POLITECNICO DI TORINO
Repository ISTITUZIONALE

Towards the establishment of a District Information Modeling

Original
Towards the establishment of a District Information Modeling / TORABI MOGHADAM, S., Lombardi, P., Toniolo, J. - In: Advances in Construction ICT and e-Business / Torabi Moghadam S.,Lombardi P., Toniolo J.. - STAMPA. - London and New York : Taylor and Francis Inc., 2017. - ISBN 9781138914582. - pp. 245-262 [10.4324/9781315690698]

Availability:
This version is available at: 11583/2645483 since: 2020-07-09T16:03:19Z

Publisher:
Taylor and Francis Inc.

Published
DOI:10.4324/9781315690698

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

28 November 2026

ADVANCES IN CONSTRUCTION ICT AND E-BUSINESS

EDITED BY
SRINATH PERERA,
BINGUNATH INGIRIGE, KIRTI RUIKAR
AND ESTHER OBONYO



ROUTLEDGE

Advances in Construction ICT and e-Business

This internationally conducted study of the latest construction industry practices addresses a broad range of Information and Communication Technology applications. Drawing on research conducted in the US and UK, this book presents the state of the art of various e-business processes, and examines BIM, virtual environments and mobile technologies.

Innovation is a theme that runs throughout this book, so in addition to the direct impact of these new technical achievements, it also considers the management styles that helped them to emerge. Examples from industry are illustrated with case studies and presented alongside research from some of the best known academics in this field.

This book is essential reading for all advanced students and researchers interested in how ICT is changing construction management and the construction industry.

Srinath Perera is Professor and Chair of Built Environment and Construction Management at the School of Computing, Engineering & Mathematics, Western Sydney University, Sydney, Australia.

Bingunath Ingirige is Professor of Project Management and Resilience at the Global Disaster Resilience Centre (GDRC), School of Art Design and Architecture, University of Huddersfield, West Yorkshire, UK.

Kirti Ruikar is a Senior Lecturer in Architectural Engineering at the School of Civil and Building Engineering, Loughborough University, UK.

Esther Obonyo is an Associate Professor of Engineering Design and Architectural Engineering at Penn State University, USA.

This page intentionally left blank

Advances in Construction ICT and e-Business

Edited by
Srinath Perera, Bingunath Ingirige, Kirti Ruikar and Esther Obonyo

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

First published 2017
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

© 2017 selection and editorial matter, Srinath Perera, Bingunath Ingirige, Kirti Ruikar and Esther Obonyo; individual chapters, the contributors

The right of Srinath Perera, Bingunath Ingirige, Kirti Ruikar and Esther Obonyo to be identified as the author of the editorial material, and of the authors for their individual chapters, has been asserted in accordance with sections 77 and 78 of the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this book may be reprinted or reproduced or utilised in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers.

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
A catalog record for this book has been applied for

ISBN: 978-1-138-91458-2 (hbk)
ISBN: 978-1-315-69069-8 (ebk)

Typeset in Times New Roman
by codeMantra

Contents

List of figures and tables vii
List of contributors xii

1 Introduction 1
SRINATH PERERA, KIRTI RUIKAR, BINGUNATH INGIRIGE, AND ESTHER OBONYO

2 Exploiting e-commerce in construction 12
PATHMESWARAN RAJU AND GERALD FELDMAN

3 Advances in electronic procurement for the construction industry 33
ROBERT EADIE AND SRINATH PERERA

4 Drivers for electronic procurement and building information modelling in the construction industry 65
ROBERT EADIE AND SRINATH PERERA

5 Building information modelling and management 87
DAVID GREENWOOD

6 BIM in practise – industry case studies 106
TRISTAN GERRISH, KIRTI RUIKAR, MALCOLM COOK, MARK JOHNSON, AND MARK PHILLIP

7 Manchester Central Library and Town Hall Extension Project: the BIM journey so far of a public sector client 131
JASON UNDERWOOD, JOANNA CHOMENIUK, LIAM BRADY, AND DAVID WOODCOCK

8 Project extranets and developments in project collaboration 153
ERIC LOU AND ANAS BATAW

9 Transforming policy documents into intelligent three-dimensional collaboration tools 182
ALAN REDMOND AND MUSTAFA ALSHAWI

10 Impact of collaboration tools and shaping the future of data exchange – A model for BIM communication waste 213
GEORGE CHARALAMBOUS, PETER DEMIAN, STEVEN YEOMANS AND TONY THORPE

11 Towards the establishment of a district information modelling 245
SARA MOGHADAM, PATRIZIA LOMBARDI, AND JACOPO TONIOLO

12 Capability maturity modelling of construction e-business processes 263
SRINATH PERERA AND ANUSHI RODRIGO

13 e-Business infrastructure and strategic frameworks 296
YONGJIE CHEN, KIRTI RUIKAR AND PATRICIA CARRILLO

14 Innovation in e-business: issues related to adoption for micro and SME organisations 316
ERIC ADZROE AND BINGUNATH INGIRIGE

15 Application of social media in the construction industry 340
PAUL WILKINSON

16 Social media in construction: an exploratory case study 376
SRINATH PERERA, MICHELE VICTORIA AND SAMUEL BRAND

17 Mobile computing applications within construction 404
ZEESHAN AZIZ, AIZUL HARUN AND NAIF ALABOUD

18 Envisioning buildings: advances in construction visualisations 423
EMINE THOMPSON

19 The multi-agent paradigm in construction e-business and its use in the next generation of data-driven decision-making tools 450
ESTHER OBONYO AND CHIMAY ANUMBA

20 Conclusions – Summary, the status quo and future trends 462
BINGUNATH INGIRIGE, SRINATH PERERA, KIRTI RUIKAR AND ESTHER OBONYO

Index 471

Figures and tables

Figures

3.1	Methods of electronic transactions	34
3.2	Stages of e-tendering	36
3.3	Restricted procedure process and timelines	37
3.4	Simplistic e-tendering document supply and submission	44
3.5	E-awarding electronic system	45
3.6	European procedures incorporating auctions	49
6.1	The hype cycle (Gartner, 2014) and adoption lifecycle (Rogers, 2003) showing coincidental adoption phases	108
6.2	Ongoing uptake and awareness of BIM in UK AEC industry (NBS, 2011, 2012, 2013, 2014)	108
6.3	Roles and design involvement undertaken by the organisation referenced here	109
6.4	(a–c) Increasing levels of detail in object modelling	111
6.5	BIM building energy performance data attribution framework	118
7.1	Manchester City Council short-term BIM4FM vision	136
7.2	Manchester City Council long-term BIM4FM vision	137
7.3	B/555 BIM implementation maturity model	139
7.4	MCC initial BIM maturity analysis of the Central Library project	141
7.5	MCC comparative BIM maturity analysis of the Central Library project (design and construction)	143
7.6	MCC comparative BIM maturity analysis of the Central Library project (FM)	144
9.1	Conceptual map of relationships	191
9.2	(a) The origin of business rules and (b) Kind of term	194
9.3	ASHRAE data base tier – architectural design	196
9.4	Example of a BIM system and process for linking material objects with health and ASHRAE documents	199
9.5	Exchanging information via BIM XML and REST	201
9.6	BIM XML + IFC product model	202
9.7	iFM and facility life-cycle data	206
10.1	Outline of requirements engineering approach followed	227

10.2 AEC-FM process flows and BIM process flows 230
10.3 The BIM process transmission: the focal unit of analysis of WIMBIM 230
10.4 BIM process transmissions: main categories and relation to BIM process flows 231
10.5 BIM process transmission waste: the 6 different types (A–E) 232
10.6 An example of a BIM process transmission with transmission waste 233
10.7 BIM data containers, transmission media and coordination tools 234
10.8 BIM transmission waste as a result of BIM data containers, transmission media and coordination tools 235
10.9 Dimensions and waste: the two dimensions of waste are the flow type dimension and the data subset dimension 235
10.10 Interaction between BIM data container, transmission medium and transmission coordination tool 236
10.11 BIM efficiency states 237
10.12 BIM transmission/interaction representations 237
10.13 BIM transmission interaction representation lenses: scale and complexity 238
11.1 Conceptual scheme of DIM, integration of BIMs and network monitoring system 252
11.2 Representation of the DIMMER' concept 253
12.1 Structure of SW-CMM 267
12.2 Five maturity levels of SW-CMM 268
12.3 Key process areas associated with each maturity level of SW-CMM 269
12.4 Main components of CMMI 270
12.5 SPICE maturity levels 272
12.6 Typical table summarising average scores in each category with traffic light indicators of VERDICT 273
12.7 The structure of the IS/IT readiness model 274
12.8 Maturity levels and their process areas of EB-CMM 276
12.9 Tabular BIM capability maturity model 277
12.10 Interactive BIM capability maturity model 278
12.11 BIM maturity ramp 279
12.12 Components of the BIM maturity matrix 280
12.13 Structure of the CeB-CMM 282
13.1 Reviewed approaches and their relationships with the strategic framework 301
13.2 The strategic e-business framework for organisations in the construction industry 302
14.1 Six forms of e-business activities 323
14.2 Four different faces of e-business models 325
14.3 e-Business trends in construction 328

14.4 Framework for e-Business development strategy 334
15.1 Device, service, content and connectivity = complexity 341
15.2 RICS social media graphic 346
15.3 The Conversation Prism, Brian Solis 347
15.4 Image of HOKLife 358
16.1 Timeline of birth of various social media platforms 379
16.2 Impact of social media on business functions 381
16.3 Research method 387
16.4 Respondent age profile 388
16.5 Usage of social media – personal purpose 388
16.6 Usage frequency – personal purpose 389
16.7 Social media for personal use by age 390
16.8 Usage of social media – business purposes 391
16.9 Usage frequency – business purposes 391
16.10 Social media for business development by age 392
16.11 Usage of social media – career development 392
16.12 Usage frequency – career development 393
16.13 Usage pattern of LinkedIn by age 394
16.14 Level of integration of social media with organisation goals and objectives 395
16.15 Importance of social media for the case study organisation 395
16.16 Drivers and barriers of social media implementation in construction organisation 400
17.1 The application model for exploring mobile computing with information management on construction sites 409
17.2 Construction mobile application 411
17.3 The components of SiteBIM systems 412
17.4 The ENSOCS architecture 417
17.5 The display of weather data, air and noise data on ENSOCS' dashboard 419
17.6 The web form (checklist) and the sample of a surveillance report (Left: Online report; Right: Emailed report) of ENSOCS 419
18.1 Temporal representation paradigm 425
18.2 Visualisation tools for built environment 426
18.3 Animation of construction process 428
18.4 Oculus rift in use 430
18.5 Cardboard VR tool, and two slightly different images which makes up the VR environment 431
18.6 System overview; the Oculus HMD, the revit viewer plug-in and the PowerPoint remote control 433
18.7 3D point cloud data and render from the 3D model generated from scan data, Baltic Art Centre, Gateshead 437
18.8 (a) 3D point-cloud data from Gateshead Old Town Hall scan, (b) 3D model created using point-cloud data from the

Gateshead Old Town Hall scan, (c) Photorealistic render from the 3D model of the Gateshead Old Town Hall 438
18.9 3D model construction of historical buildings 440
18.10 Virtual medieval Newcastle 440
18.11 Point-cloud data examples from Durham Cathedral scans and Revit model 441
18.12 Detail image from the 3D print virtual NewcastleGateshead model 443
18.13 Rendered image of the college house (Newcastle upon Tyne) and 3D print model 444
19.1 Construction e-business example 454
19.2 Roles of agent-based models in the highway infrastructure management systems 458

