

# Towards Improving the Usability of Mobile ERP

## A Model for Devising Adaptive Mobile UIs to Improve the Usability of Mobile ERP

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**Abstract:** Mobile ERP is an extension of ERP systems and many of business owners and CIOs remain reluctant to adopt this extension. The apparent reluctance stems from many challenges, most notably the usability when compared to conventional ERP packages. Usability challenges of mobile ERP could be classified based on every entity involved in these systems, namely mobile devices, mobile context, mobile connectivity, the end-user, and the back-end ERP system. The user interfaces of Mobile ERP directly affect its usability. Moreover, mobile ERP is used in variable contexts. Therefore, Adaptive user interfaces are proposed as a solution to address usability challenges and variable contexts issues by content, presentation and navigation adaptation. This research aims at providing a model for designing Adaptive Mobile User Interfaces to improve the usability of mobile ERP in variable contexts. Hence, this model will be used by mobile ERP developers to improve their product usability.

**Keywords:** Adaptive user interfaces; enterprise resource planning; mobile ERP; usability.

## 1 Introduction

Today, businesses have become increasingly reliant on Information Systems (IS) to support their business processes [MT12]. Enterprise applications are examples of using IS in businesses in order to become more flexible and productive [LL14]. One of the common examples of enterprise applications in practice are Enterprise Resource Planning (ERP) systems [LL14]. Many benefits are realized from adopting ERP systems in business, such as allowing real-time data streams between functional applications, integrating and processing large amounts of data [MT12].

The rapid technological advances in mobile computing improve modern businesses [SB12]. Enterprises started to migrate to the mobile strategy in order to meet changing requirements and expectations of their customers and business partners [DJ03]. Mobile enterprise term is used to describe a corporation or large organization that supports critical business functions and use of business applications via wireless mobile devices [GK14].

In practice, a significant number of enterprises employ a strategy of “best of breed” for their ERP systems to strive for a competitive advantage. Therefore, ERP vendors are scrambling to improve and extend their products features [GK14]. The migration to

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mobilize on-premise ERP systems is an urgent demand to execute enterprises processes anywhere and anytime to improve their Return on Investment (ROI) [Ca14].

Mobile ERP term was suggested by Willis in 2002, as an extension and future of ERP systems, that helps in solving the data capture problem [WW02]. Mobile ERP permits the user to take the ERP system anywhere [WW02]. Figure 1 shows that mobile ERP is the current wave of ERP systems [CS13].



Fig. 1: Chronological evolution of ERP systems adapted from Cailean and Sharifi [CS13]

According to Dospinescu et al. *“mobile ERP is about having access to a software that allows a mobile device (portable computer, phone, Tablet PC, PDA) to be connected to the ERP system of an organization through a mobile net of communications and transmission of data GPRS/UMTS”* [Do08].

User interface layer is an important component of any software applications because it connects their end-users to the application functionalities. Therefore, software applications deployment could eventually fail due to a weak UI layer [Ak14]. ERP systems suffer from usability challenges due to their complex, rigid and bloated UIs [SW09],[Ak14]. Mobile ERP is an extension of ERP systems [WW02], thus this extension suffers from the same UIs complexity and rigidity, which directly affects the usability of mobile ERP.

Usability term was firstly coined in 1980s, to replace the term “user-friendly” [BKM92]. There are different models for usability that describe the usability attributes and factors. In 1994, Nielsen identified five attributes of usability, namely: efficiency, satisfaction, learnability, memorability, and errors [Ni94]. The International Organization for Standardization (ISO) defines usability as:

*“The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context.”* ISO 9241-11 (1998) [ISO98]

Usability is the most important quality attribute for mobile applications [NDA12]. According to Harrison et al., the previous models used for traditional desktop applications and the emergence of mobile devices added new challenges for usability. In fact, the previous models did not take into account these new challenges, such as cognitive load [HFD13].

In 2013, Harrison et al. proposed the usability model named People At the Centre of Mobile Application Development (PACMAD). This model considers the user, task and context of use are important factors to design usable applications, and identifies seven attributes that reflect the usability of an application:

1. **Effectiveness:** the user's ability to complete tasks in a specified context;
2. **Efficiency:** the user's ability to complete tasks with speed and accuracy;
3. **Satisfaction:** the user level of comfort and pleasantness through the use of software;
4. **Learnability:** the ease of learning to use the application;
5. **Memorability:** the ability of a user to remember how to use the application, if the application was not being used for a long period;
6. **Errors:** lower error rate, error recovering and avoiding catastrophic errors are proposed by Nielsen. PACMAD model extends the previous definition to include an evaluation of the errors while using mobile applications;
7. **Cognitive load:** the amount of cognitive processing required by the user to use the application, mobile application users are performing additional tasks, such as walking, unlike using traditional desktop applications.

