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Systematic Development of mHealth Apps: Lessons Learned During Development of a Mobile Frontend for ePill

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Table of Contents

Index of Abbreviations

app	abbreviation for Application
app user	the intended audience for the app
eHealth	"a paradigm involving the concepts of health, technology, and commerce, with commerce and technology as tools in the service of health"[1]. Belonging to the field of telehealth.[2]
ePill	a patient-centered health IT service which offers information on pharmaceuticals and aggregation of data in context
framework	can contain source code, tools and libraries, which together provide specific or common but abstracted functionality
frontend	visible user interface for the app user
HECAT	Health Education Curriculum Analysis Tool[3]
HIT	abbreviation for Health Information Technology
IDE	abbreviation fro Integrated Development Environment
mHealth	"medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices".[4] Also known as m-Health.
mHealth apps	"aim at providing seamless, global access to tailored health IT services and have the potential to alleviate global health burdens." [5]
information security	Prevention from unauthorized access to information. In this context especially sensitive, personal information
OS	operating system
SDK	abbreviation for software development kit. Bundled software and tools for developing with or for a specified OS or Framework
sensitive information	information, which is personal. Can be related to financial, health or otherwise personal relevant information [6]

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1 Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013), p. 2

2 cf. Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013), p. 2

3 http://www.cdc.gov/HealthyYouth/HECAT/

4 World Health Organization (2011) cited by Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013), p. 2

5 Dehling, Sunyaev (2013), p. 1

6 Suggested by Future of Privacy Forum, Center for Democracy & Technology (2011), p. 6, although the definition varies

telehealth	delivery of medical- or health-related information or services via telecommunication technologies
usability	"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" [7]
use value	the utility of consuming a good or service
user interface	**TODO: DEFINTION!**

[7] Yeh, Fontenelle (2012), p. 64 as quoted from ISO 9241-11 (1998)

List of Tables

1. Introduction

1.1 Research Problem

While it has become easy to develop a mobile health (mHealth) application (app), there is much more to it than just the aspects of the app's core functionality. Currently only very few guidelines, best practices and systematic development approaches for mobile app development can be found. And even less can be found for the specific area of mHealth apps.

Security leaks or even abuse of private and sensitive information can lead to great harm for the app user and to legal issues for the developer. Abuse of personal health related information can result in loss of reputation (e.g. sexual transmitted diseases) or financial drawbacks and decreased chances of employment (e.g. chronic diseases, genetic dispositions)[8]. With poorly developed apps, there is a chance of security leaks and hence for data abuse. Thus the risk for app users increases. A study[9] has shown that only very few mHealth apps entail little or low risk for the app user. Self-publishing through modern sales channels like Google Play (http://play.google.com) or the iOS App Store (http://appstore.com) and the availability of easy-to-use Integrated Development Environments (IDEs) lower the barriers for entry. Even one-man developers or small teams are now able to easily publish apps with little development effort. Without fundamental knowledge of privacy and security aspects, there is an increase in the non-professional development of mobile apps with inadequate security aspects.

The usability, especially in critical situations, is another undervalued aspect in many non-professional developments. While fancy colors might look appealing to the developer himself, it might lead to confusion for the app user or even to a lack of operability for visually impaired people.[10] Also the need for a intuitive user interface might not be considered as important as it should be.

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8 cf. Dehling, Sunyaev (2013), pp. 6-7

9 cf. Njie (2013), pp. 19-20

10 cf. Badashian et al. (2008) p. 108

Knowledge of data privacy acts and laws is a premise for a legal, safe and fair development for the developer and the app user. Multiple layers of data privacy laws in Europe on international, national and state level require a certain legal knowledge.[11] Also the benefit of and the need for a privacy policy seems to be ambiguous for many non-professional developers.[12]

This lack of guidelines for mobile app development and of specific guidelines for privacy and usability sensitive apps is only superficially considered by most of the literature. The beforehand highlighted aspects usability and information security are just two of multiple possible requirements. Current research seems not to state which specific requirements, if any, mHealth apps distinguish from other apps or which are needed to be more accented.

1.2 Objectives of this Thesis

The purpose of this thesis is to discover, identify and report issues and challenges of the development of mHealth apps by developing a mobile frontend for the ePill system (developed by the University of Cologne, http://epill.uni-koeln.de). ePill is a patient-centered health IT service which offers information on pharmaceuticals and aggregation of pharmaceutical data in context.

During the development of a mobile frontend for ePill, all requirements can be addressed more easily than in a completely theoretical context. As a side effect, a mobile app for ePill will increase the accessibility for the ePill system in general and thereby increase the possible user value. Especially in critical situations in which one does not have one's desktop computer at hand, a mobile easy-to-use app can be of value.

