AGILE BASED DEVELOPMENT METHODOLOGY FOR MOBILE COMMERCE APPLICATIONS

MUAZZAN BINSALEH

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2012

Permission to Use

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to :

Dean of Awang Had Salleh Graduate School of Arts and Sciences
UUM College of Arts and Sciences
Universiti Utara Malaysia
06010 UUM Sintok

Abstrak

Terdapat beberapa metodologi pembangunan sistem termasuk kaedah tradisional dan tangkas yang digunakan dalam pembangunan sistem semasa. Walau bagaimanapun, ia boleh dikatakan bahawa metodologi yang sedia ada mungkin tidak sesuai untuk pembangunan aplikasi perdagangan mudah alih. Aplikasi ini digunakan dalam konteks yang berbeza dari aplikasi konvensional e-dagang tetap seperti paparan pada peranti skrin yang kecil, persekitaran yang tidak stabil atau yang dipindah-pindahkan dan keperluan kepada aspek keselamatan untuk menyampaikan transaksi kewangan melalui rangkaian mudah alih. Penyelidikan ini bertujuan untuk membina metodologi pembangunan berasaskan tangkas bagi aplikasi perdagangan mudah alih. Untuk mencapai matlamat ini, tiga objektif telah dicadangkan termasuk mengenal pasti amalan yang penting untuk membangunkan aplikasi m-dagang, pembinaan metodologi yang boleh diramal berasaskan tangkas yang digunakan untuk membangunkan aplikasi m-dagang dan penilaian untuk kesesuaian dan praktikaliti. Kaedah penyelidikan yang digunakan ialah reka bentuk penyelidikan, termasuk langkah-langkah kesedaran masalah, cadangan, pembangunan, penilaian dan kesimpulan. Kaedah penyelidikan yang digunakan untuk membantu penyelidikan metodologi yang disebutkan termasuklah analisis literatur, lawatan industri, temu bual separa struktur, kajian, penyelidikan formulatif dan penilaian eksperimen. Kaedah dibina mengandungi integrasi faktor penting dalam setiap fasa kitar hayat sistem pembangunan serta garis panduan untuk diikuti bagi menjalankan aktiviti-aktiviti dalam pembangunan aplikasi, termasuk model khusus, alat dan teknik. Dari penilaian kaedah yang dibina, keputusan menunjukkan dua perkara yang penting. Pertama, metodologi yang dibina boleh diaplikasikan dan digunakan untuk membina sistem yang dicadangkan, dan dalam kes ini aplikasi perdagangan mudah alih. Kedua, dari segi praktikalitinya, ia menunjukkan bahawa metodologi yang dibina ini adalah praktikal apabila dibandingkan dengan metodologi *the traditional waterfall development* dengan menggunakan sebelas ukuran tertentu, di mana didapati ia memberi lebih banyak faedah kepada proses pembangunan.

Kata kunci: Perdagangan mudah alih, Pengkomputeran mudah alih, Aplikasi mudah alih, Sistem metodologi pembangunan, Pembangunan tangkas

Abstract

There are several system development methodologies including traditional and agile methodologies which are being utilized in current systems development. However, it could be argued that existing methodologies may not be suitable for the development of mobile commerce applications as these applications are utilized in different contexts from conventional fixed e-commerce applications such as they are displayed on a small screen device, they are utilized in an unstable or movable environment and they need to be used in a secured environment to deliver financial transactions over mobile network. This study aimed to construct an agile based development methodology for mobile commerce applications. In order to achieve this aim, three objectives have been proposed including identification of essential issues for developing m-commerce applications, construction of a predictable agile based methodology used for developing m-commerce applications and evaluation for its applicability and practicality. The research methodology used in the study is the design research, which include the steps of awareness of problems, suggestion, development, evaluation and conclusion. The research methods used to assist the mentioned research methodology include literature analysis, industry visits, semi-structured interview, survey, formulative research and experimental evaluation. The methodology constructed contains the integration of essential factors in each phase of systems development life cycle as well as guidelines to follow for conducting activities in the application development, including specific models, tools, and techniques. From the evaluation of the constructed methodology, the results showed two essential outcomes. Firstly, the constructed methodology is applicable as it can be used to build the intended system, mobile commerce applications in this case. Secondly, for practicality, it showed that the constructed methodology is practical as when comparing to the traditional waterfall development by using the eleven measurements specified, it exposed more benefits to the development process.