Tables

2.1 Some of the e-commerce research studies in construction 18
2.2 e-Commerce technologies for construction 19
2.3 Drivers of e-commerce 22
2.4 Summary of e-commerce adoption barriers 24
3.1 2016 European financial thresholds above which the EU regulations apply 38
3.2 Timings for e-procurement 51
3.3 Time reductions due to e-procurement 51
4.1 Drivers to e-procurement identified from literature 67
4.2 Summary of the drivers for BIM in rank order 70
6.1 Case study 1 project datasheet 112
6.2 Case study 2 project datasheet 116
6.3 Case study 3 project datasheet 121
7.1 MCC Central Library and Town Hall Complex Project Awards 149
9.1 Cross tabulation of hospital dependencies and recovery mechanisms 188
9.2 Main groups of substance and their source known to cause indoor air pollution 198
9.3 Performance metrics of FUSION+GIS+ONUMA case study 204
12.1 Fundamental concepts of SW-CMM 266
12.2 Maturity levels and key process areas of e-procurement CMM 281
12.3 Construction e-business capability maturity characteristics for CeB-CMM 283
12.4 Construction e-business capability maturity model (CeB-CMM) 284
13.1 Industry practitioners participating in the framework evaluations 309
15.1 Social networking registrations and active use, global 345
15.2 The changing social media world 348

16.1 Drivers and barriers of social media implementation in business environment 383
16.2 Interviewee profile 396
16.3 Comparison of results of the study with other studies 399
17.1 Summary of mobile computing benefits 407
17.2 Developed mobile application systems for on-site information management 409

Contributors

Editors

Professor Srinath Perera PhD MSc IT BSc (Hons) QS MRICS AAIQS ICECA FAIB

Institution: Western Sydney University

Email: Srinath.perera@westernsydney.edu.au

Srinath Perera holds a personal chair in built environment and construction management at Western Sydney University, Sydney Australia, and leads the construction management research. He leads research in construction ICT and sustainability focusing on e-business, carbon estimating, construction management and the use of public private partnerships in construction. His expertise in dealing with multi disciplines have enabled him to be a lead partner in several EU-funded projects in disaster resilience, paving the way to apply construction economic techniques in building resilience. He is the coordinator of the International Council for Research and Innovation in Building and Construction (CIB) task group TG83: e-Business in Construction. He is a chartered surveyor and a member of the Royal Institution of Chartered Surveyors (RICS) and a Fellow of the Australian Institute of Building. He currently serves as an editorial board member of several international journals and is the chairman of the Editorial Panel's Procurement subcommittee of the Institution of Civil Engineers proceedings on Management Procurement and Law. He is also the co-author of the leading text book on construction management, *Cost Studies of Buildings, 6th Edition,* recently published by Routledge. He has over one hundred peer reviewed publications. He has supervised and examined several doctoral students worldwide.

Professor Bingunath Ingirige Bsc (Hons) MBA PhD MRICS FHEA

Institution: University of Huddersfield

Email: B.Ingirige@hud.ac.uk

Professor Bingunath Ingirige holds the chair in project management and resilience at the School of Art Design and Architecture, University of

Huddersfield, UK. He was previously a senior lecturer at the School of the Built Environment, University of Salford, UK. Prior to that, he worked at the Department of Building Economics of the University of Moratuwa, Sri Lanka as a Lecturer from 1994 to 2000. He has published and delivered keynotes in the area of web-enabled project management in many forums. He is also a member of the Royal Institution of Chartered Surveyors (RICS). Bingu is also interested in improving performance in the construction industry both from an angle of improving its overall resilience as well as improving the effectiveness and efficiency of project management in construction. Since 2011, he has held the position of the joint coordinator of the Conseil International du Bâtiment (CIB) Task Group TG83—eBusiness in construction. He teaches and leads the MSc in Advanced Project Management in Construction programme at the University of Huddersfield.

Dr Kirti Ruikar EngD MSc BArch FHEA

Institution: Loughborough University

Email: k.d.ruikar@lboro.ac.uk

Dr Kirti Ruikar is a senior lecturer in architectural engineering in the School of Civil and Building Engineering at Loughborough University. She is a fellow of the Higher Education Academy (FHEA). Her research interests are in strategic knowledge, information and technology management. Fields of active interest include e-business, e-readiness, BIM, fire-resilient building design, knowledge and information management, collaborative working environments and BPR. She has led several research projects in these areas and has supervised eight doctoral graduates to successful completion. Her research is widely published and she has over one hundred publications in these fields. She has co-edited a book on *e-Business in Construction* (Wiley-Blackwell 2008) and has co-authored a book on *Collaborative Design Management* (Routledge 2013). She has been a guest editor of the *Journal of IT in Construction*'s special issues on 'E-commerce in Construction' (2006); 'Technology Strategies for Collaborative Working' (2009); and 'Innovation in Construction e-Business' (2011). Dr Ruikar is also an associate editor of the internationally reputed *Journal of IT in Construction* (ITcon.org) and a joint coordinator of CIB Task Group, TG83 on 'e-Business in Construction'. She sits on the scientific committees of various international conferences and is a member of the editorial review boards of international journals.

Dr Esther Obonyo

Institution: The Pennsylvania State University

Email: eao4@psu.edu

Dr Esther Obonyo is associate professor of engineering design and architectural engineering at the Pennsylvania State University. She is also a

2015/2016 Jefferson Science Fellow. Between August 2004 and July 2015, she was a faculty member at the University of Florida's (UF) Rinker School of Construction Management, first serving as assistant professor until her promotion to the rank of associate professor in 2012. While at UF, she also served as a faculty entrepreneurship fellow at College of Business. In addition, for the past three years, she has been a visiting professor in TIP University Manila through the PhilDev IDEA Program (an initiative directed at enhancing the practice of technopreneurship in the Philippines). Beyond her academic credentials, Dr Obonyo has extensive industry experience, having worked as a construction engineer, project manager and innovations analyst in several engineering and construction companies in Kenya, the United Kingdom and the United States. Her research interest cuts across the following themes: sustainable structural materials, intelligent information and knowledge-based systems and entrepreneurship. Dr Obonyo has won several NSF awards. Her work has been disseminated through over a hundred journals, papers, conference proceedings and presentations.

Authors

Eric Adzroe

Institution: Evangelical Presbyterian University College, Ghana

Email: kofi.adzroe@epuc.edu.gh

Eric Kofi Adzroe is the director of physical development and estate management at the Evangelical Presbyterian University College Ho, Ghana. He holds a Ph.D. from the University of Salford. He is a chartered builder with many years of industrial experience in the Ghanaian construction industry. He had in the past several industrial engagements with professional bodies within the Ghanaian construction industry. He is actively involved in helping to bring e-business technology to micro enterprises SMEs within the Ghanaian construction industry. His area of expertise and interest is in e-business in construction and smart business.

Dr Aizul Harun BSc MSc PhD

Institution: Universiti Teknologi Malaysia

Email: aizulnahar.kl@utm.my

Dr Aizul is a senior lecturer at Universiti Teknologi Malaysia. During his career, he has worked in the areas of land administration and project development as well as in the management of the environments of the construction projects in the Malaysian private sector for nine years and now in the academic sector since 2009. His areas of research interest include the Internet of Things, environmental management system, building information modelling and sustainable development.

Professor Mustafa Alshawi BSc MSc PhD FCIOB

Institution: University of Salford

Email: M.A.Alshawi@salford.ac.uk

Professor Alshawi is the director of the BIM-Award–winning Unisearch Ltd (UK). He has over thirty years of academic and industrial experience in introducing new technologies to improve business performance of organizations. He was the associate dean at the University of Salford, and before that, he was the director of the Build and Human Environment Research Institute. He is also the editor-in-chief of the international journal *Construction Innovation* and the author of over a hundred and thirty publications in fields such as IT and process improvement, BIM and business process re-engineering.

Professor Chimay Anumba FREng DSc PhD Dr.h.c. CEng/PE FICE FIStructE FASCE

Institution: University of Florida

Email: anumba@engr.psu.edu

Chimay Anumba is professor and dean, College of Design, Construction and Planning at the University of Florida. He is a fellow of the Royal Academy of Engineering. He holds a Ph.D. in civil engineering from the University of Leeds, UK; a higher doctorate—doctor of science—from Loughborough University, UK; and an honorary doctorate from Delft University of Technology (Netherlands). His research interests include advanced engineering informatics, concurrent engineering, knowledge management, distributed collaboration systems, and intelligent systems. He has over four hundred and fifty scientific publications in these fields and more than $150 m in research support. He has also supervised forty-five doctoral graduates and mentored over twenty-three postdoctoral researchers.

Dr Zeeshan Aziz BEng MSc PhD FHEA ICIOB

Institution: University of Salford

Email: Z.Aziz@salford.ac.uk

Dr Aziz is a senior lecturer at University of Salford. He has led work on numerous research bids from funding agencies such as EU, British Council, HEA, Royal Academy of Engineering and Highways England. His areas of research interest include intelligent construction collaboration, building information modelling, building energy planning and modelling and mobile computing.

Dr Anas Bataw PhD

Company: KEF Holdings

Email: anas.bataw@kefholdings.com

Dr Anas Bataw is a certified BIM manager with proficient industrial and academic experience in building information modelling (BIM) and sustainable design in the UK, UAE and Malaysia. Anas has gained recognition as a unique BIM expert by providing high levels of BIM consultation to the public and private sectors towards establishing methodologies and best practices to support BIM implementation, adoption and management in the UK and UAE, while being actively involved with the BIM Academic Forum (BAF) contributing towards the adoption of BIM training and education at universities and training centres in the UK.

Liam Brady MRICS (lapse) MCIOB (lapse) Bsc (Hons) Building Surveying

Institution: Manchester City Council

Email: brady@manchester.gov.uk

Liam has worked at MCC for thirty-eight years, graduating from Salford University in 1997 BSc (hons) in building surveying. As client programme manager on the £100m Town Hall Complex completed in March 2014, he acted as the interface between the project team and Manchester's operational team, including working with Cabinet Office on Government Soft Landings and exploring how the project's digital technologies could add operational value and benefit post-construction.

Liam is currently leading a citywide energy-saving pilot project and is promoting the city to adopt soft landings and lessons learned on future large-scale MCC projects.

Samuel Brand BSc (QS) Hons

Institution: Northumbria University

Email: sam.brand@hotmail.co.uk

Sam Brand is a graduate quantity surveyor currently pursuing a professional cycling career with Team Novo Nordisk. Prior to this, he studied BSc quantity surveying at Northumbria University. He had a year of industry placement with Gardiner and Theobald LLP, subsequently working part time. He graduated with an honours degree in 2015. Before joining the university, he completed a HNC in construction and the built environment whilst working for a local quantity surveying firm. He is a keen sports enthusiast and a professional cyclist and has currently taken a career break in quantity surveying to pursue his sporting career.

Professor Patricia Carrillo CEng BSc MSc PhD FICE FCIOB

Institution: Loughborough University

Email: P.M.Carrillo@lboro.ac.uk

Professor Patricia Carrillo is the associate dean of teaching in the School of Civil and Building Engineering. Her research has focused on the exploitation of ICT on construction projects, knowledge management and lessons learned in UK construction organisations, PFI governance, and mergers and acquisitions in the construction sector. She was awarded the prestigious Royal Academy of Engineering Global Award to undertake research on knowledge management in Canada and the USA. To date, she has co-authored six books, including three on knowledge management, and has published over 170 journal papers, conference papers and reports.

George Charalambous MEng MPhil

Institution: CH2M

Email: giorgoscharalambous86@gmail.com

George Charalambous is assistant structural engineer at CH2M, Birmingham. Prior to that, he was graduate structural engineer at Amey, Birmingham. He obtained an MPhil from Loughborough University for which he conducted a three-year industry-based research project on BIM and collaboration tools, based at a renowned construction software-as-a-service provider. He holds a 1st Class MEng in civil engineering from the University of Bristol. His interests are BIM, digitally-mediated communication, social network analysis, semantic technology, knowledge management, systems thinking and biomimicry in engineering design. He is a member of the Institution of Civil Engineers.

Dr Yongjie Chen BSc MSc PhD PENG

Email: staryjchen@gmail.com

Institution: Independent/Freelance

Dr Yongjie Chen is currently an independent professional engineer in Kingston Ontario, Canada. Her background is a combination of civil/structural engineering and ICT with over ten years' working experience in the industry and eight years' research experience in the areas of electronic procurement, benchmarking and strategic implementation of electronic business in China, North America and the UK.

