e-Business in Construction

This page intentionally left blank

e-Business in Construction

Edited by

Chimay J. Anumba and Kirti Ruikar

Foreword by

Professor Ronald McCaffer

WILEY-BLACKWELL

A John Wiley & Sons, Ltd., Publication

This edition first published 2008
© 2008 Blackwell Publishing Ltd

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing programme has been merged with Wiley's global Scientific, Technical, and Medical business to form Wiley-Blackwell.

Registered office
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

Editorial offices
9600 Garsington Road, Oxford, OX4 2DQ, United Kingdom
2121 State Avenue, Ames, Iowa 50014-8300, USA

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell.

The right of the author to be identified as the author of this work has been asserted in accordance with the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, except as permitted by the UK Copyright, Designs and Patents Act 1988, without the prior permission of the publisher.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The publisher is not associated with any product or vendor mentioned in this book. This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

Library of Congress Cataloging-in-Publication Data
e-Business in construction/edited by Chimay J. Anumba and Kirti Ruikar.
p. cm.
Includes bibliographical references and index.
ISBN-13: 978-1-4051-8234-8 (hardback : alk.paper)
ISBN-10: 1-4051-8234-2 (hardback : alk.paper) 1. Construction industry.
2. Electronic commerce. I. Anumba, C.J. (Chimay J.) II. Ruikar, Kirti.

HD9715.A2E28 2008
381′.142—dc22 2008006976

A catalogue record for this book is available from the British Library.

Set in 9.5/12.5 pt Palatino by Charon Tec Ltd (A Macmillan Company), Chennai, India
(www.charontec.com)
Printed in Singapore by Utopia Press Pte Ltd

1 2008

Contents

Contributors xi
Foreword xvii
Acknowledgements xix
Abbreviations xxi

1 Introduction **1**
Chimay J. Anumba and Kirti Ruikar
1.1 Context 1
1.2 Structure of the book 2
References 4

2 Fundamentals of e-Business **6**
Kirti Ruikar and Chimay J. Anumba
2.1 Introduction 6
2.2 e-Business and e-commerce definitions 6
2.3 Taxonomy for e-business 7
2.4 The four faces of e-business 10
2.5 e-Business models 11
2.6 e-Business in construction 14
2.7 Summary and conclusions 20
References 21

3 e-Business: The Construction Context **23**
Kirti Ruikar, Chimay J. Anumba and Patricia Carrillo
3.1 Introduction 23
3.2 e-Business and the construction business processes 25
3.3 e-Business applications and end-user construction companies 32
3.4 Summary 40
References 40

4 Organizational Readiness for e-Business **42**
Kirti Ruikar, Chimay J. Anumba and Patricia Carrillo
4.1 Introduction 42
4.2 Methodology for e-readiness 44
4.3 Review of readiness assessment models 45
4.4 Verify end-user e-readiness using a diagnostic tool 47
4.5 Verdict: System architecture and operation 53
4.6 End-user case study 56

4.7 Conclusions and future work 60
Acknowledgements 61
Notes 61
References 61

5 Integrated Multi-Disciplinary e-Business Infrastructure Framework 65
Ihab A. Ismail and Vineet R. Kamat
5.1 Introduction 65
5.2 Integrated construction e-business infrastructure framework 66
5.3 The importance of e-construction infrastructure 67
5.4 Summary and status of e-construction challenges 69
5.5 Conclusions 77
Note 77
References 78

6 The Role of Extranets in Construction e-Business 81
Paul Wilkinson
6.1 Introduction 81
6.2 Defining construction collaboration technologies 81
6.3 Uptake of construction collaboration technologies 83
6.4 Benefits of construction collaboration technologies 86
6.5 Human aspects of collaboration 91
6.6 Moving beyond collaboration 99
6.7 Conclusions 101
References 102

7 Agent-Based Systems: The Competitive Advantage for AEC-Specific e-Business 104
Esther A. Obonyo and Chimay J. Anumba
7.1 Introduction 104
7.2 The current context 104
7.3 Understanding agent-based systems 106
7.4 A roadmap of agent-based systems in e-business 107
7.5 APRON: An agent-based prototype system for AEC-specific e-business 109
7.6 APRON's conceptual design 114
7.7 The implemented APRON architecture 116
7.8 Discussion and conclusions 117
References 120

8 The Role of e-Hubs in e-Commerce 123
Zhaomin Ren, Chimay J. Anumba and Tarek M. Hassan
8.1 Introduction 123
8.2 e-Hub concept 124