Keywords: Mobile commerce, Mobile computing, Mobile applications, Systems development methodology, Agile development

Acknowledgement

In the name of Allah, the Most Gracious and the Most Merciful.

I would like to extend my thanks and gratitude to:

Allah the Almighty for giving me the excellent health and mind for doing the research;

My supervisor, Associate Professor Dr. Shahizan Hassan for his wonderful support and efforts in assisting me formulating and constructing this thesis. Without his admirable encouragement and suggestions, this thesis would not become reality;

Staff members of School of Computing, College of Arts and Sciences (CAS UUM) for their kindness and welcome support;

The Universiti Utara Malaysia for the facilities and resources provided;

Faculty of Communication Sciences and Prince of Songkla University for the financial and grateful support;

My beloved wife, Sariya for her love, courage and patient; my son, Nasri for being an amazing companion; my daughter, Haneen for giving me such colorful days; both of my parents and parents-in-law for being there;

And all individuals involved in the establishment of this thesis.

Table of Contents

List of Tables

List of Figures

List of Appendices

List of Abbreviations

3G	3rd Generation Mobile Network
ASD	Adaptive Software Development
B2B	Business to Business
B2C	Business to Consumer
BV	Business Value
CAS	Complex Adaptive Systems
CDC	Connected Device Configuration
CDP	Customer Decision Process
CLDC	Connected Limited Device Configuration
CRC	Class, Responsibilities, and Collaboration
DBMS	Database Management System
DFD	Dataflow Diagram
DSDM	Dynamic System Development Method
EC	Electronic Commerce
ECVM	E-commerce Value Matrix
EDGE	Enhanced Data rates for GSM Evolution
ERD	Entity Relationship Diagram
FDD	Feature-Driven Development
G/Q/M	Goal/Questions/Metrics
GPRS	General Packet Radio Service
GUI	Graphical User Interface
HCI	Human Computer Interaction
HCSDLC	Human-Centered Systems Development Methodology
HTML	Hypertext Mark-up Language
HTTP	Hypertext Transport Protocol
IDE	Integrated Development Environment
J2EE	Java2 Enterprise Edition
J2ME	Java2 Micro Edition
M-commerce	Mobile Commerce
MIDP	Mobile Information Device Profile
MLM	Multi Level Marketing
MS	Microsoft

PC	Personal Computer
PDA	Personal Digital Assistant
PV	Point Value
R&D	Research and Development
RAD	Rapid Application Development
RMS	Record Management System
RUP	Rational Unified Process
SA&D	Systems Analysis & Design
SDLC	Systems Development Life Cycle
SEI	Software Engineering Institute
SMS	Short Message Service
UI	User Interface
UML	Unified Modelling Language
VCC	Virtual Value Chain
VMD	Visual Mobile Designer
WAP	Wireless Application Protocol
WML	Wireless Mark-up Language
WSA	Web Services Architecture
XP	Extreme Programming
ZFR	Zero-feature Release

CHAPTER ONE
INTRODUCTION

1.1 Background

Mobile commerce or commonly known as m-commerce, typically designates the use of wireless devices (particularly mobile phones) to conduct electronic business transactions, such as product ordering, fund transfer, and stock trading, (Kalakota & Robinson, 2002). According to Liang, Huang, Yeh, and Lin (2007), m-commerce refers to any transactions, either direct or indirect, via mobile devices, such as phones or Personal Digital Assistants (PDAs). While many different definitions of m-commerce exist in the literature (Turel & Yuan, 2006), these usually refer to e-commerce activities conducted through mobile devices such as mobile phones and Personal Digital Assistants (PDAs).