Joanna Chomeniuk MSc

Institution/organisation: North West Construction Hub

Email: j.chomeniuk@manchester.gov.uk

Joanna Chomeniuk is an organizational psychologist, urbanism enthusiast and framework lead for the North West Construction Hub (NWCH). Her areas of interest are focused on relationships between urban space and its users as well as on modern building technologies and the opportunities that they bring to renovations and revitalization projects. She is interested in social, economic and technological development of urban public space, heritage initiatives and new building technologies. She advises and works with clients who wish to procure building contractors to deliver much more than just a building and who are interested in BIM and achieving social value on construction projects across the North West. Joanna has a master's degree from University of Gdansk, Poland.

Professor Malcolm Cook

Institution: Loughborough University

Email: Malcolm.Cook@Lboro.ac.uk

Malcolm Cook is a professor of building performance analysis and associate dean of research for the School of Civil and Building Engineering in Loughborough University. His research interests include the use of computational fluid dynamics and dynamic thermal simulation programs for modelling natural ventilation in non-domestic buildings.

Dr Peter Demian BA/MA MEng MSc PhD MASCE MCIOB FHEA

Institution: Loughborough University

Email: P.Demian@lboro.ac.uk

Peter Demian is senior lecturer at Loughborough University. He teaches design and design management and conducts research on software for design and construction, particularly BIM. His postgraduate studies were at Stanford University and undergraduate studies at Cambridge University (all in civil engineering). He is a chartered construction manager, a member of the Chartered Institute of Building and the American Society of Civil Engineers, and a fellow of the Higher Education Academy.

Dr Robert Eadie BEng(Hons) MSc(DIS) PhD PGCertPD(Researchers) CEng FIEI MCIHT MAPM EURING FHEA

Institution: Ulster University

Email: r.eadie@ulster.ac.uk

Dr Robert Eadie is course director for the MSc Civil and Infrastructure Engineering course at Ulster University. His PhD was related to e-procurement in construction, and his research focuses on procurement

and pedagogy. He spent twenty years in industry before moving into academia. A fellow of Engineers Ireland, he is currently northern region secretary and is on the Professional College of CIGNI. He is a chartered Northern Ireland committee member of CIHT.

Dr Gerald Feldman PhD MSc BSc PGCert LT FHEA

Institution: Birmingham City University

Email: gerald.feldman@bcu.ac.uk

Gerald Feldman is a postdoctoral researcher at the Centre for Enterprise Systems at Birmingham City University, UK. He received his PhD from Birmingham City University in 2015. His PhD research explored enterprise systems upgrade decision processes and drivers. Before joining academia, Gerald has worked in several industries, managing enterprise information systems for over seven years. His research and teaching interests focus on improving the integration of people, processes, and technology to support decision-making at all levels, mainly through the application of structured decision analysis, business process modelling and socio-technical systems theory.

Tristan Gerrish

Institution: BuroHappold Engineering and Loughborough University

Email: Tristan.Gerrish@BuroHappold.com

Tristan Gerrish is a research engineer with BuroHappold Engineering and Loughborough University, investigating how BIM can be used to help understand and improve building energy performance.

Professor David Greenwood MA MSc. FCIOB PhD

Institution: Northumbria University

Email: david.greenwood@northumbria.ac.uk

David Greenwood is professor of construction project management in the faculty of Engineering and Environment, Northumbria University, UK. He is director of BIM Academy (Enterprises) Ltd., an industry-academia joint venture spin-out company, a member of the Board of Construct-IT, and former chair of the Association of Researchers in Construction Management (ARCOM). He has published over one hundred academic journal and conference papers and has authored and co-authored several textbooks. He has over twenty years of experience in consulting, training and lecturing around the world for commercial and governmental organisations and is an active promoter of better practice in the construction industry.

Mark Johnson

Institution: BuroHappold Engineering (at time of writing—but now at Brentwood Design Partnership)

Email: Mark.Johnson@BuroHappold.com (see note above Mark.Johnson@BrentwoodGroup.co.uk)

Mark Johnson is an associate director in BuroHappold Engineering, leading the Environments team in the north of England. With fifteen years' experience in the industry, he delivers client-focussed, high quality affordable engineering solutions across a wide range of projects.

Professor Patrizia Lombardi PhD MSc BA/MA

Institution: Politecnico di Torino, Interuniversity Department of Urban and Regional Studies and Planning, Viale Mattioli 39, 10125 Turin (IT)

Email: patrizia.lombardi@polito.it

Patrizia Lombardi (PhD, MSc, BA/MA) is full professor of urban planning evaluation and project appraisal of Politecnico di Torino and head of the Interuniversity Department of Regional and Urban Studies and Planning (DIST). She is an established figure in the field of evaluating smart and sustainable urban development for over twenty years, publishing widely in the subject area and coordinating, or serving as lead partner, in several pan-European projects related to smart cities, post carbon society and cultural heritage: BEQUEST, INTELCITY, INTELCITIES, ISAAC; SURPRISE; UNImetrics; MILESECURE-2050; POCACITO; DIMMER; KIC InnoEnergy/EIT ICT Lab; EEB Cluster/MIUR, SHAPE-ENERGY.

Dr Eric Lou

Institution: University of Manchester

Email: eric.lou@manchester.ac.uk

Eric Lou spent a decade in construction, higher education, information technology and environmental industries in managerial positions; and completed over £60 million in building refurbishment and new build projects before joining academia. He is now the programme director for the MSc in project management (Professional Development Programme) for the Asia Pacific region. His research interest encompasses the trichotomy of people-process-technology in the areas of project management, sustainability, corporate responsibility, BIM and IT management. Dr Lou is also the principal investigator for the Newton-Ungku Omar Institutional Links fund with Malaysia researching into sustainability-led design through building information modeling (SuLeD-BIM).

Sara Moghadam MSc BSc

Institution: Politecnico di Torino, Interuniversity Department of Urban and Regional Studies and Planning, Viale Mattioli 39, 10125 Turin (IT)

Email: sara.torabi@polito.it

Sara Torabi Moghadam graduated *cum laude* from the Polytechnic university of Turin in 2014 with a BSc and MSc in sustainable architecture. She is currently a PhD student under the supervision of Professor Patrizia Lombardi at the Polytechnic University of Turin, where she works in the field of "zero energy buildings in smart urban districts" at the Interuniversity Department of Regional and Urban Studies and Planning. Her research focuses on spatial decision support systems for evaluating different energy retrofitting scenarios for built environment at the urban scale based on multiple criteria analysis, promoting effective and sustainable urban planning toward low carbon cities.

Dr Naif Alaboud BEng MSc PhD

Institution: Umm Al-Qura University

Email: nsaboud@uqu.edu.sa

Dr Naif is an assistant professor at Umm Al-Qura University. His areas of research interest include construction project management, building information modelling, ICT in construction, mobile computing.

Mark Phillip

Institution: BuroHappold Engineering

Email: Mark.Phillip@BuroHappold.com

Mark Phillip is a partner and regional director in BuroHappold Engineering. With over twenty years' experience as a consulting engineer, Mark has delivered many high profile and award winning projects, engaging with clients to deliver technical solutions with value and elegance.

Dr Pathmeswaran Raju PhD MSc BCompSc PGCert FHEA

Institution: Birmingham City University

Email: path.raju@bcu.ac.uk

Dr Pathmeswaran Raju is a reader in knowledge engineering in the Knowledge-Based Engineering Lab at the Birmingham City University (BCU). His research interests centre around investigating the model-based engineering approach for solving complex problems in the areas of knowledge-based engineering and system engineering. He led the development of knowledge models

for Rolls-Royce and EU Clean Sky-funded Platform Independent Knowledge Model project and also knowledge-based decision support tools for the Energetic Algae project. Dr Raju joined BCU in September 2011 from the University of Salford, where he worked for six years in an EPSRC-funded Innovative Manufacturing Research Centre.

Dr Alan Redmond PhD MRICS MCSCE PGCE

Institution: UCIrvine Division of Continuing Education

Email: redmonda@uci.edu

Dr Alan Martin Redmond received his PhD in late 2013 from the School of Real Estate & Construction Economics and Management at Dublin Institute of Technology. He is currently completing a professional credit course at University of California, Irvine studying system engineering; a combination of product development and service delivery fundamentals including program and project management techniques and keen business skills. His professional certifications feature both finance and engineering principles, such as a chartered member of the Royal Institution of Chartered Surveyors (MRICS) and member of The Canadian Society of Civil Engineers (MCSCE) and CFIRE (Council Member of Finance, Investment, and Real Estate—National Institute of Building Science, USA) and member of Association Française d'Ingénierie System (AFIS—Recherches et Innovations en IS, France).

Dr Anushi Rodrigo PhD BSc (QS)

Institution: Faithful and Gould, USA

Email: Anushi.Rodrigo@fgould.com

Anushi Rodrigo recently joined Faithful and Gould, USA and currently working with the Koch Pipeline Company (Flint Hills Resources) team, providing large capital cost management and project control services. She recently completed her PhD at Northumbria University, UK majoring in construction e-business. Her PhD focused on e-business capability and maturity in construction processes. She graduated as a quantity surveyor with a first-class degree from University of Moratuwa, Sri Lanka in 2009 and moved to UK in 2010 to complete her postgraduate studies. She currently lives in Minnesota, USA and work and research in the area of construction e-business.

Dr Emine Thompson BA MA MSc PhD FHEA AoU

Institution: Northumbria University

Email: emine.thompson@northumbria.ac.uk

Emine Mine Thompson is a senior lecturer in the Department of Architecture and Built Environment, Faculty of Engineering and Environment, Northumbria University, and the programme leader for MSc Future Cities. She has substantive expertise in areas related to digital place-making activities, in particular to smart and future cities, virtual city modelling and city information modelling, with a focus on smart/future cities with a public engagement and involvement perspective. Emine is also a manager of the Virtual Reality and Visualisation group that runs the Virtual Newcastle-Gateshead project at Northumbria University, and has skills, knowledge and numerous publications relating to BIM, VR, AR and architectural and urban visualisation.

Professor Tony Thorpe CEng CITP BSc MSc PhD FICE FBCS FCIOB FRICS MIMgt

Institution: Loughborough University

Email: A.Thorpe@lboro.ac.uk

Tony Thorpe is dean of the School of Civil and Building Engineering at Loughborough University, and professor of construction information technology. He graduated in civil engineering at Nottingham University, followed by a masters and doctorate at Loughborough. He was seconded for periods to both industry and the Building Research Establishment developing advanced IT systems for construction organisations. His current research interests are in information and communications modelling and systems, innovative construction technologies, and site-based computing. He is a chartered engineer and a fellow of the Institution of Civil Engineers, the British Computer Society, the Chartered Institute of Building and the Royal Institution of Chartered Surveyors.

Dr Jacopo Toniolo PhD MSc BSc

Institution: Politecnico di Torino, Interuniversity Department of Urban and Regional Studies and Planning, Viale Mattioli 39, 10125 Turin (IT)

Email: jacopo.toniolo@polito.it

Jacopo Toniolo, born in 1981, research fellow at Politecnico di Torino since 2008, PhD in energy engineering, is an expert on the energy consumption of building. He has designed more than fifty heating ventilation and air conditioning systems, and he worked in specific research project on district heating and HVAC systems. He developed a specific knowledge in biomass heating systems, building management systems and district energy systems with practical design and European-funded projects (milesecure2050.eu, dimmer.eu, iservcmb.info).

Professor Jason Underwood BEng MSc PhD MCInstCES MBPsS FHEA

Institution: University of Salford

Email: j.underwood@salford.ac.uk

Professor in the digital built environment and programme director of the MSc in building information modelling and integrated design within the School of the Built Environment at the University of Salford. Director of construct IT for business industry-led non-profit–making collaborative membership-based network. Background in civil/structural engineering and construction ICT. Over twenty years' research experience in the area of concurrent engineering, integrated and collaborative computing in construction, product and building information modelling, and organisational e-readiness towards delivering strategic value from ICT investment through both UK- and EU-funded research on which he has published extensively. Editor-in-chief of the *Journal of 3D Information Modelling* (IJ3DIM), specifically focused on BIM along with 3D GIS and their integration.