8.3 e-Hubs' services 125
8.4 Engineering e-Hub 132
8.5 Engineering services 140
8.6 Problems and challenges 144
8.7 Conclusions 145
Acknowledgements 147
References 147

9 Web Services and aecXML-Based e-Business System for Construction Products Procurement 149
Stephen C.W. Kong, Heng Li and Chimay J. Anumba
9.1 Introduction 149
9.2 The need for e-procurement of construction products 149
9.3 Existing e-business systems for construction products procurement 151
9.4 Limitations of existing e-business systems 153
9.5 The E-Union concept 154
9.6 Standardization of construction products information 155
9.7 The Web Services model of interoperable construction products catalogues 157
9.8 The E-Union Web Services prototypical implementation 160
9.9 Conclusions 164
References 164

10 Using Next Generation Web Technologies in Construction e-Business 167
Darshan Ruikar, Chimay J. Anumba and Alistair Duke
10.1 Introduction 167
10.2 The construction context 168
10.3 The need for the Semantic Web 169
10.4 The Semantic Web 172
10.5 Evolution of the Semantic Web in the construction sector 178
10.6 Semantic Web-based construction e-business 181
10.7 Summary 191
References 192

11 Trust in e-Commerce 195
Zhaomin Ren and Tarek M. Hassan
11.1 Introduction 195
11.2 Trust and trust building 196
11.3 Trust building in e-commerce 199
11.4 Conclusions 208
References 209

12 Legal Issues in Construction e-Business **211**
Ihab A. Ismail and Vineet R. Kamat
12.1 Introduction 211
12.2 Types of legal risks in construction e-business 212
12.3 Contract formation, validity and errors 212
12.4 Jurisdiction 213
12.5 Privacy 214
12.6 Authentication, attribution and non-repudiation 215
12.7 Agency 216
12.8 Conclusions 218
References 219

13 Knowledge Management for Improved Construction e-Business Performance **222**
Charles O. Egbu
13.1 Introduction 222
13.2 Knowledge management in context 223
13.3 Exploiting opportunities in the fast-changing environment of e-business: A knowledge management perspective? 224
13.4 Organizational challenges in using the internet to commercialize knowledge assets 226
13.5 Knowledge assets employed by construction organizations in e-business initiatives 229
13.6 Organizational readiness to launch a knowledge-business (k-business) 230
13.7 Conclusions and recommendations 233
References 233

14 e-Commerce in Construction: Industrial Case Study **235**
Tim C. Cole
14.1 Introduction 235
14.2 Background 235
14.3 A historic perspective 236
14.4 e-Commerce implementation: Practical issues and benefits 239
14.5 The first adopters 241
14.6 Implementation issues: Case study examples 242
14.7 Specific case study examples 245
14.8 Summary 247
References 247

15 Assessment of e-Business Implementation in the US Construction Industry **248**
Raymond R.A. Issa, Ian Flood and Bryce Treffinger
15.1 Introduction 248

15.2 US construction industry 249
15.3 e-Business assessment survey findings 254
15.4 Conclusions 264
References 264

16 Concluding Notes **266**
Chimay J. Anumba and Kirti Ruikar
16.1 Introduction 266
16.2 Summary 266
16.3 Benefits of e-business in construction 267
16.4 Considerations in construction e-business implementation 268
16.5 Future directions 270

Index 273

This page intentionally left blank

Contributors

Chimay J. Anumba is Professor and Head, Department of Architectural Engineering, The Pennsylvania State University. He holds a PhD from the University of Leeds, and a higher doctorate (DSc) from Loughborough University. He is a Chartered/Professional Engineer with many years of industrial experience. Until recently, he was founding Director of the Centre for Innovative and Collaborative Engineering (CICE) and Professor of Construction Engineering and Informatics at Loughborough University. Professor Anumba's work has received support worth over £15 million and he has supervised over 31 doctoral candidates. He has over 400 publications and was recently awarded an Honorary Doctorate by Delft University of Technology. His Visiting Professorships exceed 10, including MIT and Stanford.

Patricia Carrillo holds a personal chair in Strategic Management in Construction in the Department of Civil and Building Engineering at Loughborough University. Professor Carrillo is also Programme Director for the department's MSc programmes in Construction Management and Construction Project Management. She has worked as a civil engineer with a range of clients, consultants and contractors. In 2002, she was awarded the prestigious Royal Academy of Engineering Global Award. This allowed her to have research secondments at the University of Calgary, Canada and University of Colorado, USA. Her area of expertise is in business performance and IT in construction.

