UNIVERSITI PUTRA MALAYSIA

IT-INTEGRATED DESIGN COLLABORATION ENGAGEMENT MODEL IN SUPPORT OF MALAYSIAN BUILDING DESIGN PROFESSIONALS

NAEIMEH DELAVARI

FRSB 2011 11
IT-INTEGRATED DESIGN COLLABORATION ENGAGEMENT MODEL
IN SUPPORT OF MALAYSIAN BUILDING DESIGN PROFESSIONALS

By

NAEIMEH DELAVARI

Thesis is Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

December 2011
DEDICATIONS

“This Doctor of Philosophy degree dissertation is the ultimate result of a twenty-two year study and it is my honour to dedicate it to my husband, my sister and my parents

MOHAMMAD REZA DELAVARI & SHAHLA ALIZADEGANI

Whom without their support, I wouldn’t be standing here”

NAEIMEH DELAVARI

2011

Abstract of thesis presented to the Senate of University Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy
Design collaboration is an activity that requires the participation of various individuals to accomplish an agreed design task or goal. Globalization is what has changed the character of this field, integrating geographically dispersed participants through the Internet or an intranet server. Professional design team members can now communicate via collaborative tools and utilize technologies beyond physical boundaries and time. However, many design team members fail to utilize these technological developments. This predicament is exacerbated by various issues, such as the misunderstanding that tends to occur when professionals switch from face-to-face to technological communication and limited professional education programs on the subject.

The purpose of this research was to find a way to engage Malaysian professional architects in IT-integrated collaborations and to improve their interaction with
computing systems using the concept of Human Computer Interaction (HCI). It intended to understand how human factors (physical, cognitive, intrinsically or extrinsically motivated) can be used to facilitate and improve the interaction in professional building design and collaborative technologies to achieve a sustainable IT-integrated design collaboration process.

This study used Grounded Theory research methodology to develop an IT-engagement model to increase architects’ motivation to collaborate using collaborative technologies. Firstly, this study identified current collaborative technologies and how design team members use them. They include Virtual Prototyping (VP) for producing realistic graphical simulations, collaborative Computer-Aided Design (CAD) and Computer Supported Collaborative Work (CSCW) tools such as video conferencing, and shared document management which facilitates the flow of data. In addition, using the existing parameters of engagement from theories of technology adoption and studies of IT-integrated design collaboration, this study determined feedback, control and functionality as the criteria for developing a model of engagement for design team members using IT-supported technology.

At the conclusion of this study, feedback was defined as the knowledge that is allocated to the appropriate design team members and the knowledge that is retrieved from other design team members for improving purpose. Meanwhile, control was defined as the control effect of behaviour on a user. Similarly, functionality was defined as the degree of user performance with the computing system and the degree of technological flexibility afforded to the user. Finally, the study identified that in
Malaysian building projects, collaborations tend to occur in face-to-face meetings, where Architecture-Engineering-Construction (AEC) design team members communicate by exchanging paper documents, technical drawings and so on. This highlighted a working-culture deficiency with regards to IT-supported technologies in the design collaboration process.

Thus, this study contributes towards the development of an IT-integrated design collaboration (IT-DC) engagement model for Malaysian building design collaborations. It is expected to improve the acceptance of IT-integrated design project collaborations, increase the degree of engagement in collaborative team work projects and support future research to mitigate knowledge losses in complex project lifecycles. This in turn will encourage and facilitate more participation from Malaysian building stakeholders in global projects, thus fulfilling the country’s desire to increase exports in the services industry.
MODEL KEASYIKAN REKABENTUK KOLABORASI INTEGRASI-IT DALAM MENYOKONG PROFESIONAL REKABENTUK BANGUNAN MALAYSIA

Oleh

NAEIMEH DELAVARI
Disember 2011

Pengerusi: Profesor Rahinah Ibrahim, PhD.