Michele Victoria BSc (Hons) QS

Institution: Northumbria University

E-mail: michele.f.victoria@northumbria.ac.uk

Michele is currently undertaking a PhD in embodied carbon estimating in buildings at Northumbria University. She also worked as a demonstrator on a part-time basis and involved in other research activities. Before she joined Northumbria University, she worked as a lecturer in the Department of Building Economics, University of Moratuwa, Sri Lanka. She graduated from the same department with a first-class honours degree in quantity surveying. She has published several book chapters, conference papers and research reports in the areas of sustainable development, cost management, social media in construction and organisational studies.

Dr Paul Wilkinson BA PhD DipPR FCIPR

Institutions: University of Westminster; pwcom.co.uk Ltd

Email: paul.wilkinson@pwcom.co.uk

Paul Wilkinson has been working in the UK construction industry since 1987 and researches and writes about construction collaboration technology platforms, SaaS and related developments in fields such as BIM, mobile technologies and social media. He is deputy chair of the information systems panel at the Institution of Civil Engineers, and on the management team at Construction Opportunities for Mobile IT. A fellow of the CIPR, he chairs its policy and campaigns committee and its construction and property special interest group (CAPSIG), and was a member of its social media panel. He also co-founded built environment social media group Be2camp.

David Woodcock

Organisation: Manchester City Council (MCC)

Email: d.woodcock@manchester.gov.uk

David started out working as a project and technical support officer in 1999. After years of sitting behind a computer monitor, he took a more physical role in facilities management with MCC. This helped to shape his knowledge on building issues and the need for accurate building information and data. In 2011, he took a new position within Capital Programmes to investigate how digital technologies used during construction could bring added value to the day-to-day building operations. David now works in Corporate Property to enhance their property systems. He now sits behind two monitors instead of one!

Dr Steven Yeomans BSc(Hons) MSc(Dist) EngD ICIOB AFHEA MInstLM

Institution: Loughborough University

Email: S.G.Yeomans@lboro.ac.uk

Steven Yeomans is the centre research manager at the Centre for Innovative and Collaborative Construction Engineering at Loughborough University, where he completed his own doctorate of engineering in ICT-enabled collaborative methodologies. His subsequent research and teaching focuses on collaborative building information modelling underpinned by cloud based digital technologies. Steven was formerly head of collaboration for an international engineering consultancy, and a consulting board member of the Avanti programme. He has been an advocate of digital collaboration in construction for more than fifteen years.

This page intentionally left blank

1 Introduction

Srinath Perera, Kirti Ruikar,
Bingunath Ingirige, and Esther Obonyo

1.1 Background

The construction industry of most countries is considered the growth engine of the economy often acting as the regulator of economic activity. This makes it important to continually innovate its practice and processes. One of the primary ways of infusing innovation in to the construction industry is through the adoption of Information Communication Technologies (ICT) in to its endemic processes. Many previous reports that analysed the level of adoption of ICT by sectors (e-Business W@tch, 2007, 2008, 2010) and its performance (Kang *et al*., 2013) reported that the construction industry as one of the sectors that is most IT backward in terms of ICT adoption and use.

These issues of low ICT adoption in the construction industry is further exacerbated due to the fact that it is heavily fragmented in its operations in terms of design and construction, through the involvement of different distinct professions (architecture, civil engineering, structural engineering, mechanical engineering, quantity surveying, construction management, planning, among others) multi-layered supply chains and other silos of separation. This provides a greater role for ICT in the construction industry to act as a catalyst for integration and collaboration creating a platform for innovative applications and process re-engineering. ICT offers a plethora of enabling technologies that create the platform for these developments to take hold. This book aims to explore the use of numerous e-business enabling technologies within the construction industry.

This chapter first defines the term construction e-business and introduces the different types of enabling technologies that are explored in the various chapters of this book. Finally, it provides a guide to the structure and the layout of the book.

1.2 Defining construction e-business

This section is an attempt in defining construction e-business by first analysing the definition of e-business and projecting it to application in the construction sector. The term e-business first originated from the work of

IBM (Gerstner, 2002; Chaffey, 2011) and introduced the term e-business as a way of transforming key business processes by using Internet technologies (IBM, 1997). Subsequently they revised the definition giving it a much broader outlook (IBM, 2001: p. 5) as;

> the process of using web technology to help businesses streamline processes, improve productivity, and increase efficiency. It is about using the internet infrastructure and related technologies to enable business anywhere and anytime.

However, in the UK, the Department of Trade and Industry (DTI) developed a much broader view of e-business in their international benchmarking study analysing the adoption of e-business by Small and Medium Enterprises (SMEs). They termed e-business as

> the integration of Information and Communication Technologies (ICTs) for business processes (DTI, 2000).

Here, ICT is defined as any technology used to support information gathering processing, distribution and use which includes hardware, software and network systems (Baynon-Davies, 2013). This broader definition of e-business as adoption of ICT to business processes indicates that it has transformative potential to reinvent business processes through integration and redefining of business processes (DTI, 2004).

Li (2007) takes a similar approach and defines e-business as

> e-business is about developing new ways of working by innovatively exploiting the new capabilities of Information and Communication Technologies in general and the Internet and related technologies in particular.
>
> (Li, 2007: p. 2)

More recently, Chaffey (2011) used a more information centric approach to define e-business activities as

> All electronically mediated information exchanges, both within an organisation and with external stakeholders supporting the range of business processes.
>
> (Chaffey, 2011: p. 12)

These definitions identify several central characteristics in defining e-business. Information and its process of communication, the technologies used are primary constructs of the definition. These processes are considered within the context of business applications. This broader approach to e-business definition is supported by many authors (Laudon and Laudon, 2002;

Aranda-Mena and Stewart, 2005; Anumba and Ruikar, 2008; Xu and Quaddus, 2010; Goncalves *et al*., 2010).

Therefore, the application of e-business with this broader definition in mind, to the processes in the construction industry is termed as construction e-business. In this book the term construction e-business if defined as 'the application of information communication technologies to construction business processes'. These include business processes utilised by construction companies (be it construction contractors, sub-contractors, suppliers, or consultants such as designers, engineers, managers or surveyors). The process of adoption of ICT to construction processes would naturally lead to creating new ways of conducting business activities which enable transformation of business processes with added value. This is considered as innovation in construction business processes, thus ICT led innovation.

1.3 e-Business–enabling technologies

e-Business–enabling technologies play a vital role in organisations when e-business activities blend with their day to day business practices. The technologies that enable organisations to adopt ICT and reinvent business processes are considered as e-business enabling technologies. Organisations should carefully consider the selections and choices of hardware, software, human resource and IT services as they persuade functional, financial and technical requirements of an organisation (Perera and Karunasena, 2008). The IT solutions generated through the use of e-business enablers are the driving forces behind the e-business adoption that would pronounce potential competitive advantages for adopting businesses. They have changed not only the way in which businesses communicate and interact, but also the way in which information is stored, exchanged and viewed (Anumba and Ruikar, 2008). The construction e-business enabling technologies discussed in this chapter are briefly explored below.

1.3.1 Internet technologies

Internet refers to the global information system that is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions (Leiner *et al*., 2009). It is able to support communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) suite or its subsequent extensions, and other compatible protocols and provides, users or makes accessible, either publicly or privately, high level services layered on the communications and related infrastructure. The Internet is implemented in three primary methods (Ashworth and Perera, 2015: chap. 23). Firstly, as the World Wide Web where information is provided to the masses through the use of Internet technologies. Secondly, Intranet is its implementation as a private network used exclusively within a company or organisation. It uses the Internet technologies, but does not

necessarily function through the Internet (Vlosky *et al.*, 2000). These are private computing networks, internal to an organisation, allowing access only to authorised users. The third implementation is the Extranets. It is a network that links business partners to one another over the Internet (Volsky *et al.*, 2000) and this linkage is usually occurring by companies allowing their partners to access certain areas of their intranet (Greengard, 1997). It is private to a group of users defined by membership of the group. Chapter 8 explores the use of Extranets for project collaboration. Although there are no other dedicated chapters on the Internet and its variations most enabling technologies discussed are often implemented either fully or partially using Internet technologies.

1.3.2 e-Commerce and its infrastructure

e-Commerce involves use of electronic transactions in commercial processing related activities of businesses. There are a number of definitions that explains e-commerce in many ways. This book considers e-commerce as a subset of broadly defined e-business. Chapter 2 of this book explores the e-commerce infrastructure, its classifications, technologies and drivers and barriers.

1.3.3 Cloud computing

Cloud computing (CC) can be defined as 'a model for enabling convenient, on demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction' (Mell and Grance, 1999). Organisations can use CC as a service to obtain software, platform, infrastructure or data storage (Sultan, 2010). CC makes e-business concept more accessible by providing a foundation and cost effective infrastructure for e-business activities. e-Business services can be borrowed through public clouds, private clouds, community clouds or hybrid clouds. There are many advantages of using CC as an enabling technology for e-business within an organisation as on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service (Dillon *et al.*, 2010). In construction context, CC can be utilised to develop cost effective collaborative and data sharing solutions. Chapters 9, 10 and 11 explore the use of BIM within a cloud-based environment for collaborative design.

1.3.4 e-Procurement

e-Procurement originated with the use of various digital media such as CDs for media common formats such as EDI for data exchange, but found its natural residence in Internet technologies. Chaffey (2009) defines e-procurement as 'electronic integration and management of all procurement activities

including purchase request, authorisation, ordering, delivery and payment between purchaser and supplier'. e-Procurement includes sourcing, tendering, invoicing, auctions and transactions completed utilising electronic means (Ashworth and Perera, 2015). In the construction industry e-procurement includes on the one hand sourcing of labour, material and plant by contractors, and on the other hand the e-tendering processes followed to procure buildings and other structures as well as for materials procurement. Chapter 3 explores e-procurement in details followed by Chapter 4 dealing with e-procurement within a BIM environment.

1.3.5 BIM

Building information modelling (or management) is one of the fastest growing enabling technologies that have high relevance and applicability to the construction industry. In the UK and in many other parts of the world there is significant government led promotion of use of BIM in the construction industry. BIM represents a building or structure as a hierarchical computer based object model often using object oriented modelling techniques. It enables to define buildings and its constituent elements and components in a hierarchical object structure that represent the characteristics of each object in terms of attribute–value pairs. This information rich platform has great potential for integrating the fragmented construction industry provided it is used in the right way as a collaborative tool. These aspects of BIM are explored in Chapters 5, 6 and 7 with industry case studies explaining successful applications of the technology. Chapters 9, 10 and 11 further explore use of BIM as collaboration tools both at project level and district level modelling.

1.3.6 Social media

Social media in one technology that has surpassed the scope of its own original purpose of social interactions to become one of the greatest applications of Internet technologies for business purposes. The advent of Web 2.0 technology has propelled social media beyond mere social interactions to marketing, recruitment, sourcing to many other business applications (Ashworth and Perera, 2015). Chapter 15 provides the background knowledge related to social media in construction with Chapter 16 providing a case study analysis followed by Chapter 17 exploring mobile computing.

1.3.7 AI-agents

Artificial Intelligence grew from its origins of Turing experiments to the popular research paradigm in the 1980s and 1990s to becoming a major part in modern hardware to software applications. The potential for application of AI is limitless. Some construction industry specific applications are based on the paradigm of Multi-Agent Systems (Vermeulen and Pyka, 2015).

Chapter 19 reviews the use of multi agent systems in construction e-business operations taking APRON (Obonyo *et al.*, 2005) a prototype for the specification and procurement of construction products as one such example.