Tim C. Cole is a Director at Causeway Technologies. He has been described as 'the construction industry's e-Envoy' by *Construction News* and *Construction Manager*. He has worked over 12 years to bring the benefits of e-business into mainstream construction. He has been involved in national and international e-business initiatives, including development of construction, banking and government data exchange standards. He is the author of '*Electronic Communication in Construction – Achieving Commercial Advantage*', a book published in 2000, aimed at making e-business accessible to business professionals. He is also actively involved with the Network of Construction Collaboration Technology Providers (NCCTP) and is a founder member of the Hub Alliance.

Alistair Duke is a Principal Researcher within the Next Generation Web Research Group of British Telecommunications plc. He holds a

MEng from Aston University and a PhD in Collaboration Systems for Concurrent Engineering from Loughborough University. His primary interest is in Semantic Web and its application to the fields of Knowledge Management, Service Oriented Architecture and Business Systems. He was a member of the EU OnToKnowledge and Semantic Web-enabled Web Services (SWWS) projects and a work package leader on the EU DIP (focusing on applying Semantic Web Services to the Telecommunications industry) and SEKT project (where he led the Knowledge Access work package, developing end-user tools supported by Semantic technology).

Charles O. Egbu holds a personal Chair in Project Management and Strategic Management in Construction at the University of Salford, UK. Professor Egbu lectures at undergraduate and postgraduate levels in the areas of Construction Management, Project and Programme Management. With over 200 publications, his research interests are in innovation, knowledge management, e-business and construction project management.

Ian Flood received his PhD from the University of Manchester in 1986, developing parallel approaches to construction process simulation. He has held academic positions in Building and Civil Engineering at the National University of Singapore and the University of Maryland, and is currently at the Rinker School, University of Florida. His research has focused on the application of artificial intelligence methods of modelling to project planning and the simulation of the behaviour of engineered systems. Dr Flood has edited four books, has published over 100 refereed articles, and is highly cited, being the most frequently referenced author within the ASCE *Journal of Computing in Civil Engineering*.

Tarek M. Hassan is a Senior Lecturer and Director of the European Union Research Group in the Department of Civil and Building Engineering at Loughborough University. Dr Hassan's academic experience is complemented by 10 years of industrial experience with several international organizations. He has been leader and partner in 10 EU projects funded by the European Commission under the Information Society Technologies (IST) programme. He is also an appointed expert evaluator for research proposals submitted to the European Commission and appointed expert reviewer for ongoing EU research projects. He has over 95 publications and his areas of research include advanced ICTs, collaborative engineering, virtual enterprise business relationships, e-business, e-commerce and legal aspects of ICT.

Ihab A. Ismail is the Founder and Managing Director of Enovio, an international management consulting firm operating in several industries. After founding and developing Enovio, he focused his consulting practice on the capability development of firms with special interest in

developing risk management capabilities within construction. He is currently a PhD student at the Construction Engineering and Management Department at the University of Michigan, USA. His research interests are in the areas of e-business and legal risk management in the construction industry. He holds a BSc in Civil Engineering from the American University in Cairo, and an MSc in Construction Management from the University of Michigan.

Raymond R.A. Issa is currently Rinker Professor and Director of Graduate and Distance Education programmes at the Rinker School, University of Florida. He received his PhD from Mississippi State University in 1982 and his JD in Law from the University of Memphis in 1985. He has held academic positions at various universities in the United States and his research has focused on the use of information technologies in construction and the legal aspects of construction management. Professor Issa has edited two books and five proceedings, has published over 120 refereed articles and he has chaired over 200 Masters and PhD Committees.

Vineet R. Kamat is an Assistant Professor in the Department of Civil and Environmental Engineering at University of Michigan. He holds a PhD and an MS in Civil Engineering from Virginia Tech, USA and a BE degree in Civil Engineering from Goa University, India. Dr Kamat's primary research interests are in advanced applications of computing for engineering and construction.

Stephen C.W. Kong is a researcher at Hong Kong Polytechnic University. His research interest is in the application of information technology in construction organizations. He has developed an e-business system for construction material trading that has been adopted in Hong Kong and China. Currently, he is working on adopting virtual prototyping technology in construction to improve construction planning through providing consultancy services to contractors. He also utilizes virtual prototyping technology to enhance student learning in construction technology.

Heng Li started his academic career in Tongji University in 1987. He then researched and lectured at the University of Sydney, James Cook University and Monash University before joining Hong Kong Polytechnic University. During this period, he worked with engineering design and construction firms and provided consultancy services to both private and government organizations in Australia, Hong Kong and China. He has led many funded research projects related to the innovative application and transfer of construction information technologies, and has published two books, in excess of 190 journal papers and presentations at numerous national and international conferences.