Therefore, this research aims at improving the previous attributes of usability for mobile ERP.

## 2 Motivation

Many benefits are realized from adopting ERP systems in business, such as allowing real-time data streams between functional applications, integrating and processing large amounts of data [MT12]. ERP evaluation and selection processes need to consider the role of mobile applications in its overall business solution [Sc14]. According to Willis, mobile ERP is the future and another extension of ERP Systems that helps solving the data capture problem, it permits the user to take the ERP system with her/him [WW02].

Redshift Research Ltd. commissioned by Epicor Software Corporation recently conducted an online survey by interviewing 1500 business professionals in 10 countries. Many findings were revealed by this survey related to mobile ERP such as [Ep14]:

- *“65% perceive mobility as important to enable access to information and support communication for virtual workers.*
- *Only 1 in 2 have any form of remote access to their ERP systems.*
- *Only 25 percent can access their ERP via smartphones and tablet PC.*
- *In the future, 43% want ERP access via their smartphones, and 38 desire access via tablets.”*

However, adopting ERP Systems over smartphones or tablet PCs requires a completely new designed user interfaces because of the limited space on the screen using touch-

based interactions [So14]. Furthermore, most ERP vendors provide generic mobile-to-enterprise data, which poorly display the standard ERP on mobile devices, which only reinforce complexity and frustration for user [Ri14]. Therefore, many CIOs are reluctant to invest more in mobility because of complexity concerns [Co13].

Usability challenges of mobile ERP could be classified based on every entity involved in this system, namely mobile devices, mobile context, mobile connectivity, the end-user, and the back-end ERP system [OM15].

- **Mobile Devices<sup>2</sup>**

Smartphones and tablet PCs vary in their features and specifications. Actually, their capabilities are not comparable to desktop computers. The following is a brief explanation of mobile devices' features and its technologies that pose usability challenges for mobile ERP:

- **Limited Screen Size**

Mobile devices have a limited screen size compared to desktop computers. Therefore, there is a limitation on the information volume that can be displayed, and there is a huge possibility to lose its meaning.

Van Baker, research vice president of Gartner Group, during a presentation to IT leaders in China in august 2014 said:

*"Enterprise application development teams use traditional practices to define and develop desktop applications; however, most don't work with mobile app development, due to device diversity, network connectivity and other mobile-specific considerations,"*

*"The experience associated with mobile devices is significantly different from that of desktop devices, including shorter session lengths and limited presentation, due to screen size constraints that affect how mobile apps need to function" [Cyl4]*

Adopting ERP systems on smartphones or tablet PCs require a completely new designed user interface because of the limited space on the screens and operation via touch screens [So14]. Accordingly, the limited screen sizes of mobile devices will adversely affect mobile ERP end-user satisfaction attribute.

- **Limited Processing and Power Capabilities**

Mobile devices are less powerful than desktop computers in respect to processing capability, memory and power [ZA05]. Therefore, some business functions and even ERP application features which were developed to facilitate the usage will be dispensed. As a result, this will directly impact

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<sup>2</sup> This research is focusing on smartphone devices and tablet PCs

on the usability of mobile ERP.

- **Data Entry Methods**

Today, most of mobile devices use touch-based interactions (virtual keyboard). A recent study at Northern Illinois University found that the average typing speed on a virtual keyboard was found to be 25 words per minute, compared to 63 words on conventional and notebook keyboards [Ki14]. Another study revealed that virtual keyboards had higher discomfort ratings than conventional keyboards [KAJ12].

We conclude that the following: the usability of mobile ERP will be hindered by using virtual keyboards due to its slow input speed (efficiency). Moreover, the probability of causing errors will be increased (effectiveness), and the end-user feeling will be discomforted (satisfaction).

- **Diversity of Mobile Operating Systems**

End-users have strong personal connections to their mobile devices and mobile Operating Systems like Apple IOS, android, windows phone, etc. Therefore, this will affect their satisfaction if they were forced to use a particular mobile OS [An14].

- **Security**

Security is a major concern for business owners when it comes to access ERP systems via mobile devices. In spite of device options that are available: bring-your-own-device (BYOD), choose-your-own-device (CYOD) and corporate-owned, personally enabled (COPE) devices, securing valuable data in ERP systems and devices from unauthorized access is compulsory. This is besides having a balancing strategy between security and usability without hindering the satisfaction of end-user.