Liang *et al.* (2007) stated that the most significant features of mobile technology are mobility which is the state of being in motion and portability which is the ability to be carried or moved easily. It is therefore essential for m-commerce application developers to develop applications carefully to conform to the significant features of m-commerce as mentioned, which are mobility and portability. Some prominent examples of m-commerce include mobile financial services (e.g. m-banking, m-payment, and m-brokering), mobile shopping (e.g. m-retailing, m-auctions), mobile entertainment (e.g. m-gaming, m-music, m-video, and m-betting), and mobile information (e.g. mobile access to sports news, weather forecasts, maps, and so on.) (Khalifa & Shen, 2008).

The contents of the thesis is for internal user only

REFERENCES

Advanced Development Methods Inc. (2009). What is Scrum?. Retrieved October 7, 2009: *www.controlchaos.com/about/*

Andreou, A. S., Chrysostomou, C., Leonidou, C., Mavromoustakos, S., Pitsillides, A., Samaras, G., & Schizas, C. (2002). Mobile Commerce Applications and Services: A Design and Development Approach. In CD-ROM Proceedings of the First International Conference on Mobile Business.

Abrahamsson, P., Hanhineva, A., Hulkko, H., Ihme, T., Jaalinoja, J., Korkala, M., Koskela, J., Kyllonen, P., & Salo, O. (2004). Mobile-D: An Agile Approach for Mobile Application Development. *OOPSLA'04.* 174-175.

Abrahamsson, P.,Warsta, J., Siponen, M.T., & Ronkainen, J. (2003). New Directions on Agile Methods: A Comparative Analysis. *Paper presented at the 25th International Conference on Software Engineering,* Portland, Oregon.

Agile Manifesto. (2001). Principles behind the Agile Manifesto. Retrieved October 5, 2009: *http://www.agilemanifesto.org/principles.html*

Ambler, S.W. (2009). *Agile Modeling Throughout the XP Lifecycle*. Retrieved Oct 7, 2009: *http://www.agilemodeling.com/essays/agileModelingXPLifecycle.htm#Figure1XPProjectLifecycle*

Argyris, M., & Schön, D. (1974). *Theory in Practice: Increasing professional Effectiveness*. San Francisco: Jossey-Bass.

Argyris, C., & Schön, D. (1996). *Organizational learning II: Theory, method and Practice*: Addison Wesley.

Basili, V. R., & Weiss, D. M. (1984). A Methodology for Collecting Valid Software Engineering Data. *IEEE Transactions on Software Engineering*. *10*(3), 728-738.

Basili, V., Caldeira, G., & Rombach, H. D. (1994). *The Goal Question Metric Approach. In J. Marciniak. Encyclopedia of Software Engineering*. New York: John Wiley & Sons.

Beck, K. (2000). *Extreme Programming Explained: Embrace Change*: Addison-Wesley.

Beck, K., & Fowler, M. (2001). *Planning Extreme Programming*: Addison-Wesley.

Bisignano, M., Modica, G., & Tomarchio, O. (2006). An intended-oriented approach for multi-device user interface design. *IEEE in Proceeding of the 20th International Conference on Advanced Information Networking and Applications (AINA'06)*.

Blum, B. (1996). *Beyond Programming: To a New Era of Design*: Oxford University Press.

Boehm, B. (2011). Towards richer process principles. *Proceedings of the 2011 International Conference on on Software and Systems Process (ICSSP '11)*. 234.

Cao, L., & Ramesh, B. (2007). Agile Software Development: Ad Hoc Practices or Sound Principles?. *IT Professional*, *9*(2), 41-47.

Carleton, A.D., Park, R.E., Goethert, W.B., Florac, W.A., Bailey, E.K., & Pfleeger, S.L. (1992). *Software Measurement for DoD Systems: Recommendations for Initial Core Measures*. Technical Report CMU/SEI-92-TR-19. Pensylvania: Software Engineering Institute, Carnegie Mellon University.