Esther A. Obonyo is an Assistant Professor at the University of Florida's Rinker School of Building Construction. She offers courses in construction engineering and productivity improvement. Her other research interests include continuous business improvement and the effective use of Information Technology to promote knowledge sharing. Dr Obonyo is a member of the Powell Centre for Construction and Environment and also sits in the College's Sustainability Committee. Previously, she worked as a business improvement analyst within the Balfour Beatty Group in the United Kingdom and a construction project manager in Nairobi, Kenya.

Zhaomin Ren is a Senior Lecturer at the School of Technology of Glamorgan University. Dr Ren's academic experience is complemented by 16 years of industrial experience as a design engineer, chief engineer, and project manager with several international organizations. He has been a key researcher on several national and international research projects in areas of construction management, project management and e-engineering including project procurement, contract management, project planning and control, collaborative engineering, risk management, value management, advanced ICT, virtual enterprise business relationships, and legal and trust aspects of ICT. He has over 32 publications and is also a senior consultant for China-Geo Engineering Corp. in Hong Kong and Sri Lanka.

Darshan Ruikar is a Senior Consultant at Ove Arup and Partners, an internationally renowned design and business consulting firm. He works within the Arup Major Projects group providing strategic advice on ICT implementation for Infrastructure and Building projects. He has also worked as a structural engineer both nationally and internationally. His industry experience is complemented by years of academic experience. He holds a PhD in Civil Engineering from University of Nottingham, an MSc in Structural Engineering from UMIST (Manchester) and a BE in Civil Engineering from Pune University in India. Dr Ruikar's area of expertise is in improving business performance through the use of advanced ICTs in the architectural, engineering and construction sector.

Kirti Ruikar is a Lecturer in Architectural Engineering in the Department of Civil and Building Engineering at Loughborough University. Dr Ruikar is an architect with experience of working on several building projects. Her industry experience is complemented by several years of academic experience. She holds a Bachelor of Architecture degree from University of Pune in India, following which she completed an MSc in Construction Innovation and Management and an EngD (Doctor of Engineering) from Loughborough University. Her primary research interests are in the strategic use of emerging technologies such as e-business, advanced ICTs and KM in construction. She is also Associate Editor of *Journal of Information Technology in Construction*.

Bryce Treffinger holds a Bachelor of Design degree from University of Florida, 2003 and a Master of Science in Building Construction from University of Florida, 2005. She is currently working for a large construction company in Jacksonville, Florida.

Paul Wilkinson is head of corporate communications at BIW Technologies Ltd, a leading provider of Software-as-a-Service applications to the architecture, engineering and construction sector. His construction experience dates back to 1987 and includes seven years with a firm of consulting engineers, four years with a major contractor, and two years running his own consultancy business. He is the author of '*Construction Collaboration Technologies: The Extranet Evolution*', published in 2005. He is also actively involved with the Network of Construction Collaboration Technology Providers (NCCTP) and Constructing Excellence.

This page intentionally left blank

Foreword

The construction industry is frequently described as fragmented by its critics; however, disseminated would be a better description. For each construction project a whole new organization is created involving the client, designers, contractors, sub-contractors, material suppliers, plant hire companies, government, local authorities and agencies such as the environmental agency, Health and Safety Executive and many others. Each 'new' and 'transient' project organization is, in fact, a virtual organization or enterprise. The communications between the parties both contractual and non-contractual are of a scale nearing unmanageable proportions. Many of the inefficiencies identified in the reports of Latham and Egan were rooted in the communications processes.

The developments in information and communication technologies are changing the way that many industry sectors conduct their business operations and offer the solution to the construction industry's communications in the project delivery process. Not only is there now a growing dependence on electronic communications by construction sector, some companies and researchers in the sector are actually leading the way in the development of e-business for the benefit of our industry as well as other sectors. However, many companies and organizations still have difficulties in maximizing the opportunities offered by conducting business electronically.

e-Business has much to offer the construction sector, as it directly addresses the issues that a disseminated industry has to deal with – distributed collaboration, electronic sourcing and purchasing of products and services that meet well-defined requirements, globalization, need for improved efficiency and timely delivery (amongst others).