1.4 Structure of the book

This book is an attempt to provide a coherent monograph of the state of construction e-business and its advancements following from Anumba and Ruikar (2008) fulfilling a knowledge gap in construction ICT literature. The book consists of 20 chapters structured in to seven sections:

1 Introductions: Chapter 1 defining the scope of the subject and the text.
2 Procurement: chapters dealing with ICT applications enhancing construction procurement (Chapters 2, 3 and 4).
3 Building information modelling (BIM): reviewing the state of application of BIM (Chapters 5, 6 and 7).
4 Cloud and Collaboration Technologies: reviewing the use of many collaboration technologies such as extranets, could computing and BIM (Chapters 8, 9, 10 and 11).
5 Process Issues: analysing the methodologies and status of ICT adoption related process issues and their management (Chapters 12, 13 and 14).
6 Social and Media Technologies: reviewing the state of Internet based technologies such as social media (Chapters 15 and 16), communication technologies such as mobile computing (Chapter 17) and visualisation technologies such as virtual reality (Chapter 18).
7 Conclusions: providing trends and development for the future with a review of agent technology (Chapter 19) and with conclusions and future trends (Chapter 20).

The following paragraphs provide a quick overview of the individual chapters in the book.

Chapter 1 provides an introduction to the book providing the background context within which this book has been conceived. It defines construction e-business and provides an overview of the e-business enabling technologies that have been reviewed within this book.

Chapter 2 discusses the use of e-commerce with the construction industry exploring e-commerce classifications and technologies used based on features of e-commerce. The chapter provides a detailed account of drivers and barriers for e-commerce in construction.

Chapter 3 analyses the advances in e-procurement in the construction industry taking a step by step detailed look at the various stages of the procurement process. It reviews the European e-advertising requirements for construction contracts. The electronic awarding and e-auctions are analysed in detail explaining the stages involved in each of these e-procurement

methods. It also tracks major government backed initiatives that promote e-procurement.

Chapter 4 reviews the drivers for e-procurement and BIM in the construction industry. It compares and contrasts the drivers and barriers to BIM with those of e-procurement. It also looks at the interoperability between the two systems.

Chapter 5 sets the background for building information modelling/management (BIM) within the context of UK government and other countries taking active steps towards implementation and adoption of BIM within the construction industry. BIM has been reviewed as a radical, disruptive and fast-moving phenomenon. It provides a state of the art account with a full coverage of BIM from its origins to current level of development and beyond, to its future potential.

Chapter 6 is an attempt to showcase the implementation of BIM in the construction industry taking three case studies of BIM applications. Each case study describes the project and its uses of BIM in place of conventional design and construction processes, and then looks at the challenges and solutions developed as part of the BIM adoption throughout these projects.

Chapter 7 provides a detailed single case study of a public sector organisation implementing BIM as a test case. It provides an account of the BIM journey for implementing BIM for the Manchester Central Library and Town Hall Extension Project. The influences of key decisions during this journey and on behaviours that enhance collaboration and cooperation in understanding of BIM requirements are discussed in the chapter.

Chapter 8 provides the latest highlights on extranets for web-enabled project management. Extranet software use in the construction industry enables its participants to communicate, exchange information, data storage and collaborate across a standard platform. The chapter provides details on how extranets have changed everyday business operations and the challenges in the future if such technologies are to be implemented within day to day practice in the construction industry.

Chapter 9 describes the use of business rules associated with semantic knowledge in order to identify appropriate environmental and health policies on the Web. The authors discuss techniques for semantically enhancing policy documents within an open BIM model by exchanging information via BIM XML and representational state transfer (REST) 'systems-of-systems' they adopted to realise their objective of creating a 3D virtual representation model connected to policy documents.

Chapter 10 discusses the development of a context-specific conceptual-model ontology, which can support the discourse of requirements engineering while also providing a robust and universally applicable framework for evaluating the communication capabilities of BIM. The authors outline their use of this approach to develop a model for waste in BIM process interactions in their 'WIMBIM' project.

Chapter 11 discusses the district information modelling concept (DIM) and presents it as a feasible approach in efforts directed at scaling up the impact of energy efficiency models from the individual building to neighbourhood level. DIM is presented in this chapter as a new concept based on integration building information modelling (BIM) and geospatial information systems (GIS) with real-time data. The chapter includes a description of an open platform being developed as part of ongoing research for real-time data processing and visualization at the district level based on information about buildings, the energy distribution grid and user behaviour.

Chapter 12 presents capability maturity modelling (CMM) of construction e-business processes as a ICT process-management methodology that enables organisations to seek improvements to their e-business processes. It reviews CMM concepts and different approaches used in various sectors and evaluates their applicability in the construction industry. It also provides a detailed account of a construction e-business capability model that has been developed for use within the construction industry.

Chapter 13 discusses the development of a novel strategic e-business framework that highlights the aspects to be considered internally (within an organisation) and externally (within projects) to enhance collaboration and derive business benefits from the implementation. It focuses on the development and implementation of the framework. The chapter starts from the discussion of the crucial needs of industry organisations when formulating their e-business strategies, and the he introduction of the adopted methodology for developing the framework. This is followed by a review of the different relevant approaches for strategy formulation and framework development. The main body of the chapter presents a detailed description of the framework and its evaluation. Future implementation consideration is also discussed in the concluding section of the chapter.

Chapter 14 presents SMEs in construction as a very good source for e-business, thereby demonstrating that e-business is not just a tool for larger organisations but also a good tool that will be well received if positioned well among smaller businesses. This chapter reinforces the position of e-business use not only by examining e-business use that are appropriate for SME and micro organisations in construction but it also reports from a developing country case of the Ghananian construction industry to demonstrate the importance of e-business within their industry.

Chapter 15 provides a brief introduction to and history of the emergence of social media, highlighting the evolution from the first-generation 'Web 1.0' technologies of the early 1990s to more user-friendly and interactive 'Web 2.0' Internet platforms. It also discusses the use of social media in the construction industry and uses examples and case studies for added context.

Chapter 16 defines social media, classifies the various social media platforms, discusses the emergence of the social media platforms against a timeline and discusses the benefits of, drivers of and barriers to social media usage across various industries. It then specifically discusses the application

of social media in the construction industry using two case studies. Conclusions and discussions highlight the most popular social media platforms among construction organisations, including the drivers and barriers of social media implementation in construction organisations.

Chapter 17 introduces mobile computing in construction as a technology, which is widely being publicised as a means to cope with the problems associated with the hazardous nature of the construction industry. Innovation is generated in this area to link various facets of construction with the power of emerging mobile computing technologies. The chapter provides a very good literature review and a synthesis and also discusses a case of application of mobile services for on-site environmental surveillance. The discussion here will be beneficial for many upcoming practitioners in the construction industry.

Chapter 18 provides a state-of-the-art review on visual communication tools based on an analysis of published literature and selected case studies. The chapter discuss trends that are continue to enhance the interactive and customization features within visualization tools such as 3D modelling, animation/walkthrough, virtual reality, augmented reality, building information modelling, and others.

Chapter 19 discusses the benefits of using agent-based systems in information and knowledge management for construction. In described first generation agent-based models that were generally speaking, agent-centred multi-agent systems' (ACMAS). The authors discuss the potential for scaling up their impact through the design and use of organization-centred multi-agent systems' (OCMAS). They also examine feasibility of adapting solutions-driven agent models to enhance data-driven decision support tools.

Chapter 20 provides a conclusion to the book. It first provides a brief summary of the key issues covered in each chapter before following on to advancements and enablers in ICT in construction. It then provides an account of key barriers to e-Business in construction and explores the benefits of adoption of ICT in construction processes and practices. Finally it provides an overview of future directions in e-Business in Construction.

References

Anumba, C. J. and Ruikar, K. (2008). *e-Business in Construction*. Oxford, UK: Wiley-Blackwell.

Aranda-Mena, G. and Stewart, P. (2005). 'Barriers to e-business adoption in construction: international literature review', QUT Research Week 2005 Conference. Brisbane 4–8 July 2005.

Ashworth, A. and Perera, S. (2015). *Cost Studies of Building*. Abingdon and New York: Routledge.

Beynon-Davies, P. (2013). *eBusiness*. 2nd ed. New York: Palgrave Macmillan.

Chaffey, D. (2011). *e-Business and e-commerce management: strategy, implementation and practice*. 5th ed. Essex: Pearson Education Limited.

———. (2009) *e-Business and e-commerce management*. 4th ed. Essex: Pearson Education Limited.

Dillon, T., Wu, C. and Chang, E. (2010). Cloud computing: issues and challenges. 24th IEEE International Conference on Advanced Information and Applications, pp. 27–33.

DTI (2000). Business in the Information Age—International Benchmarking Study 2000. UK Department of Trade and Industry.

——— (2004). Business in the Information Age—International Benchmarking Study 2004, UK Department of Trade and Industry. https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwiChvrX04bRAhWDVZQKHd8_BE0QFggpMAM&url=http%3A%2F%2Fwww.knowledgebusiness.com%2Fknowledgebusiness%2FTemplates%2FViewAttachment.aspx%3FhyperLinkId%3D2254&usg=AFQjCNGiE2-vw4M1xL1OdnG-ZJSN_dFpAg&sig2=Vyn5ptmPV4F5fgNQrSMk_A&cad=rja. Accessed on 22 December 2016.

e-Business W@tch (2006–7). The European e-business report, A portrait of e-business in 10 sectors of the EU economy, 5th Synthesis Report of the e-Business W@tch, Retrieved January 28, 2012, from http://bookshop.europa.eu/en/the-european-e-business-report-pbNBAU06001/

——— (2008). The European e-Business Report 2008 The impact of ICT and e-business on firms, sectors and the economy 6th Synthesis Report of the Sectoral e-Business Watch, Office for Official Publications of the European Communities, 2008 ISBN 978-92-79-09355-5, Retrieved March 21, 2016, from http://aei.pitt.edu/54205/1/2008.pdf

e-Business W@tch (2010). ICT and e-Business for an Innovative and Sustainable Economy, 7th Synthesis Report of the Sectoral e-Business Watch (2010). Retrieved March 21, 2016, from http://www.aimme.es/archivosbd/observatorio_oportunidades/ICT_and_e-busuness_for_an.pdf

Gerstner, L. V. (2002). Who says elephants can't dance. New York: Harper Collins Publishers Inc.

Goncalves, R. M., Santos, S. S. and Morais, E. P. (2010). E-business maturity and information technology in Portuguese SMEs, IBIMA Publishing [Online]. [Viewed April 2015]. Available from: http://www.ibimapublishing.com /journals/CIBIMA/2010/303855/303855.pdf.

Greengard, S. (1997). Extranets – Linking Employees With Your Vendors. Workforce. Nov. 1997 28–33.

IBM (1997). IBM100 – e-business. [Online]. IBM's 100 Icons of Progress. [Viewed April 2015]. Available from: http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/ebusiness.

——— (2001). IBM @server iSeries e-business handbook: a V5R1 technology and product reference. IBM Corporation, International Technical Support Organization.

Kang, Y., O'Brien, W. J. and Mulva, S. P. (2013). Value of IT: indirect impact of TI on construction project performance via best practices. *Automation in Construction*, 35, pp. 383–396.

Laudon, K. C. and Laudon, J. P. (2002). Management Information systems: managing the digital firm. 7th ed. USA: Prentice-Hall Inc.

Leiner, B. M., Cerf, V. G., Clark, D. D., Kahn, R. E., Kleinrock, L., Lynch, D. C., Postel, J., Roberts, L. G. and Wolff, S. (2009). A brief history of the Internet. *ACM SIGCOMM Computer Communication Review*, 39 (5), pp. 22–31.

Mell, P. and Grance, T. (2010). The NIST Definition of Cloud Computing, NIST, viewed 21 June 2011, http://www.nist.gov/itl/cloud/upload/cloud-def-v15.pdf

Obonyo, E. A., Anumba, C. J. and Thorpe, A. (2005). Specification and procurement of construction products using agents. In Anumba, C. J., Ugwu, O. O and Ren. Z., eds, *Agents and Multi-Agent Systems in Construction*. London and New York: Taylor & Francis Group.

Perera, S. and Karunasena, G. (2008). A decision support model for the selection of best value information technology procurement method. *Journal of Information Technology in Construction*, 13, pp. 224–243.