The experiences made during the development refer to general mobile app development, but also to the specific development of mHealth apps.
Mainly this thesis aims to describe the planning and the development process and dis-

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[11] cf. Directive 95/46 of the European Parliament and of the Council (October, 24th 1995), Directive 2002/58 of the European Parliament and of the Council (July, 12th 2002) cited by Future of Privacy Forum, Center for Democracy & Technology (2011), p. 16

[12] cf. Njie (2013), p. 20

cuss all discovered issues and challenges for planning and developing mHealth apps. One sub-objective is to give a short overview about the state of research on guidelines and important factors of mHealth app development. Subsequently, this thesis aims to highlight specific characteristics of mHealth apps and focus on them during the development as well in the conclusion.

2. The ePill System

2.1 The System in general

The ePill system (http://epill.uni-koeln.de) was developed by the University of Cologne to improve the readability and comprehensibility of instruction leaflets of medical drugs. Additionally ePill aims to provide further information on adverse reactions and interactions of different medical drugs. ePill emphasizes an easy readability and access to informations.

There are three major functions covered by the system: Searching for pharmaceuticals, display information on pharmaceuticals and supplementing services.[13] The search enables the user to find corresponding pharmaceuticals depending on specified parameters in the underlying database. As an extend, the display functionality enables the user to read the leaflet information in an optimized fashion. Finally supplementing services are provided to refine the displayed information (e.g. select the level of detail of the displayed information), linking pharmaceuticals as well as other information and aggregate pharmaceutical information (e.g. interactions).

An integration and personalization depending on the current user's health records was not implemented due to the arising privacy and trust challenges.[14, 15]

2.2 The Web Application

The web application of the ePill system introduces itself highly customizable to the user. It offers the user the choice between a default view, a customizable view and an expert view. The default view aims to provide all necessary information in a compact way. The customizable view offers more choices for the elements to be displayed. The expert view activates all options for the most detailed information level. The pharmaceutical informations to be displayed can be fine tuned for every view. ePill offers four different presets varying from only the most basic up to all available information. These presets can be further customized by afterwards selecting or deselecting items. Additionally the font-size

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[13] cf. for this section Dehling, Sunyaev (2012), p. 2

[14] cf. Kaletsch, Sunyaev (2011) cited by Dehling, Sunyaev (2012), p. 2

[15] cf. Kaletsch, Sunyaev (2011), pp. 5-6

can be set to normal, bigger and biggest to support visually impaired users.

Three columns shape the layout. The leftmost column contains the main navigation for searching, pharmaceutical listings, basic functionality like help pages and settings as well as extended functionality like interactions research and adverse reaction lookup or pharmaceutical comparisons. The centered column contains the current content. This column has tabs, which can be assigned different contents. With this tabular layout, e.g. multiple, different search queries can easily be switched and held in parallel. The rightmost column can be used to dynamically display or hide specific information. Depending on the beforehand selected view, the left or right columns are hidden or visible. The website also offers the user on the pharmaceutical detail page to explain any term as well as a shortcut to the page's top.

The specific content layout is very consistent. Headlines are made salient and the arrangement of common sections are congruent. Changes in settings are apply with no delay and without a page reload. Any changes are applied congruent with the chosen layout and other related settings.

3. What is mHealth?

3.1 Definition

mHealth, also known as m-Health, is an abbreviation for mobile health and is a refinement of eHealth (or e-Health, an abbreviation for electronic health), which itself belongs to the field of telehealth.[16]

eHealth is defined as "a paradigm involving the concepts of health, technology, and commerce, with commerce and technology as tools in the service of health".[17]

Telehealth means the delivery of medical- or health-related information or services via telecommunication technologies.

mHealth in detail is defined as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices".[18] The introduction of smart phones like the Apple iPhone or any Android device led to a greater audience and the evolution of mobile tablets further increased the audience for mHealth purposes. Some studies rely on the Health Education Curriculum Analysis Tool (HECAT)[19] to group different mHealth apps together. A study[20] illustrates the distribution of apps in different categories. As Tab. 3-1 illustrates, most of the available apps in 2011 in the Apple App Store in the United States of America belonged to the Physical Activity area, whereas drug-related and safety-related apps (like ePill) are the least two.

3.2 mHealth App Categories

Although the Tab. 3-1 listed categories for mHealth apps, it focusses on content or functionality and less on the specifics for mHealth apps on other topics, such as information

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16 cf. Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013), p. 2

17 Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013), p. 2

18 World Health Organization (2011) cited by Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013), p. 2

19 http://www.cdc.gov/HealthyYouth/HECAT/

20 cf. West et al. (2012)

21 Apps could be added to multiple categories

22 cf. West et al. (2012), p. 5, Table 2

HECAT content area	n	%[21]
Physical Activity	1108	33.21
Personal health and wellness	962	28.84
Healthy eating	651	19.51
Mental and emotional health	414	12.41
Sexual and reproductive health	243	7.28
Alcohol, tobacco, and other drugs	131	3.93
Violence prevention and safety	96	2.88

Tab. 3-1: HECAT Content Area App Distribution (N = 3336)[22]

security or usability. Other literature focusses on data practices and privacy risks with a more technical aspect[23] or into administrative connectivity, financial connectivity or medical connectivity.[24] The third categorization was stated already in 2004, so this article cannot take the recent development in mobile devices into account. Nevertheless the categorization is still appropriate. The administrative connectivity handles appointments, electronic patient records and any non-financial transactions, the financial connectivity handles all financial transactions like purchases, billing or any financial services. The third connectivity, the medical connectivity, handles mobile monitoring and diagnostics.