This book is a clear guide to e-business in the construction industry and will raise the awareness and knowledge of the industry. The authors cover a wide range of issues – basic definitions and fundamental concepts, the construction industry context for e-business, the role of emerging information and communication technologies, socio-technical and legal aspects of e-business implementation, and industry perspectives from both Europe and North America. Practical examples from construction and other industry sectors are used throughout to illustrate the various aspects of e-business. The challenges in implementing e-business are clearly articulated and the ensuing benefits highlighted.

It is widely accepted that e-business is the way to conduct construction business in the 21st century. It is the means available to companies to

continuously improve efficiency and effectiveness in serving their clients' needs and in delivering a return to their shareholders. The development of e-business is upon us, now affecting the short and medium term but it is also the way business will develop over the long term.

This book provides practical guidance on how this can be done and I strongly recommend it to all participants in the construction process. It is based on sound research, scholarship and practical experience, and I consider it is essential reading for both construction researchers and industry practitioners.

Professor Ronald McCaffer, FREng
December 2007

Acknowledgements

We would like to thank the various colleagues, contemporaries and friends who have contributed towards our understanding and knowledge of the role of e-business in the construction sector. This book is a combined effort of several authors who have spent a considerable amount of time and effort in sharing their experiences and knowledge. We are immensely grateful for their contributions. Jo Brewin and Sara Cowin provided administrative assistance. We would also like to acknowledge the contribution of the various agencies and organizations that funded the research projects and initiatives on which this book is based. We owe special thanks to our families, for their continued love, support and encouragement that made this book both possible and worthwhile. Last but not the least, we must thank our young ones for the much needed distractions from work.

Professor Chimay J. Anumba
Dr Kirti Ruikar

This page intentionally left blank

Abbreviations

A2A	Administration-to-Administration
A2B	Administration-to-Business
A2C	Administration-to-Consumer
AEC	Architecture, Engineering and Construction
B2A	Business-to-Administration
B2B	Business-to-Business
B2C	Business-to-Consumer
BCP	Basic Collaboration Platform
C2A	Consumer-to-Administration
C2B	Consumer-to-Business
C2C	Consumer-to-Consumer
CAD	Computer Aided Design
CITE	Construction Industry Trading Electronically
CRM	Customer Relationship Management
DRM	Digital Rights Management
DSL	Digital Subscriber Lines
EAI	Enterprise Applications Integration
e-HUBs project	e-Engineering Enabled by Holonomic and Universal Broker Services
ENR	Engineering News Record
ESPs	Engineering Service Providers
EU	European Union
GUI	Graphical User Interface
ISP	Internet Service Provider
IT	Information Technology
OCS	Online Contracting System
OECD	Organisation for Economic Cooperation and Development
PKI	Public Key Infrastructure
PMIs	Privilege Management Infrastructures
PP	Project Planning
PPM	Project Planning Model
ROI	Return on Investment
SCM	Supply Chain Management
SMEs	Small and Medium-Sized Enterprises
SOAP	Simple Object Access Protocol
UDDI	Universal Description, Discovery, Integration
UETA	Uniform Electronic Transaction Act

UN/EDIFACT	Electronic Data Interchange for Administration Commerce and Transport
UPS	Uninterrupted Power Supply
VAT	Value-Added Tax
VHS	Video Home System
WF	Workflow
WfMS	Workflow Management System
WSDL	Web Service Description Language
WSIL	Web Service Inspection Language
XML	eXtensible Markup Language

1 Introduction

Chimay J. Anumba and Kirti Ruikar

1.1 Context

The rapid expansion of the Internet has transformed the way in which people and businesses communicate and interact. It has revolutionized the way in which information is stored, exchanged, viewed, and manipulated. This has opened up new opportunities for businesses, which were almost inconceivable before, as it is now possible to conduct business transactions on a global basis, within a relatively short span of time, and at a fraction of the amount it would have cost previously (using conventional methods).

Businesses have recognized the possibilities the Internet has to offer and hence the need to adopt new business processes. This has had some immediate consequences but there is a need for businesses to assess and rethink their existing processes and working methods in order to make the most of the available opportunities. In some cases, this will only require small, incremental changes; while in others, a radical transformation from staid, traditional methods is required to benefit from the new technologies. Such changes can prompt businesses to improve their traditional business processes, innovate their products and services, and develop strategies that are flexible enough to incorporate new technologies as they emerge. The increase in electronic ways of conducting business has had a major impact on virtually every business sector. The construction industry is no exception.

The construction industry is an ideal sector for the adoption of e-business, given the number of disparate organizations involved in the project delivery process. Each construction project has a supply chain that includes architects, engineers, project managers, contractors, quantity surveyors, sub-contractors, materials suppliers, and self-employed professionals or artisans. Increasingly, these supply chain members are geographically distributed and rely on electronic communications for business transactions and collaboration. This makes the use of e-business tools inevitable.