Sultan, N. (2010). Cloud computing for education: A new dawn?. *International Journal of Information Management*, 30, pp. 109–116.

Vermeulen, B. and Pyka, A. (2015). Agent-based Modeling for Decision Making in Economics under Uncertainty. Economics Discussion Papers, No. 2015–45, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2015-45.

Vlosky, R. P., Fontenot, R., and Blalock, L. (2000). Extranets: Impacts on Business Practices and Relationships. *Journal of Business and Industrial Marketing*, 15(6).

Xu, J. and Quaddus, M. (2010). E-business in the 21st century: realities, challenges and outlook. Singapore: World Scientific Publishing Co. Pte. Ltd., Intelligent Information Systems – Vol. 2.

Introduction

Anumba, C. J. and Ruikar, K. (2008). e-Business in Construction. Oxford, UK: Wiley-Blackwell.

Aranda-Mena, G. and Stewart, P. (2005). Barriers to e-business adoption in construction: international literature review, QUT Research Week 2005 Conference. Brisbane 48 July 2005.

Ashworth, A. and Perera, S. (2015). Cost Studies of Building. Abingdon and New York: Routledge.

Beynon-Davies, P. (2013). eBusiness. 2nd ed. New York: Palgrave Macmillan.

Chaffey, D. (2011). e-Business and e-commerce management: strategy, implementation and practice. 5th ed. Essex: Pearson Education Limited.

Chaffey, D. (2009) e-Business and e-commerce management. 4th ed. Essex: Pearson Education Limited.

10 Dillon, T. , Wu, C. and Chang, E. (2010). Cloud computing: issues and challenges. 24th IEEE International Conference on Advanced Information and Applications, pp. 2733.

DTI (2000). Business in the Information AgeInternational Benchmarking Study 2000. UK Department of Trade and Industry.

DTI (2004). Business in the Information AgeInternational Benchmarking Study 2004, UK Department of Trade and Industry.

https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwiChvrX04bRAh
WDVZQKHd8_BE0QFggpMAM&url=http%3A%2F%2Fwww.knowledgebusiness.com%2Fknowledgebusiness%2FTemplates%2FViewAttachment.aspx%3FhyperLinkId%3D2254&usg=AFQjCNGiE2-vw4M1xL1OdnG-ZJSN_dFpAg &sig2=Vyn5ptmPV4F5fgNQrSMk_A&cad=rja. Accessed on 22 December 2016 .

e-Business W@tch (20067) . The European e-business report, A portrait of e-business in 10 sectors of the EU economy, 5th Synthesis Report of the e-Business W@tch, Retrieved January 28, 2012, from http://bookshop.europa.eu/en/the-european-e-business-report-pbNBAU06001/

DTI (2008). The European e-Business Report 2008 The impact of ICT and e-business on firms, sectors and the economy 6th Synthesis Report of the Sectoral e-Business Watch, Office for Official Publications of the European Communities, 2008 ISBN 978-92-79-09355-5, Retrieved March 21, 2016, from http://aei.pitt.edu/54205/1/2008.pdf

e-Business W@tch (2010). ICT and e-Business for an Innovative and Sustainable Economy, 7th Synthesis Report of the Sectoral e-Business Watch (2010). Retrieved March 21, 2016, from http://www.aimme.es/archivosbd/observatorio_oportunidades/ICT_and_e-busuness_for_an.pdf

Gerstner, L. V. (2002). Who says elephants cant dance. New York: Harper Collins Publishers Inc.

Goncalves, R. M. , Santos, S. S. and Morais, E. P. (2010). E-business maturity and information technology in Portuguese SMEs, IBIMA Publishing [Online]. [Viewed April 2015]. Available from: http://www.ibimapublishing.com/journals/CIBIMA/2010/303855/303855.pdf.

Greengard, S. (1997). Extranets Linking Employees With Your Vendors. Workforce. Nov. 1997 2833.

IBM (1997). IBM100 e-business. [Online]. IBMs 100 Icons of Progress. [Viewed April 2015]. Available from: http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/ebusiness.

IBM (2001). IBM @server iSeries e-business handbook: a V5R1 technology and product reference. IBM Corporation, International Technical Support Organization.

Kang, Y. , OBrien, W. J. and Mulva, S. P. (2013). Value of IT: indirect impact of TI on construction project performance via best practices. Automation in Construction, 35, pp. 383396.

Laudon, K. C. and Laudon, J. P. (2002). Management Information systems: managing the digital firm. 7th ed. USA: Prentice-Hall Inc.

Leiner, B. M. , Cerf, V. G. , Clark, D. D. , Kahn, R. E. , Kleinrock, L. , Lynch, D. C. , Postel, J. , Roberts, L. G. and Wolff, S. (2009). A brief history of the Internet. ACM SIGCOMM Computer Communication Review, 39 (5), pp. 2231.

Mell, P. and Grance, T. (2010). The NIST Definition of Cloud Computing, NIST, viewed 21 June 2011 , http://www.nist.gov/itl/cloud/upload/cloud-def-v15.pdf

11 Obonyo, E. A. , Anumba, C. J. and Thorpe, A. (2005). Specification and procurement of construction products using agents. In Anumba, C. J. , Ugwu, O. O. and Ren. Z. , eds, Agents and Multi-Agent Systems in Construction. London and New York: Taylor & Francis Group.

Perera, S. and Karunasena, G. (2008). A decision support model for the selection of best value information technology procurement method. Journal of Information Technology in Construction, 13, pp. 224243.

Sultan, N. (2010). Cloud computing for education: A new dawn?. International Journal of Information Management, 30, pp. 109116.

Vermeulen, B. and Pyka, A. (2015). Agent-based Modeling for Decision Making in Economics under Uncertainty. Economics Discussion Papers, No. 201545, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2015-45.
Vlosky, R. P. , Fontenot, R. , and Blalock, L. (2000). Extranets: Impacts on Business Practices and Relationships. Journal of Business and Industrial Marketing, 15(6).
Xu, J. and Quaddus, M. (2010). E-business in the 21st century: realities, challenges and outlook. Singapore: World Scientific Publishing Co. Pte. Ltd., Intelligent Information Systems Vol. 2.

Exploiting e-commerce in construction

Aboelmaged, M.G. (2010). Predicting eprocurement adoption in a developing country: an empirical integration of technology acceptance model and theory of planned behaviour. Industrial Management and Data Systems, 110(3), 392414.
Alshawi, M. and Ingirige, B. (2003). Web-enabled project management: an emerging paradigm in construction. Automation in Construction, 12(4), 349364.
Al-Somali, S.A. , Gholami, R. and Clegg, B. (2015). A stage-oriented model (SOM) for e-commerce adoption: a study of Saudi Arabian organisations. Journal of Manufacturing Technology Management, 26(1), 235.
Alshawi, M. and Ingirige, B. (2003). Web-enabled project management: an emerging paradigm in construction. Automation in Construction, 12(4), pp. 349364.
Anumba, C.J. and Ruikar, K. (2002). Electronic commerce in constructiontrends and prospects. Automation in Construction, 11(3), 265275.
Anumba, C.J. and Ruikar, K. (2009). e-Business in construction. Wiley-Blackwell, Oxford, UK.
Arslan, G. , Tuncan, M. , Birgonul, M.T. and Dikmen, I. (2006). E-bidding proposal preparation system for construction projects. Building and Environment, 41(10), 14061413.
Baladhandayutham, T. and Venkatesh, S. (2010). B2B e-Commerce: an integrated approach for construction industry. In 2010 International Conference on Financial Theory and Engineering (ICFTE), Proceedings, IEEE, Computer Society, Dubai, United Arab Emirates, 1820 June, pp. 127131.
Baladhandayutham, T. and Venkatesh, S. (2012). Construction industry in Kuwaitan analysis on e-procurement adoption with respect to suppliers perspective. International Journal of Management Research and Development, 2(1), 117.
Bhasker, B. (2013). Electronic commerce: framework, technologies and applications. Tata McGraw-Hill Education, New Delhi.
Bhutto, K. , Thorpe, A. and Stephenson, P. (2005a). E-commerce in UK construction. In Proceedings of the 3rd International Conference on Innovation in Architecture, Engineering and Construction, 2, pp. 989998, Rotterdam, the Netherlands.
Bhutto, K. , Thorpe, T. and Stephenson, P. (2005b). E-commerce and the construction industry. In Proceedings of the 21st Annual Association of Researchers in Construction Management (Khosrowshahi, F. , ed.), pp. 13451353, SOAS, University of London, London.
Carayannis, E.G. and Popescu, D. (2005). Profiling a methodology for economic growth and convergence: learning from the EU e-procurement experience for central and eastern European countries. Technovation, 25(1), 114.
Castro-Lacouture, D. , Medaglia, A.L. and Skibniewski, M. (2007). Supply chain optimization tool for purchasing decisions in B2B construction marketplaces. Automation in Construction, 16(5), 569575.
Chaffey, D. , Ellis-Chadwic, F. , Mayer, R. and Johnston, K. (2009). E-business and e-commerce management, 4th ed., Prentice Hall, London.
Chassiakos, A. and Sakellaropoulos, S. (2008). A web-based system for managing construction information. Advances in Engineering Software, 39(11), 865876.
Chen, Y. , Ruikar, K. and Carrillo, P.M. (2013). Strategic e-business framework: a holistic approach for organisations in the construction industry. Journal of Information Technology in Construction, 18, 306320.
Chen, Z. , Li, H. , Kong, S.C. , Hong, J. and Xu, Q. (2006). E-commerce system simulation for construction and demolition waste exchange. Automation in Construction, 15(6), 706718.
30 Costa, A.A. and Tavares, L.V. , 2012. Social e-business and the Satellite Network model: Innovative concepts to improve collaboration in construction. Automation in Construction, 22, pp. 387397.
Dzeng, R.-J. and Lin, Y.-C. (2004). Intelligent agents for supporting construction procurement negotiation. Expert Systems with Applications, 27(1), 107119.