Chan, S.S., Fang, X., Brzexinski, J., Zhou, Y., Xu, S., & Lam., J. (2002). Usability for Mobile Commerce across Multiple Form Factors. *Journal of Electronic Commerce Research*, *3*(3), 187-199.

Chang, Y., Chen, J., & Tseng, W. (2005). A mobile commerce framework based on Web services architecture. *IEEE in Proceedings of the International Conference on Information Technology: Coding and Computing (ITCC 2005)*, 403-408.

Chen, Y., Xie, X., Ma, W.Y., & Zhang, H.J. (2005). Adapting Web Pages for Small-Screen Devices. *IEEE Internet Computing***,** *9*(1), 50–56.

Christensen, L.B. (2007). *Experimental Methodology*. Boston: Pearson Education.

Dennis, A., Wixom, B.H., & Roth, R.M. (2006). *Systems Analysis & Design.* New Jersey: John Willey & Sons.

Dingsoyr, T., Dyba, T., & Abrahamsson, P. (2008). A Preliminary Roadmap for Empirical Research on Agile Software Development. *AGILE '08 Conference.* 83 – 94.

Eisenhardt, K.M., & Martin, J.A. (2000). *Dynamic Capabilities: What Are They?*. *Strategic Management Journal*, *21*(10-11), 1105-1121.

Fingar, P. (2000). Component-based frameworks for e-commerce. *Communications of the ACM, 43*(10), 61 – 67.

Fowler, M. (2005). *The New methodology*. Retrieved October 5, 2009: *http://martinfowler.com/articles/newMethodology.html#Scrum*

Ge, X., Paige, R.F., Polack, F.A.C., Chivers, H., & Brooke, P.J. (2006). Agile development of secure web applications. *ACM in Proceedings of the 6th international conference on Web engineering*, 305-312.

Germain, E., & Robillard, P N. (2005). Engineering based processes and agile methodologies for software development: a comparative case study. *Journal of Systems and Software, 75*(1-2), 17-27.

Ghosh, A.K., & Swaminatha, T.M. (2001). Software Security and Privacy Risks in Mobile e-commerce. *Communications of the ACM. 44*(2). 51-57.

Gill, N.S. (2005). Factors Affecting Effective Software Quality Management Revisited. *ACM SIGGSOFT Software Engineering Notes, 30*(2), 1-4.

Giorgis, R.S.D., & Agurto, N.R. (2004). New UML 2.0 based models to design WAP applications. *Paper presented at the 5th Aspect-Oriented Modeling Workshop'04*, Lisbon, Portugal.

Gruhn, V., Ko¨hler, A., & Klawes, R. (2007). Modeling and analysis of mobile Business processes. *Journal of Enterprise Information Management*, *20*(6), 657-676.

Henry, S., & Kafura, D. (1981). Software Structure Metrics Based on Information Flow. *IEEE Transaction on Software Engineering*, *7*(5), 510-518.

Hoffer, J.A., George, J.F., & Valacich, J.S. (2005). *Modern Systems Analysis and Design*. New Jersey: Prentice Hall.

Highsmith, J. (1999). *Adaptive Software Development: A Collaborative Approach to Managing Complex System.* New York: Dorset House Publishing.

Hsia, T.L., Wu, J.H., & Li, E.Y. (2008). The e-commerce value matrix and use case model: A goal-driven methodology for eliciting B2C application requirements. *Information & Management, 45*, 321–330.

Jeffries, R., Anderson, A. & Hendrickson, C. (2001). *Extreme Programming Installed*: Addison-Wesley.

Jeong, Y.J., Lee, J.H., & Shin, G.S. (2008). Developent Process of Mobile Application SW Based on Agile Methodology. *ICACT 2008.* 362-366.

Kalakota, R., & Robinson, M. (2002). *M-Business: The Race to Mobility*. New York: McGraw-Hill.

Khalifa, M., & Shen, K.N. (2008). Explaining the adoption of transactional B2C mobile commerce. *Journal of Enterprise Information Management*, *21*(2), 110-124.