In the light of the above, the use of e-business tools in construction has been on the increase (Berning and Diveley-Coyne, 2000). The benefits of using these tools on construction projects have been documented in

several publications (Anumba and Ruikar, 2002; Berning and Flanagan, 2003). However, the use of these tools is still not ubiquitous within the industry. For those construction companies that seek to adopt e-business tools there is a need to undertake an analysis of their business processes and working methods to ensure a productive and beneficial implementation of these tools.

This book is concerned with the implementation of e-business in the construction industry. In this context, e-business is broadly defined as the conduct of construction business by electronic means. The term, e-business, as used in this book, should therefore not be considered synonymous with narrow definitions of e-commerce as the process of buying and selling goods and services online (Laudon and Laudon, 2002; Unisys, 2004). In this regard, the issues and applications in this book cover both 'simple' buying and selling transactions as well as the wider aspects of doing business by electronic means. This makes the book essential reading for all stakeholders in a construction enterprise.

1.2 Structure of the book

This book consists of chapters that describe current developments and future directions in the theory and application of e-business in the architecture, engineering and construction (AEC) sector. The book reflects an effort from an international network of construction researchers investigating different aspects of e-business in construction.

The chapters, each of which is briefly described below, can be broadly grouped into four areas:

(1) Introduction to e-business and the construction context (Chapters 2–5).
(2) Technological support for e-business in construction (Chapters 6–11).
(3) Socio-technical issues in e-business (Chapters 11–13).
(4) Industrial case studies (Chapters 14–15).

Chapter 1 introduces the book, its context and contents. It explains the use of the term 'e-Business' and discusses the structure of the book, particularly the relationships between the various chapters.

Chapter 2 focuses on the fundamentals of e-business. It presents a general taxonomy for e-business and discusses the various classifications in details. It also discusses trends and developments in e-business both within and outside the construction industry. e-Business models and the general benefits of e-business are also covered, drawing on construction industry examples, where appropriate.

Chapter 3 discusses the construction context for e-business and draws on case studies involving both e-business product suppliers and construction end-user companies. The potential for business process re-engineering

based on the implementation of e-business is highlighted and some of the associated benefits outlined.

Organizational readiness for e-business forms the focus of Chapter 4. It is argued that for construction sector organizations to reap the benefits of e-business they must be 'ready' with respect to four critical aspects of their operations – technology, management, process, and people. VERDICT – a tool specifically developed to help organizations measure their e-readiness is also described in detail.

Chapter 5 is concerned with an e-business infrastructure for multi-disciplinary teams. It argues that such an infrastructure extends beyond the physical hardware and routers that supports the network connections enabling e-business transactions. It proposes a framework for an integrated infrastructure that covers business process, trading models, network hardware and software infrastructure, software interoperability standards, legal standards, and related issues.

Chapter 6 discusses the role of extranets in construction e-business. It describes how these systems are expanding beyond the core area of document/drawing management towards support for various key AEC business processes. It also explores the current slow adoption of technology adoption, the reasons for this, and the human issues to be addressed.

Chapter 7 describes how agent technology can make AEC-specific e-business more effective and more efficient. The chapter provides an overview of agent technology and the vision for agent-based e-business, and presents the conceptual design of a prototype system that demonstrates the suggested approach. It also emphasizes the need to have realistic expectations when deploying agent-based systems in commercial settings.

Chapter 8 presents the basic concept of an electronic hub (e-Hub), and its key characteristics and services. The focus is on an engineering e-Hub – a novel concept developed by the EU funded e-Hubs project. The chapter describes the e-Hub developed as being able to offer a systematic approach to collaborative project planning through basic collaborative engineering services and collaborative workflows.

Chapter 9 introduces the concept of electronic union (E-Union), which integrates the information and services provided by different e-business systems for construction products procurement. It describes the underlying technologies (such as Web Services and XML) for implementing E-Union. The last part of the chapter describes the Web Services and aecXML-based framework of E-Union and a prototypical implementation.

Chapter 10 explores the potential of emerging Web technologies (such as the Semantic Web) and describes the potential for the future application of Semantic Web technologies in construction e-business. Using examples, it argues that the use of Semantic Web technologies will, in future, offer considerable benefits in terms of enhanced e-business, project management, knowledge management, supply chain management, integration of distributed applications and services, and improved project delivery processes.