3.3 Classification of the ePill Web Application

3.4 Why is a special Focus on mHealth Apps warranted?

23 cf. Njie (2013), pp. 13-14

24 cf. Istepanian, Jovanov, Zhang (2004), p. 6

4. The Development of the mobile Client

4.1 Preconditions

4.1.1 Norms for mobile Apps

4.1.2 Best Practices

4.1.3 Internal requirements

4.2 Analysis

4.2.1 Assignment of a mHealth App Category

4.2.2 The different Operation Systems

Android

iOS

Windows Phone 7 and 8

other

4.2.3 Possible Frameworks and Technologies

Xamarin

Vaadin

HTML 5, jQuery mobile and Phone Gap

Completely native

4.2.4 The Choice for Framework XYZ

4.3 The Planning Process

4.4 (The Design Process)

4.5 The Implementation Process

4.6 Validation of the mobile Client

5. Lessons Learned

6. Conclusion

Bibliography

Badashian et al. (2008)

Ali Sajedi Badashian, Mehregan Mahdavi, Amir Pourshirmohammadi, Minoo Monajjemi nejad: “Fundamental Usability Guidelines for User Interface Design”. In: *Computational Sciences and Its Applications, 2008. ICCSA ’08. International Conference on*. 2008, pp. 106–113

Dehling, Sunyaev (2012)

Tobias Dehling, Ali Sunyaev: Architecture and Design of a Patient-Friendly eHealth Web Application: Patient Information Leaflets and Supplementary Services. In: AMCIS 2012 Proceedings. 2012, pp. 1–8

Dehling, Sunyaev (2013)

Tobias Dehling, Ali Sunyaev: Information Security and Privacy Implications of mHealth Apps: An Overview. 2013, pp. 1–12

Future of Privacy Forum, Center for Democracy & Technology (2011)

Future of Privacy Forum, Center for Democracy & Technology: Best Practices for Mobile Application Developers: App Privacy Guidelines. In: Future of Privacy Forum and the Center for Democracy & Technology. 2011, pp. 1–20

Istepanian, Jovanov, Zhang (2004)

R.S.H. Istepanian, E. Jovanov, Y.T. Zhang: Guest Editorial Introduction to the Special Section on M-Health: Beyond Seamless Mobility and Global Wireless Health-Care Connectivity. In: IEEE Transactions on Information Technology in Biomedicine. Nr. 4, Jg. 8, 2004, pp. 405–414

Kaletsch, Sunyaev (2011)

Alexander Kaletsch, Ali Sunyaev: Privacy Engineering: Personal Health Records in Cloud Computing Environments. In: ICIS 2011 Proceedings. 2011, pp. 1–11

Martínez-Pérez, de la Torre-Díez, Isabel, López-Coronado (2013)

Borja Martínez-Pérez, de la Torre-Díez, Isabel, Miguel López-Coronado: Mobile health applications for the most prevalent conditions by the World Health Organization: review and analysis. In: Journal of medical Internet research. Nr. 6, Jg. 15, 2013, e120

Njie (2013)

C.M.L. Njie: Technical Analysis of the Data Practices and Privacy Risks of 43 Popular Mobile Health and Fitness Applications. In: Privacy Rights Clearinghouse. 2013, pp. 1–31

West et al. (2012)

Joshua H. West, P. Cougar Hall, Carl L. Hanson, Michael D. Barnes, Christophe Giraud-Carrier, James Barrett: There's an App for That: Content Analysis of Paid Health and Fitness Apps. In: Journal of medical Internet research. Nr. 3, Jg. 14, 2012, pp. 1–11

World Health Organization (2011)

World Health Organization: mHealth: New horizons for health through mobile technologies, 2011. http://whqlibdoc.who.int/publications/2011/9789241564250_eng.pdf, visited on 08/30/2013

Yeh, Fontenelle (2012)

Shea-Tinn Yeh, Cathalina Fontenelle: Usability study of a mobile website: the Health Sciences Library, University of Colorado Anschutz Medical Campus, experience. In: Journal of the Medical Library Association. Nr. 1, Jg. 100, 2012, pp. 64–68

Erklärung

Hiermit versichere ich an Eides Statt, dass ich die vorliegende Arbeit selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Alle Stellen, die wörtlich oder sinngemäß aus veröffentlichten und nicht veröffentlichten Schriften entnommen wurden, sind als solche kenntlich gemacht. Die Arbeit ist in gleicher oder ähnlicher Form oder auszugsweise im Rahmen einer anderen Prüfung noch nicht vorgelegt worden.

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