Kristoffersen, S., & Ljungberg, F. (1999). Designing Interaction Styles for a Mobile Use Context. *Springer-Verlag in Proceedings of the 1st international symposium on Handheld and Ubiquitous Computing*. 281-288.

Krutchen, P. (2001). Agility with the RUP. *Cutter IT Journal, 14*(12), 27-33.

Kurkovsky, S., & Harihar, K. (2006). Using ubiquitous computing in interactive mobile marketing. *Personal and Ubiquitous Computing, 10*(4), 227-240.

Larman, C. (2004). *Agile & Iterative Development: A Manager's Guide*. Boston: Addison-Wesley.

Lawrence, E., Lawrence, B., Pernici, B., & Krogstie, J. (2004). Mobile Information Systems. *Springer in Proceedings of the IFIP TC8 Working Conference on Mobile Information Systems*.

Lee, Y.E., & Benbasat, I. (2004). A Framework for the Study of Customer Interface Design for Mobile Commerce. *International Journal of Electronic Commerce, 8*(3), 79–102.

Leuf, B., & Cunningham, W. (2001). *The Wiki Way: Quick Collaboration on the Web*. Boston: Addison-Wesley.

Liang, T., & Wei, C. (2004). Introduction to the Special Issue: Mobile Commerce Applications. *International Journal of Electronic Commerce*, *8*(3), 7–17.

Liarokapis, F., & Conradi, E. (2007). User interfaces for mobile navigation. *Library Hi Tech*, *25*(3), 352-365.

Livermore, J.A., & College, W. (2007). Factors that impact implementing an agile software development methodology. *IEEE SoutheastCon Proceedings.* 82-86.

Liang, T., Huang, C., Yeh, Y., & Lin, B. (2007). Adoption of mobile technology in business: a fit-viability model. *Industrial Management & Data Systems*, *107*(8), 1154-1169.

Mar, K., & Schwaber, K. (2002). *Scrum with XP*. Retrieved November 9, 2009: *http://www.informit.com/articles/article.aspx?p=26057&seqNum=3*

May, P. (2001). *Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business.* Cambridge: Cambridge University Press.

Mayuk, O., & Torabi, T. (2006). Framework for Mobile Application Development and Content Integration. *IEEE in Fourth IEEE International Workshop on Wireless, Mobile and Uniqitous Technology in Education*, 69-73.

McCall, J.A., Richards, P.K., & Walters, G.F. (1997). *Factors in Software Quality.* Rome Air Development Center, RADC TR-77-369.

Meso, P., & Jain, R. (2006). Agile Software Development: Adaptive Systems Principles and Best Practices. *Information Systems Management, 23*(3), 19-30.

Morales-Aranda, A.H., Maroya-Ibarra, O., & Negrete-Yanlevich, S. (2004). M-Modeller: A Framework Implementation for Modeling m-commerce Applications. *Sixth International Conference on Electronic Commerce.* 596-602.

Neilsen, J., & Mack, R.L. (1994). *Usbility Inspection Methods*. New York: John Wiley & Son.

Newkirk, J., & Martin, R. (2001). *Extreme Programming in Practice*. Reading Massachusetts: Addison Wesley.

Ngai, E.W.T., & Gunasekaran, A. (2007). A review of mobile commerce research and applications. *Decision Support Systems, 43*(1), 3-15.

Olson, T.G. (2003). *Using a Process Measurement Framework^{SM} to Rapidly Achieve Measurable Results*. Presentation. ASQ13 ICSQ. Texas: American Society of Quality.

Pascoe, J., Ryan, N., & Morse, D. (2000). Using While Moving: HCI Issues in Fieldwork Environments. *ACM Transactions on Computer-Human Interaction. 7*(3). 417-437.

Patil, S. B., Rao, S., & Patil, P. S. (2011). Agile principles as a leadership value system in the software development: are we ready to be unleashed? *Proceedings of the International Conference & Workshop on Emerging Trends in Technology (ICWET '11)*. 765-766.