Chapter 11 discusses the issue of Trust, which is seen as a cornerstone of e-business. It reviews fundamental concepts associated with Trust and specifically focuses on trust building in e-business environments. It also discusses a number of trust building models and outlines some of the technologies that are intended to foster trust building in e-commerce by improving online security and privacy.

The legal framework for construction e-business is the subject of Chapter 12. The legal issues and risks associated with various aspects of e-business are described in detail, and guidance provided on how to avoid major problems. The chapter classifies the risks under contract formation, validity and errors, jurisdiction, privacy, authentication, attribution, non-repudiation, and agency.

Chapter 13 documents the key contributions which knowledge management (KM) can make to effective e-business initiatives and the factors that promote and inhibit the contributions of KM to e-business. It outlines the main strategies and processes needed to fully exploit the benefits of KM, and argues that to be successful in the e-business environment, construction sector companies need to become knowledge-based businesses.

Chapter 14 addresses the practical implementation of e-business systems within the UK construction industry. Drawing on case studies, it discusses the key issues that often arise in implementing e-business. It provides tips on how these problems can be avoided or overcome, and argues that technological solutions must be flexible enough to support the business objectives and facilitate innovation.

In Chapter 15, a survey of e-business implementation in the US construction industry is presented. It explores the extent to which the US construction industry has redefined its way of doing business based on e-business, and discusses the future implementation potential for various industry participants: general contractors, design firms, suppliers, and sub-contractors in general. It focuses on the integration of e-business into construction project management systems by general contractors.

Chapter 16 summarizes the main issues raised in various chapters of the book. It highlights the benefits, barriers, and practical implementation issues in the adoption of e-business in the construction industry.

The chapters in the book can be read in any sequence. However, it is important that readers appreciate the need for a balance between the technological and human/organizational aspects of e-business implementation in the construction industry.

References

Anumba, C.J. and Ruikar, K. (2002) E-commerce in construction: trends and prospects. *Automation in Construction*, **11**, 265–275.

Berning, P.W. and Diveley-Coyne, S. (2000) *E-commerce and the Construction Industry: The Revolution is Here*. Thelen Reid and Priest LLP. Available at http://www.constructionweblinks.com (accessed November 2007).

Berning, P.W. and Flanagan, P. (2003) *E-commerce and the Construction Industry: User Viewpoints, New Concerns, Legal Updates on Project Websites, Online Bidding and Web-based Purchasing*. Thelen Reid and Priest LLP. Available at: http://www.constructionweblinks.com (accessed November 2007).

Laudon, K.C. and Laudon, J.P. (2002) Management information systems. In *Managing the Digital Firm*, 7th edition. Prentice-Hall Inc., NJ, USA.

Unisys (2004) *2000 Annual Report: Glossary*. Available at: http://www.unisys.com/annual/annual2000/glossary/ (accessed November 2007).

2 Fundamentals of e-Business

Kirti Ruikar and Chimay J. Anumba

2.1 Introduction

This chapter discusses the fundamentals of e-business including the definitions of e-business and e-commerce. It presents taxonomy for e-business and the four faces of e-business. It discusses some e-business models and reviews e-business trends in construction including the barriers and enablers for e-business in construction.

2.2 e-Business and e-commerce definitions

There are a range of definitions of e-business. Damanpour (2001), for example, defines e-business as any 'net' business activity that transforms internal and external relationships to create value and exploit market opportunities driven by new rules of the connected economy. The Gartner Advisory Group (Damanpour, 2001), a research and advisory services firm, describes e-business in terms of a quantity rather than an absolute state of a company. They consider a business an e-business to the degree that it targets the market opportunities of conducting business under new electronic channels, which revolve around the Internet. This is an acknowledgement that e-business comes in many forms and can be implemented to a very small or a large degree. It is also an acknowledgement that the 'Internet' is an essential component of an e-business strategy. Laudon and Laudon's (2002) definition of e-business, as the use of the Internet and other digital technology for organizational communication, coordination and the management of the firm, encompasses these different adaptations. In the broadest possible terms, however, e-business is an electronic way of doing business. The fact that the value proposition of e-business includes the creation of new market opportunities through electronic channels, should not be ignored as these electronically channelled market opportunities enable companies to lower transaction costs, reduce delivery times, improve customer services, and add convenience (Damanpour, 2001).