Eadie, R. , Perera, S. and Heaney, G. (2010). Identification of e-procurement drivers and barriers for UK construction organizations and ranking of these from the perspective of quantity surveyors. Journal of Information Technology in Construction, 15, 2343.
Eadie, R. , Perera, S. , Heaney, G. and Carlisle, J. (2007). Drivers and barriers to public sector e-procurement within Northern Irelands construction industry. Journal of Information Technology in Construction, 12, 103120.
Egan, J. , Raycraft, M. , Gibson, I. , Moffatt, B. , Parker, A. , Mayer, A. , Mobbs, N. , Jones, D. , Gye, D. and Warburton, D. (1998). Rethinking Construction. Available at: http://constructingexcellence.org.uk/wp-content/uploads/2014/10/rethinking_construction_report.pdf [Accessed 23rd January 2016].
Flanagan, R. and Marsh, L. (2000). Measuring the costs and benefits of information technology in construction. Engineering, Construction and Architectural Management, 7(4), 423435.
Goulding, J.S. and Lou, E.C.W. (2013). E-readiness in construction: an incongruous paradigm of variables. Architectural Engineering and Design Management, 9(4), 265280.
Hadikusumo, B. , Petchpong, S. and Charoenngam, C. (2005). Construction material procurement using Internet-based agent system. Automation in Construction, 14(6), 736749.
HM Government . (2013). Construction 2025, Industrial Strategy: Government and Industry in Partnership. (URN BIS/13/955). Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf [Accessed 23rd January 2016].
Isikdag, U. , Underwood, J. , Ezcan, V. and Arslan, S. (2011). Barriers to e-procurement in Turkish AEC industry. In Proceedings of the CIB W78-W102 2011: International Conference, Sophia Antipolis, France.
Ismail, I.A. and Kamat, V.R. (2006). Evaluation of legal risks for e-commerce in construction. Journal of Professional Issues in Engineering Education and Practice, 132(4), 355360.
Johnson, R. , Clayton, M. , Xia, G. , Woo, J.H. and Song, Y. (2002). The strategic implications of ecommerce for the design and construction industry. Engineering Construction and Architectural Management, 9(3), 241248.
Johnson, R.E. and Xia, G. (2000). The impact of e-commerce on the design and construction industry. In Proceedings of the 22nd Annual Conference of the Association for Computer-Aided Design in Architecture, Washington, D.C.
Kaklauskas, A. , Zavadskas, E.K. and Trinkunas, V. (2007). A multiple criteria decision support on-line system for construction. Engineering Applications of Artificial Intelligence, 20(2), 163175.
Kalakota, R. and Whinston, A.B. (1997). Electronic commerce: a managers guide. Addison-Wesley, Reading, MA.
Kamaruzaman, K.N. , Handrich, Y.M. and Sullivan, F. (2010). e-Commerce adoption in Malaysia: trends, issues and opportunities. In Ramasamy, R. and Ng, S. (eds.) ICT Strategic Review 2010/11 E-commerce for Global Reach PIKOM. The National ICT Association of Malaysia, Putrajaya, Malaysia.
31 Kheng, C.B. and Al-Hawamdeh, S. (2002). The adoption of electronic procurement in Singapore. Electronic Commerce Research, 2(1), 6173.
Kong, C. and Li, H. (2001). E-commerce application for construction material procurement. International Journal of Construction Management, 1(1), 1120.
Kong, S.C. , Li, H. , Hung, T.P. , Shi, J.W. , Castro-Lacouture, D. and Skibniewski, M. (2004). Enabling information sharing between e-commerce systems for construction material procurement. Automation in Construction, 13(2), 261276.
Laryea, S. and Ibem, E.O. (2014a). Barriers and prospects of e-procurement in the South African construction industry. In 7th Annual Quantity Surveying Research Conference, Pretoria, South Africa.
Laryea, S. and Ibem, E.O. (2014b). Patterns of technological innovation in the use of e-procurement in construction. Journal of Information Technology in Construction, 19, pp. 104125.
Laudon, K.C. and Traver, C.G. (2014). E-commerce: business, technology, society, 10th ed., Pearson, Boston, MA.
Li, H. , Kong, C. , Pang, Y. , Shi, W. and Yu, L. (2003). Internet-based geographical information systems system for e-commerce application in construction material procurement. Journal of Construction Engineering and Management, 129(6), 689697.
Lindsley, G. and Stephenson, P. (2008). E-tendering process within construction: a UK perspective. Tsinghua Science and Technology, 13(S1), 273278.
Lou, E.C.W. (2010). E-readiness: how ready are UK construction organizations to adopt IT. In Proceedings of the 26th Annual ARCOM Conference, pp. 68, Leeds, UK.
Lou, E.C.W. and Alshawi, M. (2009). Critical success factors for e-tendering implementation in construction collaborative environments: people and process issues. Journal of Information Technology in Construction, 14, 98109.

Lou, E.C.W. and Goulding, J.S. (2010). The pervasiveness of ereadiness in the global built environment arena. Journal of Systems and Information Technology, 12(3), 180195.
Love, P.E.D. , Irani, Z. , Li, H. , Cheng, E.W.L. and Tse, R.Y.C. (2001). An empirical analysis of the barriers to implementing e-commerce in small-medium sized construction contractors in the state of Victoria, Australia. Construction Innovation: Information, Process, Management, 1(1), 3141.
Manyika, J. , Chui, M. , Bisson, P. , Woetzel, J. , Dobbs, R. , Bughin, J. and Aharon, D. (2015). The Internet of Things: Mapping the Value Beyond the Hype. [Accessed 23rd January 2016]. Available at:
http://www.mckinsey.com/insights/business_technology/the_internet_of_things_the_value_of_digitizing_the_physical_world.
Noyen, K. , Volland, D. , Wrner, D. and Fleisch, E. (2014). When Money Learns to Fly: Towards Sensing as a Service Applications Using Bitcoin. CoRR abs/1409.5841. [Accessed 15 March 2016]. Available at: http://arxiv.org/pdf/1409.5841v1.pdf.
Office for National Statistics . (2015). E-commerce and ICT Activity, 2014. [Accessed 15 January 2016]. Available at: http://www.ons.gov.uk/ons/dcp171778_425690.pdf.
Oyediran, O.S. and Akintola, A.A. (2011). A survey of the state of the art of e-tendering in Nigeria. Journal of Information Technology in Construction, 16, 557576.
Porter, M.E. and Heppelmann, J.E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92(11), 6488.
32 Rankin, J.H. , Chen, Y. and Christian, A.J. (2006). E-procurement in the Atlantic Canadian AE industry. Journal of Information Technology in Construction, 11, 7587.
Ren, Y. , Skibniewski, M.J. and Jiang, S. , 2012. Building information modeling integrated with electronic commerce material procurement and supplier performance management system. Journal of Civil Engineering and Management, 18(5), pp. 642654.
Rhodes, C. (2015). Construction Industry: Statistics and Policy. [Accessed 6 October 2015]. Available at: http://www.parliament.uk/commons-library, House of Commons Library.
Rowe, F. , Truex, D. and Huynh, M.Q. (2012). An empirical study of determinants of e-commerce adoption in SMEs in Vietnam: an economy in transition. Journal of Global Information Management, 20(3), 2354.
Ruikar, K. (2004). Business process implications of e-commerce in construction organisations. Doctor of Engineering (EngD) Thesis, Loughborough University, Loughborough, UK.
Ruikar, K. (2006). E-commerce in construction. Journal of Information Technology in Construction, 11(Special Issue), 7374.
Ruikar, K. , Anumba, C. and Carrillo, P. (2003). Reengineering construction business processes through electronic commerce. The TQM magazine, 15(3), 197212.
Ruikar, K. and Anumba, C.J. (2009). e-Business: the construction context. In Anumba, C.J. and Ruikar, K. (eds.) e-Business in construction.Wiley-Blackwell,Oxford, UK.
Ruikar, K. , Anumba, C.J. and Carrillo, P.M. (2006). VERDICTan e-readiness assessment application for construction companies. Automation in Construction, 15(1), 98110.
Smyth, H. (2010). Construction industry performance improvement programmes: the UK case of demonstration projects in the Continuous Improvement programme. Construction Management and Economics, 28(3), 255270.
Stewart, P. (2001). The role of e-commerce systems for the construction industry. The Australian Journal of Construction Economics and Building, 1(2), 2436.
Tornatzky, L.G. and Fleischer, M. (1990). The processes of technological innovation. Lexington Books, Lexington, MA.
Turber, S. , Vom Brocke, J. , Gassmann, O. and Fleisch, E. (2014). Designing business models in the era of Internet of things. In Hutchison, D. , Kanade, T. and Kittler, J. et al. (eds.) Advancing the impact of design science: moving from theory to practice. Springer International Publishing, Cham, Switzerland, pp. 1731.
Vitkauskaite, E. and Gatautis, R. (2008). eProcurement perspectives in construction sector SMEs. Journal of Civil Engineering and Management, 14(4), 287294.
Wang, Y. , Yang, J. and Shen, Q. (2007). The application of electronic commerce and information integration in the construction industry. International Journal of project management, 25(2), 158163.
Wong, C.H. (2007). ICT implementation and evolution: case studies of intranets and extranets in UK construction enterprises. Construction Innovation, 7(3), 254273.
Xue, X. , Wang, Y. , Shen, Q. and Yu, X. (2007). Coordination mechanisms for construction supply chain management in the Internet environment. International Journal of project management, 25(2), 150157.

Arminas, D. (2002). Are relationships going, going, gone? Supply Management. March 14th 2002. Retrieved March, 2015, from https://www.cips.org/supply-management/news/2002/march/are-relationships-going-going-gone/.
Arrowsmith, S. (2001). E-commerce policy and the EC procurement rules: the chasm between rhetoric and reality, Kluwer Law International, 38, 14471477.
Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria, International Journal of Project Management, 17(6), 337342.
AusTender . (2015). AusTender Homepage. Retrieved March 2015 from https://www.tenders.gov.au/.
Bergeron, M. and Lacinski, P. (2000). Serious Straw Bale: A Home Construction Guide for All Climates. White River Junction, VT: Chelsea Green Publishing.
Bravosolution . (2013). BravoSolution Service Definition for SaaS Supply Management Services. Retrieved March 2015 from http://assets-production.govstore.service.gov.uk/Giii%20Attachments/BRAVOSOLUTION%20UK%20LTD/Bids/BravoSolution%20Service%20Definition%20for%20SaaS%20Supply%20Management%20Services%20G-Cloud%20III.pdf.
Brook, M. (2008). Estimating and Tendering for Construction Work (4th ed.). Burlington, MA: Butterworth-Heinemann.
BSI . (2013). PAS91:2013 Construction Prequalification Questionnaires. Retrieved March 2015 from http://shop.bsigroup.com/upload/PASs/PAS91-2013.pdf.
Cabinet Office . (1999). Modernising Government. White Paper. HMSO. Retrieved March 2015 from http://webarchive.nationalarchives.gov.uk/20140131031506/ http://www.archive.official-documents.co.uk/document/cm43/4310/4310.htm.
Cabinet Office . (2015). Procurement Guidance Note PGN02/15. Retrieved March 2015 from https://www.gov.uk/government/publications/procurement-policy-note-0215-public-contracts-regulations-2015.
CCS. (2016). Standard Selection Questionnaire. Retrieved December 2016, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/564780/Standard_Selection_Questionnaire_v3_Nov_16.docx.
53 Chu, P. , Hsiao, N. , Lee, F. and Chen, C. (2004). Exploring success factors for Taiwans government electronic tendering system: behavioural perspectives from end users, Government Information Quarterly, 21, 219234.
CourtsNI . (2008). McLaughlin and Harvey Limited -v- Department of Finance and Personnel [No. 2], Neutral Citation no.: [2008] NIQB 91, available at http://www.bailii.org/nie/cases/NIHC/QB/2008/91.html.
CPDNI . (2012a). Public Procurement: A Guide for Small and Medium Sized Enterprises PGN 02/12. Retrieved March 2015 from https://www.finance-ni.gov.uk/publications/procurement-guidance-note-0212-guide-public-procurement-small-and-medium-sized.
CPDNI . (2012b). PGN 05-12 Simplified Approach to Procurements Over 30,000 and Below EU Thresholds. Retrieved March 2015 from https://www.finance-ni.gov.uk/publications/procurement-guidance-note-0512-simplified-approach-procurement-over-%C2%A330000-and-under.
Craven, R. and Olson-Welsh, J. (2008). Northern Ireland Court Brings Down Framework Agreement, 3335. Retrieved March 2015 from http://www.mayerbrown.com/files/Publication/5d183b5c-5ab8-4474-9bd1-5f27a26b1bf5/Presentation/PublicationAttachment/b6293233-cd25-4480-b055-c9e6b5a17501/0169con_Northern_Ireland_court_Article.pdf.
Dacorum Borough Council . (2006). IEG5 Report. Retrieved March 2015 from www.bipsolutions.com/docstore/doc/12757.doc.
DCAL . (2014). ERDF National Procurement Guidance ERDF-GN-1-004 Version 3, 3 July 2014 . Retrieved March 2015 from https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCIQFjAA&url=https%3A%2F%2Fwww.gov.uk%2Fgovernment%2Fuploads%2Fsystem%2Fuploads%2Fattachment_data%2Ffile%2F326610%2FERDF-GN-1-004_ERDF_National_Procurement_Requirements_V3.doc&ei=f5AKVe-VJsmwUZnTgaAI&usg=AFQjCNEHu5RpjmdulwaSAqchvCfTLZyZqg&bvm=bv.88528373,d.d24.
DEFRA . (2015). Procurement at Defra. Retrieved December, 2016, from https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/about/procurement.2
Eadie, R. (2014). Does Europe need a specific prequalification system for highway projects? In: Proceedings of the 9th International Conference on Civil Engineering Design and Construction (Science and Practice), Varna, Bulgaria. - (Scientific-Technical Union of Construction in