Pendelidis, A. (2006). Defining the security required for WAP based Mobile ticket sales. *Proceedings of the 2006 International Conference on Privacy, Security and Trust: Bridge the Gap Between PST Technologies and Business Services, Ontario, Canada.*

Pendharkar, P.C., & Rodger, J.A. (2007). An empirical study of the impact of team size on software development effort. *Information Technology and Management, 8*(4), 253–262.

Pressman, R.S. (2010). *Software Engineering: A Practitioner's Approach*: McGraw-Hill.

Rahimian, V., & Ramsin, R. (2007). Designing an Agile Methodology for Mobile Software Development: A Hybrid Method Engineering Approach. *Second International Conference on Research Challenges in Information Science.* 337-342,

Roberts, T.L., Gibson, M.L., Fields, K.T., & Rainer, R.K. (1998). Factors that Impact Implementing a System Development Methodology. *IEEE Transactions on Software Engineering*, *24*(8), 640-649.

Sae-Tankg, S., & Esichaikul, V. (2001). Web Personalization Techniques for E-commerce. *Springer-Verlag in Proceedings of the 6th International Computer Science Conference on Active Media Technology*. 36-44.

Saghafi, F., NasserEslami, F., & Esmael, M. (2009). Ranking Secure Technologies in Security Provision Financial Transactions Mobile Commerce. ICIS 2009. 331-336.

Satzinger, J., Jackson, R., & Burd, S. (2007). *Systems Analysis & Design in a changing world.* Boston: Thomson Course Technology.

Scharff, C., & Verma, R. (2010). Scrum to Support Mobile Application Development Projects in a Just-in-time Learning Context. *CHASE'10.* 25-31.

Schmidt, A., Schröder, H., & Frick, O. (2000). WAP – Designing for Small User Interfaces. *Paper presented at the CHI '00 extended abstracts on Human factors in computing systems*, The Hague, The Netherlands.

Schneiderman, R. (2002). *The Mobile Technology Question and Answer Book: A Survival Guide for Business Managers*. New York: AMACOM.

Schusteritsch, R., Wei, C.Y., & LaRosa, M. (2007). Towards the perfect infrastructure for usability testing on mobile devices. *Paper presented at CHI '07 extended abstracts on Human factors in computing systems, California.*

Shih, G., & Shim, S.S.Y. (2002). A Service Management Framework for M-Commerce Applications. *Mobile Networks and Applications*, 7, 199–212.

Shiratuddin, N., & Hassan, S. (2010). *Design Research in Software Development*. Sintok: Universiti Utara Malaysia Press.

Singh, S., & Kotzé, P. (2003). An overview of systems design and development methodologies with regard to the involvement of users and other stakeholders. *South African Institute for Computer Scientists and Information Technologists in Proceedings of the 2003 annual research conference of the South African institute of computer scientists and information technologists on Enablement through technology*, 37-47.

Solingen, R., & Berghout, E. (1999). *The Goal/Question/Metric Method: A Practical Guide for Quality Improvement of Software Development*. Maidenhead: McGraw-Hill.

Standing, C. (2002). Methodologies for developing Web applications. *Information and Software Technology*, *44*(3), 151-159.

Zwass, V. (2003). Electronic commerce and organizational innovation: Aspects and opportunities. *International Journal of Electronic Commerce, 7*(3), 7–37.

T38 and the DuPont Global Mobility Innovation Team. (2005). *Mobile Devices.* Retrieved February 7, 2008: *http://en.wikipedia.org/wiki/Mobile_devices*

Tarasewich, P. (2003). Designing mobile commerce applications. *Communications of the ACM, 46*(12), 57-60.

Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, *18*(7), 509-533.

Turel, O., & Yuan, Y. (2006). Investigating the dynamics of the m-commerce value system: a comparative viewpoint. *International Journal of Mobile Communications*, *4*(5), 532-557.

Vainio, A.M., Tuunanen, T., & Abrahammsson, P. (2005). Developing Software Products for Mobile Markets: Need for Rethinking Development Models and Practices. *Proceeding of the 38th Hawaii International Conference on System Science.* 189b.

