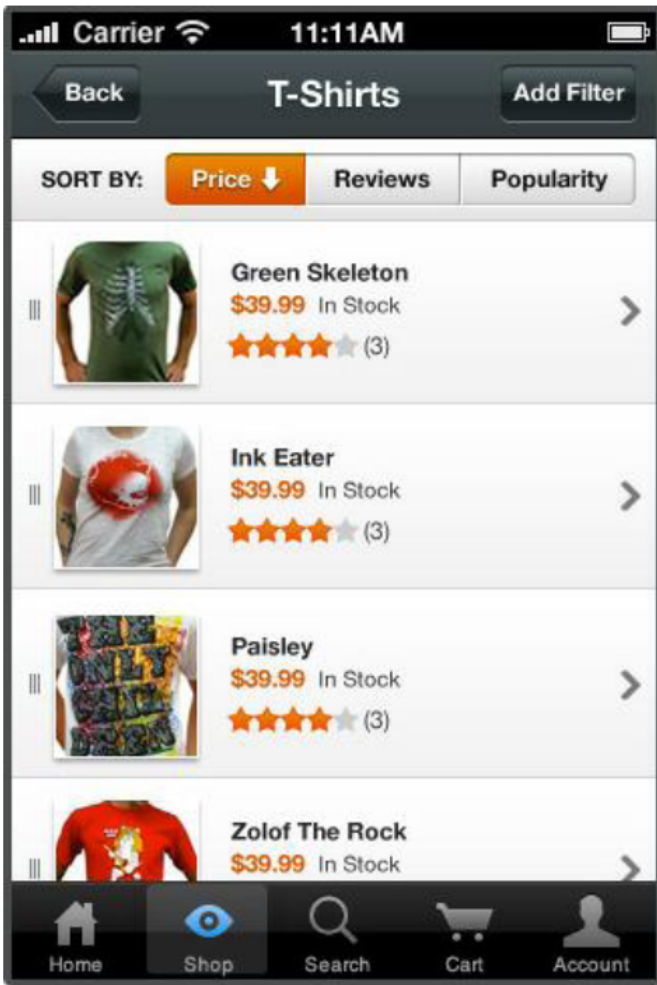


Fig. 6. Controllability in Magento Mobile. Navigation and sort.



Fig. 7. Predictability in PDN Store. Symbols vs text

Mobile use combinations of images and text.

Despite being predictable text makes UI more obtrusive.

- Unobtrusiveness. To ensure unobtrusiveness it is important to highlight most desired user actions and ensure minimal number of clicks to achieve expected result. PDN Store requires 1 (or 2 steps) to buy preferable

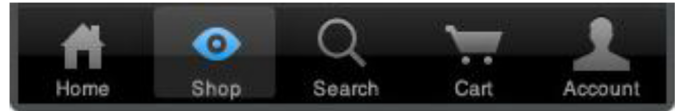


Fig. 8. Predictability in Magento Mobile. Symbols instead of text

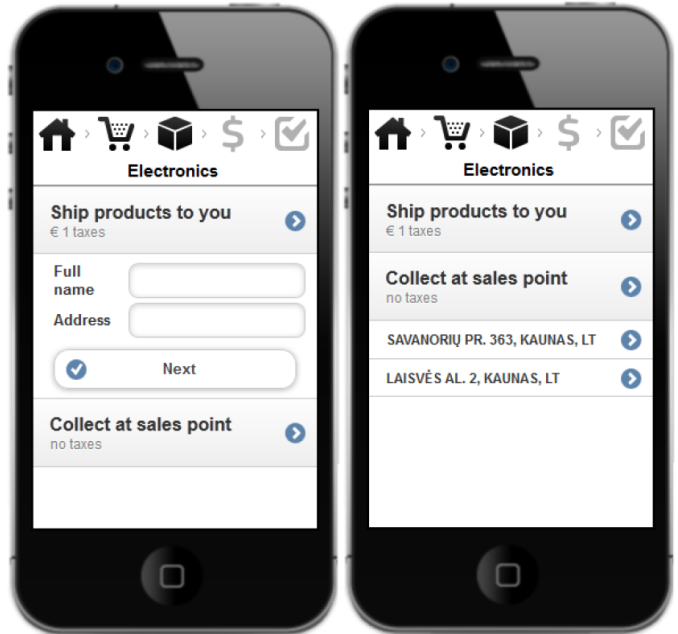


Fig. 9. Privacy in PDN Store. Personal information on-demand

product (select the category and select the product), while Magento Mobile requires at least 2 or 3 steps. Another way towards unobtrusiveness on the mobile application is to allow the user enter his personal data (ex. name, phone, password) without any unnecessary constrains (e.g., no special requirements for length, format, quality) as well as no artificial barriers that stop user from achieving the goal in timely manner (e.g., too sensitive limitations for login attempts or delays that block user in case of unsuccessful login). PDN Store is optimized to use mobile interface to enter products and most of its configuration. It makes information more compact and unobtrusive. Magento Mobile focuses on desktop version to enter product information. It results in more obtrusive information entry, validation and display in Magento Mobile.

- Privacy. People usually do not like to provide personal information especially if system is not well known yet. To not respect user privacy we ask only information which is needed to make the contract (Fig. 9 shows require recipient address and name only if user chooses shipment instead of collect at sales point). Leave the responsibility to the user about his personal data (e.g., if a user prefers not to enter a phone number we do not require it there is always an opportunity for email communication).
- Breadth of experience. People use symbols to commu-

TABLE I  
PDN STORE AND MAGENTO MOBILE EVALUATION

Principles	PDN Store	Magento Mobile
Controllability	bidirectional navigation	navigation
Predictability	images instead of text	images instead of text
Unobtrusiveness	optimized for mobile	focused on desktop
Privacy	respected	respected
Breadth of experience	small set of symbols	small set of symbols

nicate in extremely concise form. Symbols are equally good understandable among many languages and easy to remember. The PDN Store relies on a small set of symbols to make the interface equally simple for any consumer. Fig. 7 displays navigation steps—arrow suggests direction to reach user goal to buy a product or service and well known symbols (home, shopping cart, box, money) indicate progress towards it.

Both PDN Store and Magento Mobile use small set of symbols, well defined styles and standard modern UI elements for most of user actions.

The other important controllability aspect is to persist input values and do not ask user to re-enter data in case of failure (ex. required field empty or incorrect data). This behaviour is recognizable in Magento Mobile as well.

In Table I provided are the results of PDN Store and Magento Mobile evaluation.

## VI. CONCLUSION

In this paper, we have described the development of a user interface (UI) for a mobile e-commerce system based on the principles of controllability, predictability, unobtrusiveness, privacy and breadth of experience. The development of UIs for a mobile device is especially challenging because of mobile device constraints such as limited size of display and motoric limitations on information input as well as the mode of usage of a mobile device (the user wants rapid response to his actions while minimizing the amount of entered information as much as possible). As concluded from evolution of usable UI in PDN Store and Magento Mobile both mobile e-commerce applications are aware and use the design principles formulated by [2].

Our future work will focus on the evolution of a usable user interface for a PDN (Product Distribution Network) mobile e-commerce system as well as mobile collaboration platform CDB (Community Driven Business).

Further research efforts will be made to make the usable UI adoptable and customizable to the user and we will further research the ideas of UI evolution, where the usable UI design is based on the evolution through user feedback, user profiling and the community voting mechanism.

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