Fakulti: Rekabentuk dan Senibina

Kolaborasi rekabentuk adalah satu aktiviti yang memerlukan penglibatan beberapa individu bagi menyempurnakan sesuatu tugas atau matlamat yang dipersetujui secara bersama. Globalisasi telah menyebabkan berubahnya rupa bentuk bidang ini dengan mengintegrasikan penglibatan peserta yang dipisah melalui geografi melalui Internet atau server intranet. Ahli kumpulan rekabentuk profesional boleh sekarang ini berkomunikasi melalui peralatan kolaborasi dengan penggunaan teknologi melampaui masa dan sempadan. Walau bagaimana pun ramai ahli kumpulan rekabentuk yang telah gagal menggunakan pembangunan teknologi ini. Kesulitan ini diburukkan lagi dengan beberapa isu, seperti, kesalahfahaman yang sering berlaku apabila profesional bertukar kaedah dari bersemuka kepada berkomunikasi secara teknologi terutama bagi mereka yang kurang pengetahuan tentang program profesional sesuatu bidang.
Tujuan penyelidikan ini adalah untuk mengetahui cara bagaimana melibatkan Artitek Professional Malaysia dalam proses merakabentuk secara kolaborasi yang mengasyikkan melalui integrasi IT dan memperbaiki cara berinteraksi dengan sistem komputer dengan menggunakan konsep Interaksi Manusia dengan Komputer. Kajian ini bertujuan untuk memahami faktor manusia (fisikal, kognitif, motivasi secara intrinsik atau ekstrinsik) yang akan digunakan bagi memudahkan dan membaiki interaksi antara pembina profesional dan teknologi kolaborasi bagi mencapai proses rekabentuk kolaborasi secara integrasi IT.

Kajian ini menggunakan kaedah penyelidikan “Grounded Theory” dalam membentuk satu model IT yang mengasyikkan dalam meningkatkan motivasi artitekprofesional supaya bekerja secara kolaborasi dengan menggunakan teknologi kolaborasi. Pertama, penyelidikan ini telah mengenalpasti teknologi kolaborasi semasa dan bagaimana ia boleh digunakan oleh ahli kumpulan rekabentuk. Ini melibatkan Protototaip Secara Maya (Virtual Prototyping (VP) bagi menghasilkan simulasi grafik secara realistik, program CAD (Computer-Aided Design) dan peralatan CSCW (Computer Supported Collaborative Work) seperti sidang video, dan pengurusan pengkongsian dokumen yang boleh memudahkan pengaliran data. Selain daripada itu kajian ini, dengan menggunakan parameter yang sedia ada mengenai keasyikan daripada teori-teori teknologi yang dipilih dan kajian-kajian rekabentuk kolaborasi secara integrasi IT, telah menentukan bahawa tindakbalas, kawalan, dan fungsi adalah kriteria membina model keasyikan untuk ahli kumpulan rekabentuk yang menggunakan teknologi yang menyokong IT (IT-supported technology.)

Dengan itu kajian ini dapat menyumbang ke arah pembangunan Model Keasyikan Rekabentuk Kolaborasi Secara Integrasi IT (IT-integrated design collaboration (IT-DC) Engagement Model). Model ini akan dapat membaiki penerimaan Projek Rekabentuk Kolaborasi Secara Integrasi IT, meningkatkan darjah keasyikan dalam projek kolaborasi berpasukan, dan menyokong kajian akan datang mengenai mitigasi ilmu yang hilang dalam kitaran projek yang kompleks. Secara langsung dan tidak langsung kajian ini akan dapat menggalakkan dan memudahkan lebih banyak penyertaan dari golongan pembina Malaysia yang berkepentingan dalam projek-projek global, dalam mencapai inspirasi negara untuk menambah eksport dalam industri perkhidmatan.
ACKNOWLEDGEMENTS

I would like to express my utmost gratitude to my research supervisor, PROFESSOR. DR. RAHINAH IBRAHIM, and the respectable supervisory committee members, DR. NORMAHDIAH SHEIKH SAID and DR. MUHAMAD TAUFIK ABDULLAH for getting me started on the fundamental basis of my research study and their great support and guidance throughout this thesis. Without their patient and constant guidance, this thesis could not have been prepared.