Vaishnavi, V., & Kuechler, W. (2004/5). *Design Research in Information Systems*. Retrieved October 29, 2010: http://desrist.org/design-research-in-information-systems

Varshney, U., & Vetter, R. (2002). Mobile Commerce: Framework, Applications and Networking Support. *Mobile Networks and Applications*, *7*, 185–198.

Wake, W.C. (2002). *Extreme Programming Explored*: Addison Wesley.

Wells, D. (2009). *The Rules of Extreme Programming*. Retrieved November 4, 2009: *http://www.extremeprogramming.org/rules.html*

Xinyan, Z., Wei, G., & Tingjie, L. (2009). Study on Consumer Demands and Merchant Participation Motives of Mobile Payment Services in China. *ICIS 2009.* 1447-1451.

Zhang, D. (2007). Web content adaptation for mobile handheld devices. *Communications of the ACM*, *50*(2), 75-79.

Zhang , P., Carey, J., Te'eni, D., & Tremaine, M. (2005). Integrating Human-Computer Interaction Development into the Systems Development Life Cycle: A Methodology. *Communications of the Association for Information Systems*, *15*, 512-543.

Zhou, D., Islam, N., & Ismael, A. (2004). Adaptive Replication for Mobile Services. *Proceeding of the 13th World Wide Web Conference*, 131-142.

FURTHER READING

Angelides, M.C. (2004). Guest Editorial: Special Issue on Mobile Multimedia and Communications and m-commerce. *Multimedia Tools and Applications, 22*, 115–116.

Anil, S., Ting, L.T., Moe, L.H., & Jonathan, G.P.G. (2003). Overcoming barriers to the successful adoption of mobile commerce in Singapore. *International Journal of Mobile Communications*, *1*(1/2), 194-231.

Bartelt, C., Fischer, T., Niebuhr, D., Rausch, A., Seidl, F., & Trapp, M. (2005). Dynamic integration of heterogeneous mobile devices. *ACM in Proceedings of the 2005 workshop on Design and evolution of autonomic application software*, 1-7.

Bergh, J.V., & Karin Coninx, K. (2004). Model-based design of context-sensitive interactive applications: a discussion of notations. *ACM in Proceedings of the 3rd annual conference on Task models and diagrams* ,43-50.

Cervone, H.F. (2007). The system development life cycle and digital library development. *OCLC Systems & Services: International digital library perspectives*, *23*(4), 348-352.

Chan, S.S., Fang, X., Brzexinski, J., Zhou, Y., Xu, S., & Lam., J. (2002). Usability for Mobile Commerce across Multiple Form Factors. *Journal of Electronic Commerce Research*, *3*(3), 187-199.

Chapman, N., & Chapman, J. (2004). *Digital Multimedia.* Chichester: John Willey & Sons.

Dix, A., Finlay, J., Abowd, G., & Beale, R. (1993). *Human-Computer Interaction.* Hertfordshire: Prentice Hall.

Donnell, J.O., Jackson, M., Shelly, M., & Ligertwood, J. (2007). Australian case study in Mobile Commerce. *Journal of Theoretical and Applied Electronic Commerce Research*, *2*(2), 1-18.

Feng, H., Hoegler, T., & Stucky, W. (2006). Exploring the Critical Success Factors for Mobile Commerce'. *IEEE in Proceedings of the International Conference on Mobile Business (ICMB'06)*, 40-40.

Gao, J., Cai, J., Patel, K., & Shim, S. (2005). A wireless payment system. *IEEE in Proceedings of the Second International Conference on Embedded Software and Systems,* 367-374.

Hadjiefthymiades, S. (2003). Mobile e-commerce and Location-Based Services: Technology and Requirements. *Helsinki University of Technology in Proceedings of The 9th Scandinavian Research Conference on Geographical Information Science*, 1-14.

Hansen, B.H., & Kautz, K. (2005). Grounded Theory Applied: Studying Information Systems Development Methodologies in Practice. *IEEE in Proceedings of the 38th Hawaii International Conference on System Sciences*, 1-10.