This book is concerned with the implementation of e-business in the construction industry. In this context, e-business is defined broadly as the

conduct of construction business by electronic means. This fits with broad definitions of the term 'e-commerce' exemplified by the definitions below:

- The Organization for Economic Cooperation and Development (OECD): 'The electronic exchange of information that support and govern commercial activities including organizational management, commercial management, commercial negotiations and contracts, legal and regulatory frameworks, financial settlement arrangements and taxation' (OECD, 1999).
- Learnthat (2004): e-Commerce is not just about buying and selling online, but also includes all forms of business activities that are conducted over the Internet (e.g. the business-to-business flow of information between companies or within a company, communication between businesses, online advertising, etc.).
- Kalakota and Whinston (1997): e-Commerce at its grass root level can be described as an electronic method of doing business, typically over the Internet. Broadly defined, however, 'e-commerce is a modern business methodology that addresses the needs of organizations, merchants and consumers to cut costs while improving the quality of goods and services, and increasing the speed of service delivery'.

Thus, the term, e-business, as used in this book should not be considered synonymous with narrow definitions of e-commerce as the process of buying and selling goods and services online (Laudon and Laudon, 2002; Unisys, 2004).

2.3 Taxonomy for e-business

e-Business can be broadly divided into the following categories as illustrated in Figure 2.1:

- Business-to-Business (B2B)
- Consumer-to-Consumer (C2C)
- Administration-to-Administration (A2A)
- Business-to-Consumer (B2C) or Consumer-to-Business (C2B)
- Business-to-Administration (B2A) or Administration-to-Business (A2B)
- Consumer-to-Administration (C2A) or Administration-to-Consumer (A2C)

2.3.1 Business-to-Business (B2B)

Business-to-Business (or B2B as it is commonly referred to) is an electronic means of carrying out business transactions between two or more businesses. B2B incorporates everything from manufacturing to service providers.

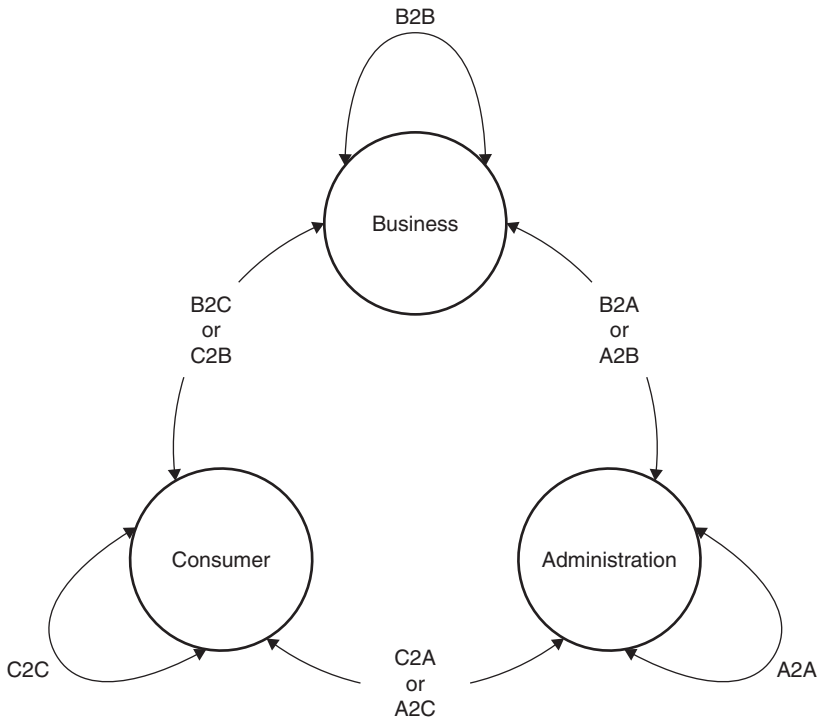

Figure 2.1 e-Business taxonomy

There are several examples of B2B models. Using B2B a company can leverage the Internet to place orders electronically, receive electronic invoices and make electronic payments. Other examples include project extranets, e-Hubs and e-commerce applications which are covered in Chapters 6, 8 and 14 of this book, respectively.

2.3.2 Consumer-to-Consumer (C2C)

Examples of C2C business models include, consumer e-auctions and blogs. In a C2C business model, although there may be no financial transaction, there is still an exchange of value and these are economic activities and could be referred to as peer-to-peer (Timmers, 2000). Blogs, for example, have led to the development of news C2B and C2C applications by presenting the opportunity and tools for virtually anyone to express their views easily and to communicate these globally and inexpensively. For instance, Nano-publishing is an application of C2C (and C2B) schemes using low-cost online publishing techniques such as blogging (writing weblogs) to target a specific audience. Additionally, Podcasting, video casting, and other