A great deal of my appreciation also goes to those in my faculty, Faculty of Design and Architecture, department of Integrated Design Studies. I also would like to thank the Dean of Faculty, PROFESSOR. DR. RAHINAH IBRAHIM for her moral support and the insights that she has shared.

I am privileged to have had the steadfast support of my parents. They have given me the very best prospects from the beginning of my research and provided me with support and encouragement from the start and throughout my academic journey.

I would also like to express my sincerest thanks to my beloved husband for giving me support, inspiration and patience. My utmost gratitude to my sister whose sincerity and encouragement I will never forget. These two individuals were my constant inspiration during the trials and tribulations of this research.
APPROVAL

I certify that a Thesis Examination Committee has met on 20/12/2011 date of viva to conduct the final examination of Naeimeh Delavari on her thesis entitled "IT-integrated Design Collaboration Engagement Model in Support of Malaysian Building Design Professionals" in accordance with the Universities and Universities Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The committee recommends that the student be awarded the degree of Doctor of Philosophy (Integrated Design Studies).

Members of the Examination Committee were as follows:

Chairman, PhD
Professor Madya Dr. Ar. Azizah Salim binti Syed Salim
Faculty of Design and Architecture
Universiti Putra Malaysia
(Chairman)

Examiner 1, PhD
Professor Y.Bhg. Dr. Mustafa Kamal bin Mohd Shariff
Faculty of Design and Architecture
Universiti Putra Malaysia
(Internal Examiner)

Examiner 2, PhD
Dr. Nor Atiah binti Ismail
Faculty of Design and Architecture
Universiti Putra Malaysia
(Internal Examiner)

External Examiner, PhD
Professor Dr. Renate Fruchter
Department of Civil Engineering
Stanford University
United States
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:
This thesis was submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

**Rahinah Ibrahim, PhD**  
Professor  
Faculty of Design and Architecture  
Universiti Putra Malaysia  
(Chairman)

**Normahdiah Sheikh Said, PhD**  
Senior Lecturer  
Faculty of Modern Languages and Communication  
Universiti Putra Malaysia  
(Member)

**Muhamad Taufik Abdullah, PhD**  
Senior Lecturer  
Faculty of Computer Science and Information Technology  
Universiti Putra Malaysia  
(Member)

______________________________  
BUJANG BIN KIM HuAT  
Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date:
DECLARATION

I declare that the thesis is based on my original work except for quotations and citations, which have been dully acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at University Putra Malaysia or at any other institution.

_______________________
NAEIMEH DELAVARI

Date:
TABLE OF CONTENTS

ABSTRACT iii
ABSTRAK vi
ACKNOWLEDGEMENTS ix
APPROVAL x
DECLARATION xii
LIST OF TABLES xvii
LIST OF FIGURES xix
LIST OF ABBREVIATIONS xxii

CHAPTER

1 INTRODUCTION 1
  1.1. Introduction 1
  1.2. Problem Statement 1
  1.3. Background Literature 6
  1.4. Research Question 6
  1.5. Research Objectives 7
  1.6. Research Methodology 9
    1.6.1. Eagle Research Design Framework Overview 9
    1.6.2. Research Framework of Study 11
  1.7. Organization of Thesis 14