- **Mobile Context**

Dey et al. defines context as:

*“any information that can be used to characterize the situation of entities (i.e., whether a person, place, or object) that are considered relevant to the interaction between a user and an application, including the user and the application themselves”* [DAS01].

The interaction between the end-user of the mobile application, nearby people, objects, and environmental elements may distract end-user attention because the end-user will not be tied to a single location [ZA05]. Additionally, performing additional tasks while using mobile application (cognitive load) may cause distraction [HFD13]. Therefore, mobile ERP end-user may suffer from distraction that may lead to inaccuracy of data entry and failure in completing business process (effectiveness). Furthermore, it may slow down the business process

completeness (efficiency).

- **Mobile Connectivity**

Mobile connectivity attributes such as bandwidth and reliability will affect the usability of mobile ERP in effectiveness, efficiency, and error in case of slow or loss of internet connection. On the contrary, the desktop computers have a stable connection to the back-end ERP systems.

- **The End-User**

Today, companies design and develop their products with user-oriented methods instead of technology-oriented methods [NDA12]. End-users with different levels of skill (e.g., novices, experts, etc.) and ages need to be considered when adopting ERP systems into mobile context.

According to the European Commission report “the 2015 Ageing Report” [Eu14], people aged 65 and over will become a much larger share of population by 2060, the expected rise percentage is 18% to 28% of the population, and this implies to:

*“the EU would move from having four working-age people for every person aged over 65 years to only two working-age persons”*

Elderly people usually have problems in the senses and movement and they will make up a large share of labour force in the near future [Eu14]. Therefore, mobile ERP vendors should consider this while dealing with usability.

- **Back-end ERP Systems**

In recent years, several research works have revealed that ERP systems suffer from specific usability challenges [La14]. ERP systems integrate and process large amounts of data, therefore, their user interfaces are complex, rigid and suffer from poor usability [SW09]. Moreover, these systems have bloated user interfaces that affect end-user effectiveness [Ak14].

Mobile ERP suffers from usability challenges which exists in ERP systems, because of its complex user interfaces. Furthermore, the topic of mobile ERP is still a young topic in practice and research [CS13]. Table 1 shows related works and user studies focusing on user interface aspects in ERP usability in stationary devices. We conclude that there is a lack of research works and empirical studies focusing on the usability of mobile ERP.

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Author(s)	Year	Data sample	Methodology	System	Main aspects
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Topi et al.[TLB05]	2005	9 users 1 non-user	in-depth interviews; semi-structured	unknown ERP (confidential)	<ul style="list-style-type: none"> <li>• identification and access to information</li> <li>• transaction execution</li> <li>• system output</li> <li>• error support</li> <li>• terminology</li> <li>• system complexity</li> </ul>
Singh & Wesson [SW09]	2009	3 experts	literature review; heuristic evaluation	SAP Business One	<ul style="list-style-type: none"> <li>• navigation</li> <li>• presentation</li> <li>• task support</li> <li>• learnability</li> <li>• customization</li> </ul>
Scholtz et al. [SCC10]	2010	21 users (students)	user study with questionnaires and diaries	SAP R/3	<ul style="list-style-type: none"> <li>• navigation</li> <li>• presentation</li> <li>• task support</li> <li>• learnability</li> <li>• customization</li> </ul>
Parks [Pa12]	2012	38 users	user study with talk-aloud and measurements	PeopleSoft	<ul style="list-style-type: none"> <li>• UI complexity</li> <li>• task success</li> <li>• task time</li> </ul>

Tab. 1: User studies focusing on user interface aspects in ERP usability [La14]

### 3 Problem Definition

Mobile ERP is the current wave of ERP systems [CS13], and this wave is currently a young topic in practice and research, therefore, more research works and studies need to be conducted.

User interface layer is an important component of any software applications because it connects their end-users to the application functionalities. Consequently, software applications deployment could fail due to a weak UI layer [Ak14]. ERP systems suffer from usability challenges due to their complex, rigid and bloated UIs [SW09], [Ak14].

Mobile ERP is an extension of ERP systems [WW02], Consequently, mobile ERP might suffer from the same ERP UIs complexity and rigidity. This in turn can directly affect the usability of mobile ERP.