Hassan, S., & Li, F. (2005). Evaluating the Usability and Content Usefulness of Web Sites: A Benchmarking Approach. *Journal of Electronic Commerce in Organisations*, *3*(2), 46-67.

Holleis, P., Otto, F., Hussmann, H., & Schmidt, A. (2007). Keystroke-level model for advanced mobile phone interaction. *ACM in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1505-1514.

Hussain, Z., Lechner, M., Milchrahm, H., Shahzad, S., Slany, W., Umgeher, M., Vlk, T., & Wolkerstorfer, P. (2008). User Interface Design for a Mobile Multimedia Application: An Iterative Approach. *IEEE in Proceedings of the First International Conference on Advances in Computer-Human Interaction,* 189-194.

Huang, H., Liu, L., & Wang, J. (2007). Diffusion of Mobile Commerce Application in the Market. *IEEE in Proceedings of the Second International Conference on Innovative Computing, Information and Control*, 485-485.

Huang, J., Wang, J., Chang, T., Zhao, C., & Wang, L. (2003). A Comparative Framework for EB Systems Development Methodologies. *IEEE in Proceedings of the IEEE/WIC International Conference on Web Intelligence*, 442 – 445.

Hurson, A.R., & Kavehrad, M. (2001). Guest Editor's Introduction: Multimedia Systems, Mobile Computing and Global Information Sharing. *Multimedia Tools and Applications*, *15*, 111–114.

Leedy, P.D., & Ormrod, J.E. (2005). *Practical Research: Planning and Design.* NewJersey: Prentice Hall.

Neilsen, J. (2000). *Designing Web Usability.* Indiana: New Riders.

Pavio, A. (1986). *Mental Representations: A Dual Coding Approach.* Oxford: Oxford University Press.

Pham, B., & Wong, O. (2004). Handheld devices for applications using dynamic multimedia data. *ACM in Proceedings of the 2nd international conference on Computer graphics and interactive techniques in Australasia and South East Asia*, 123 – 130.

Rangone, A., & Renga, F.M. (2006). B2e mobile internet: an exploratory study of Italian applications. *Business Process Management Journal*, *12*(3), 330-343.

Rob, M.A. (2006). Dilemma between the Structured and Object-Oriented Approaches to Systems Analysis and Design. *Journal of Computer Information Systems*, *46*(3), 32-42.

Schaar, M.V., & Chou, P.A. (2005). *Multimedia over IP and Wireless Networks.* Burlington: Academic Press.

Shneiderman, B. (2002). Promoting universal usability with multi-layer interface design. *ACM in Proceedings of the 2003 conference on Universal usability*, 1-8.

Sutcliff, A. G. (1995). *Human Computer Interface Design.* London: Macmilan Press.

Tsalgatidou, A., Veijalainen, J., Markkula, J., Katasonov, A., Valcourt, E., Robert, J.M., & Beaulieu, F. (2005). Investigating mobile payment: supporting technologies, methods, and use. *IEEE in Proceedings of IEEE International Conference on Wireless And Mobile Computing, Networking And Communications 2005,* 29- 36.

Turban, E., King, D., Lee, J., & Viehland, D. (2004). *Electronics Commerce: A Managerial Perspective.* New Jersey: Prentice Hall.

Varshney, U. (2005). Vehicular Mobile Commerce: Applications, Challenges, and Research Problems. *Communications of the Association for Information Systems, 16,* 329-339.

Wan Ismael, W. (2004). Still Pictures and Audio: Second Class Multimedia Elements?. *Malaysian Online Journal of Instructional Technology, 1*(1), 20-29.

Wright, T., Yoong, P., Noble, J., Cliffe, R., Hoda, R., Gordon, D., & Andreae, C. (2005). Usability methods and mobile devices: an evaluation of MoFax. *ACM in Proceedings of the 4th international conference on Mobile and ubiquitous multimedia*, 26 – 33.