2 LITERATURE REVIEW 16
  2.1. Introduction 16
  2.2. Motivation of Study 17
    2.2.1. Globalization Definition 18
    2.2.2. Globalization and IT/ICT 18
    2.2.3. Globalization Effect in Organizational Structure: Global Virtual Team 20
    2.2.4. Globalization’s Effects on the Building Design Process 21
  2.3. Introduction to Design Collaboration Process 24
    2.3.1. IT-integrated Design Collaboration Process 26
    2.3.2. IT/ICT Adaptation by Construction Industries 28
    2.3.3. Collaborative Technology Practices in IT-integrated Design Collaboration 31
  2.4. Design Communication 33
    2.4.1. Solution to Communication Problems in Design Collaboration 34
    2.4.2. Analysis of Previous Studies in Solving Communication Problems in Design Collaboration 36
  2.5. Theoretical Formation 39
    2.5.1. Design Collaboration Trends 39
      2.5.1.1. Introduction 39
2.5.1.2. Related Design Collaboration Studies 40
2.5.1.3. Conclusion to Design Collaboration Studies 45
2.5.2. HCI Application Domains 46
   2.5.2.1. Introduction 46
   2.5.2.2. HCI Frameworks 47
   2.5.2.3. Analysis of Current HCI Frameworks 52
   2.5.2.4. Human Dimension in HCI 52
   2.5.2.5. Existing HCI Application Area 54
   2.5.2.6. HCI Applications in the Design Process 56
   2.5.2.7. Conclusion to HCI Studies 59
2.5.3. Engagement 60
   2.5.3.1. Introduction 61
   2.5.3.2. The Different Categories of Engagement 63
   2.5.3.3. Related Components of Engagement 64
   2.5.3.4. Relevant Theories of Engagement 66
   2.5.3.5. Application of Engagement Theory 67
   2.5.3.6. Engagement Theory in Architecture/Engineering/Construction (AEC) 72
   2.5.3.7. Alternative Models of Engagement 73
   2.5.3.8. Conclusion to Engagement Studies 77
2.5.4. Point of Departure (POD) 77
2.5.5. Theoretical Framework 81
2.6. Towards the Development of a Theoretical Proposition of an Engagement Model 83
   2.6.1. Parameters of Engagement 83
      2.6.1.1. Engagement Parameters in Design Collaboration 84
      2.6.1.2. Theories of Technology Adaptation 86
      2.6.1.3. Technology Acceptance Model (TAM) 87
      2.6.1.4. Theory of Planned Behaviour (TPB) 88
      2.6.1.5. Unified Theory of Acceptance and Use of Technology (UTAUT) 88
   2.6.2. Theoretical Proposition 90
   2.6.3. Development of Operationalized Variables Based on Parameters of Engagement 92
2.7. Summary 98

3. **RESEARCH METHODOLOGY** 100
   3.1. Introduction 101
   3.2. Research Implementation 101
   3.3. Grounded Theory Methodology (GTM) 102
      3.3.1. Key Stages in Grounded Theory Development 103
      3.3.2. Elements of Grounded Theory 105
      3.3.3. Selection of Grounded Theory 106
      3.3.4. Processes of Building Grounded Theory 108
   3.4. Research Design 110
      3.4.1. Introduction 110

xiv
4.3.2.4. Matching Independent Variables With Identified Supporting Statements 178
4.3.2.5. Matching Operationalized Variables with the Identified Supporting Concepts 182
4.3.2.6. Synthesis of Supporting Statements From Professional Design Team Members 187
4.3.3. Results of Substantive Selective Coding 189
  4.3.3.1. Developing Coding Paradigm for Developed Categories 190
  4.3.3.2. Developing the IT-integrated Design Collaboration (IT-DC) Engagement Model 192
  4.3.3.3. Description of IT-DC Engagement Model based on Taxonomic Analysis 193

4.4. Summary 197

5. VALIDATION OF RESULTS 198
  5.1. Introduction 198
  5.2. Implementation of Supplemental Validation by Enfolding Literature 198
  5.3. Validation of the IT-DC Engagement Model 210
    5.3.1. Assessing Generated Theory 210
    5.3.2. Adequacy of Research Process 213
    5.3.3. Grounding the Finding 214
  5.4. Determination of Quality Criteria Factors 215
  5.5. Summary 218

6. CONCLUSION 220
  6.1. Introduction 220
  6.2. Answers to Research Questions (RQs) 221
  6.3. Knowledge Contribution 228
  6.4. Benefits of Study 232
  6.5. Future Studies 234

REFERENCES 236
APPENDIXES 253
  Appendix A: Interview 254
  Appendix B: Process of Coding and Analysis 285
  Appendix C: Qualitative Software Research (QSR): NVIVO 9.1 331

BIODATA OF STUDENT 341
LIST OF PUBLICATIONS 342

xvi