Many research works have exploited the adaptive UIs to address some usability

challenges of applications software and their variable contexts. Adaptive UIs (AUIs) have the capability to be aware of its context-of-use and automatically react to the changes of this context in a continuous way. This is done by changing the UI presentation, contents, navigation or even behaviour [Fo10]. Therefore, Mobile ERP can benefit from adaptive UIs to improve its usability when it is utilized in variable contexts.

The development process of mobile applications can't show a high level of usability in adopting ERP system into mobile context because it is using the traditional methodologies (desktop applications) for developing mobile enterprises applications.

Therefore, this research aims at providing a model for designing Adaptive Mobile User Interfaces (AMUIs) and a prototype as a proof of concept to improve the usability of mobile ERP. This model will be used by mobile ERP developers to devise adaptive user interfaces that will improve the usability of mobile ERP.

## 4 Research Objectives and Questions

The main objective of this research is to improve the usability of mobile ERP by exploiting adaptive user interfaces. Hence, the main research question is:

**How can adaptive user interfaces be exploited for improving the usability of mobile ERP?**

In order to achieve the main research objective, several sub-objectives need to be achieved in this research.

- RO1)** To identify the usability issues and challenges of mobile ERP. Accordingly, we conclude the following research question:
  - RQ1)** What are the usability issues and challenges of mobile ERP?
- RO2)** To determine how AMUIs could be used to resolve the identified usability issues and challenges from RO1. Accordingly, we conclude the following research question:
  - RQ2)** How AMUIs could be modelled and used to resolve the identified usability issues and challenges in RO1?
- RO3)** To design and develop a prototype as a proof of concept for mobile ERP developers. Accordingly, we conclude the following research question:
  - RQ3)** How can we apply the identified AMUIs model in RO2 for mobile ERP?
- RO4)** to evaluate the developed prototype, in order to answer the following question:

**RQ4)** What are the improvements in the usability of mobile ERP after applying AMUIs model?

## 5 Research Methodology

This research employs design science research to achieve the main research objective by following the design science research guidelines, namely: design as an artifact, problem relevance, design evaluation, research contributions, research rigor, design as a search process, and communication of research [He04].

Starting with the business needs, to ensure that this research meets the goal of relevance, the researcher needs to identify the usability challenges and problems of mobile ERP in practice by conducting a usability evaluation questionnaire for mobile ERP end-users. In addition to that, a field study will be conducted to identify mobile ERP usability issues using the appropriate heuristics of usability evaluation for mobile applications.

To ensure research rigor, this research relies on existing knowledge bases and literature review within three main domains, namely: mobile usability, enterprise mobility, and human computer interaction. This will be done through an exhaustive review of the state of the art of adaptive UIs in literature and in practice besides evaluating and analysing the existing solutions.

Modelling the expected artifact this research which is the AMUIs model. This model will explain how to devise adaptive UIs for mobile ERP developers to improve the usability of their products. The AMUIs model contains the following interconnected sub-models based on AUIs types. These models need to be identified by the researcher:

- **Content adaptation model:** this model will explain how the UI of mobile ERP adapts its content (texts, labels, and images) by processing and delivering a personalized information for a specific end-user, task and dialog for a specific mobile context of use.
- **Presentation adaptation model:** this model will explain how the UI of mobile ERP presents the most appropriate presentation version (multimedia elements, interaction techniques, layout and graphical attributes) for a specific user, task and dialog for a specific mobile context of use.
- **Navigation adaptation model:** this model will explain how the UI of mobile ERP adapts its navigation links for a specific user to accomplish a specific task and dialog without feeling lost in a specific mobile context of use.

The previous models will be presented to the scientific community and conferences with the purpose of receiving feedback and constructive comments. Accordingly, these sub-models will be updated based on obtained feedback.

The AMUIs model will be implemented as a proof of concept, and the developed prototype will be evaluated using the field study evaluation method. This method is done by monitoring the use of the resulted artifact in multiple projects and observation of any improvements. The field study will use the appropriate evaluation heuristics, in order to identify any improvements in mobile ERP usability after applying AMUIs model.

## 6 Conclusion

Mobile ERP is the current wave of ERP systems, however, this wave suffers from usability challenges, which can be classified based on every entity involved in these systems. Furthermore, this wave is currently a young topic in practice and research.

Mobile ERP is an extension of ERP systems, therefore, this extension suffers from the same UIs complexity and rigidity, which negatively impact its usability. AUIs are proposed as a solution to improve the usability of mobile ERP. Therefore, this research aims at providing a model for devising AMUIs and a prototype as a proof of concept to improve the usability of mobile ERP. This model could be used by mobile ERP developers for devising adaptive user interfaces.

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