Bulgaria).
Eadie, R. and McCavigan, M. (2015). Random Selection: Winning the lottery in construction contracts, International Journal of Procurement Management, Vol. 9, No. 2, pp. 185204.
Eadie, R. , Perera, S. , Heaney, G. and Carlisle, J. (2007). Construction contractors perspective on web-based advertising of public sector construction contracts. In Boyd, David (ed.) Proceedings of ARCOM, September 2007, Belfast, Northern Ireland, 767776.
Eadie, R. , Perera, S. and Heaney, G. (2010). A cross discipline comparison of rankings for e-procurement drivers and barriers within UK construction organisations, Journal of Information Technology in Construction, 15, 2343, http://www.itcon.org/2010/17.
Eadie, R. , Millar, P. and McMorran, G. (2012) Public and private sector views of electronic government advertising in light of the Glover report in Northern Ireland. In: 7th International Conference on Innovation in Architecture, Engineering and Construction (AEC), Sao Paulo, Brazil. Escola Politecnica, University of Sao Paulo Brazil.
54 Eastern v. EME Developments (1991) Emson Eastern Ltd (in receivership) v EME Developments Ltd QUEEN'S BENCH DIVISION (OFFICIAL REFEREES' BUSINESS) His Honour Judge John Newey QC 55 BLR 114, 1991, p. 125 Retrieved December, 2016 From Lexus Library https://www.lexisnexis.com/uk/legal/search/enhRunRemoteLink.do?A=0.7840076570694092&service=citation&langcountry=GB&backKey=20_T25266237069&linkInfo=F%23GB%23CONLR%23vol%2526%25page%2557%25sel2%2526%25&ersKey=23_T25266237059.
ECI News . (2003). ECI NewsletterAchieving Continuous Improvement and Value. Autumn 2003. Retrieved March 2015 from http://www.researchandmarkets.com/reports/1530394/long_term_partnering_achieving_continuous.
Egan, J. (1998) Rethinking Construction. Retrieved December 2016, from http://constructingexcellence.org.uk/wp-content/uploads/2014/10/rethinking_construction_report.pdf.
Eom, S. , Kim, S. and Jang, W. (2015). Paradigm shift in main contractor-subcontractor partnerships with an e-procurement framework, KSCE Journal of Civil Engineering, DOI 10.1007/s12205-015-0179-5, 111.
E-SourcingNI . (2015). E-sourcing NI. Retrieved March 2015 from https://e-sourcingni.bravosolution.co.uk/web/login.shtml.
Eurlex . (2004a). European Union Directive 2004/17 Coordinating the Procurement Procedures of Entities Operating in the Water, Energy, Transport and Postal Services Sectors. Retrieved March 2015 from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0017:en:HTML.
Eurlex . (2004b). European Union Directive 2004/18 on the Coordination of Procedures for the Award of Public Works Contracts, Public Supply Contracts and Public Service Contracts. Retrieved March 2015 from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0018:En:HTML.
Eurlex . (2012). A Strategy for e-Procurement. Retrieved March 2015 from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0179.
Eurlex . (2013). Commission Regulation (EU) No 1336/2013 of 13 December 2013 Amending Directives 2004/17/EC, 2004/18/EC and 2009/81/EC of the European Parliament and of the Council in Respect of the Application Thresholds for the Procedures for the Awards of Contract (Text with EEA Relevance). Retrieved March 2015 from http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1398238103896&uri=CELEX:32013R1336.
Eurlex . (2014a). Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on Public Procurement and Repealing Directive 2004/18/EC (Text with EEA Relevance). Retrieved March 2015 from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.094.01.0065.01.ENG.
Eurlex . (2014b). Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on Procurement by Entities Operating in the Water, Energy, Transport and Postal Services Sectors and Repealing Directive 2004/17/EC (Text with EEA Relevance). Retrieved March 2015 from http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1426711583200&uri=CELEX:32014L0025.
European Commission. (2007). The European e-business report, a portrait of e-business in 10 sectors of the EU economy, 5th Synthesis Report of the e-Business W@tch. Retrieved March 2015 from http://aei.pitt.edu/54204/.
European Dynamics (2014a). Newsroom. Retrieved March 2015 from http://www.e-pps.eu/default/page-view_category/catid-89/id-23.html.
55 European Dynamics (2014b). Pioneering the e-procurement era, Retrieved December, 2016, from http://www.eurodyn.com/ePPS_broch_portrait_02_high.pdf.

European Dynamics (2014c). Press Releases. Retrieved December 2016, from http://www.eurodyn.com/default/page-view_category/catid-16/id-408/type-press.html.
Gov.UK. (2015). Contracts Finder. Retrieved March 2015 from https://www.gov.uk/contracts-finder.
Griffith, A. , Knight, A. and King, A. (2003). Best Practice Tendering for Design and Build Projects. London: Thomas Telford, Ltd.
Gupta, A. , Parente, S. and Sanyal, P. (2012). Competitive bidding for health insurance contracts: Lessons from the online HMO auctions, International Journal of Health Care Finance and Economics, Vol. 12, Iss 4, 303322.
HA (2016). Highways Agency PQQ Assessment Questionnaire, Retrieved December, 2016, from http://assets.highways.gov.uk/about-us/procurement-pre-qualification-pack/Pre%20Qual%20Annex%20C%20Min%20H%26S%20Requirement%20.doc.
HMSO . (1988). Local Government Act 1988. London: Her Majestys Stationary Office Limited.
Hung, P. , Dickson K. , and Chiu, L. (2013). e-Tendering with Web Services: A Case Study on the Tendering Process of Building Construction, In 2013 IEEE International Conference on Services Computing, pp. 582588.
Hung, W. , Lin, C. , Tai, Y. Ho , C. and Jou, J. (2014). Exploring the impact of web-based e-procurement on performance: organisational, interorganisational and systems perspectives, International Journal of Logistics Research and Applications, 17(3), 200215.
JCT . (2015). Procurement. Retrieved March 2015 from http://corporate.jctltd.co.uk/products/procurement/.
Jetro . (2015). Japanese Government Procurement. Retrieved March 2015 from http://www.jetro.go.jp/en/database/procurement/.
Justia US Law . (2012). Title 41Public Contracts. Retrieved March 2015 from http://statecodesfiles.justia.com/us/2012/title-41/subtitle-ii/chapter-61/section-6101/section-6101.pdf.
Khknen, K. and Rannisto, J. (2015). Understanding fundamental and practical ingredients of construction project data management, Construction Innovation, 15(1), 723.
Katok, E. and Roth, A. (2004). Adoption of electronic commerce tools in business procurement: enhanced buying center structure and processes, Management Science, 50(8), 10441063.
Kim J. and Shunk D. (2003). Matching indirect procurement process with different B2B e-procurement systems, Computers in Industry Vol. 53. 153164.
Klemperer, P. and Temin, P. (2001). An early example of the Winners Curse in an auction, Journal of Political Economy, 109(6). Retrieved March 2015 from http://www.nuff.ox.ac.uk/users/klemperer/earlyexample.pdf.
Kumar, S. and Chang, C. (2007). Reverse auctions: how much total supply chain cost savings are there? A conceptual overview, Journal of Revenue and Pricing Management, 6(2), 7785.
Laryea, S. and Hughes, W. (2009). Commercial reviews in the tender process of contractors, Engineering, Construction and Architectural Management, 16(6), 558572.
Latham, Sir M. (1994). Constructing the Team, Joint Government of Industry Review of Procurement and Contractual Arrangements in the U.K. Construction Industry, HMSO, London.
Liao, T. , Wang, M. and Tserng, H. (2002). A framework of electronic tendering for government procurement: a lesson learned in Taiwan, Automation in Construction, 11(6), 731742.
56 Lim, Y. (2015). Use of BIM approach to enhance construction interface management: a case study, Journal of Civil Engineering and Management, 21(2), 201217.
Loosemore, M. and Richard, J. (2015). Valuing innovation in construction and infrastructure: Getting clients past a lowest price mentality, Engineering, Construction and Architectural Management, Vol. 22 Iss: 1, 3853.
Lopes, J. (2012). Construction in the economy and its role in socio-economic development. In Ofori, G. (ed.) New Perspectives on Construction in Developing Countries. Abingdon: Spon, 4071.
Lu, Q. , Meng, F. and Goh, M. (2014). Choice of supply chain governance: Self-managing or outsourcing?, International Journal of Production Economics, Vol. 154, August 2014, 3238.
MERX . (2015). Construction Procurement. Retrieved March 2015 from http://www.merx.com/English/NonMember.asp?WCE=Show&TAB=3&PORTAL=MERX&State=42&TEMPLATE_NAME=PrivateBuyerConstructionProcurement&hcode=rRUg6dgcJeejzMQ4uH7uBw%3d%3d.
Miller, D. , Doh, J. and Mulvey, M. (2015). Concrete slab comparison and embodied energy optimisation for alternate design and construction techniques, Construction and Building Materials, 80, 329338.
Minahan, T. and Degan, G. (2001). Best Practices in e-Procurement. The Abridged Report, Boston: Aberdeen Group. Retrieved March 2015 from http://www.inkoopportal.com/inkoopportal/download/common/e-procurement_1_.pdf.

Murdoch, J. and Hughes, W. (2008). Construction Contracts (4th ed.). London: Taylor & Francis.
NHS . (2015). Welcome to the NHS Commercial Solutions Tendering Site. Retrieved March 2015 from https://commercialsolutions.bravosolution.co.uk/web/login.shtml.
Northern Ireland Assembly . (2008). Appendix 4: Memoranda and Papers from Department of Finance and Personnel. Retrieved March 2015 from http://archive.niassembly.gov.uk/finance/2007mandate/reports/Report_19_08_09R_memoranda.htm.
Office of the First Minister and Deputy First Minister . (2005). A Review of Government Advertising. Belfast, Northern Ireland: Office of the First Minister and Deputy First Minister.
OGC . (2008). eAuctions. Retrieved March 2015 from http://webarchive.nationalarchives.gov.uk/20110601212617/httpogc.gov.uk/documents/OGC_Guidance_on_eAuctions.pdf.
Pham, L. , Teich, J. , Wallenius, H. and Wallenius, J. (2015). Multi-attribute online reverse auctions: recent research trends, European Journal of Operational Research, 242(1), 19.
Raghavan, N. and Prabhu, M. (2004). Object-oriented design of a distributed agent-based framework for e-procurement, Production Planning & Control, 15(7), 731741.
Ray, A. , Jenamani, M. and Mohapatra, P. (2013). Relationship preserving multi-attribute reverse auction: a web-based experimental analysis, Computers & Industrial Engineering, 66(2), 418430.
Sambhara, C. , Keil, M. , Rai, A. and Kasi, V. (2011). Buyers perceptions of the risks of Internet enabled reverse auctions. In Baumann, C. , Blasum H. , Bormer, T. and Tverdyshev, S. (eds.) Proceedings of Architectures and Applications for 57 Mixed-Criticality Systems (AMCIS) 2011, Newport Beach, March 2011, Paper 352. Retrieved March 2015 from http://aisel.aisnet.org/amcis2011_submissions/352/.
Scottish Government . (2015). Public Contracts Scotland. Retrieved March 2015 from http://www.publiccontractsscotland.gov.uk/search/search_mainpage.aspx.
Sell2Wales . (2015). Welcome to Sell2Wales. Retrieved March 2015 from http://www.sell2wales.gov.uk/.
SIMAP . (2015). NUTS. Retrieved March 2015 from http://simap.ted.europa.eu/web/simap/nuts.
Smeltzer, L. and Carr, A. (2003). Electronic reverse auctions promises, risks and conditions for success, Industrial Marketing Management, 32(6), 481488.
Soudry, O. (2004). Promoting economy: electronic reverse auctions under the EC directives on public procurement, Journal of Public Procurement, 4(3), 340374.
Staffordshire County Council . (2015). Welcome. Retrieved March 2015 from https://www.staffordshire.gov.uk/Homepage.aspx.
Stationary Office . (1999). Modernising Government White Paper. Retrieved March 2015 from http://webarchive.nationalarchives.gov.uk/20140131031506/http://www.archive.official-documents.co.uk/document/cm43/4310/4310.htm.
Tassabehji, R. , Taylor, W. , Beach, R. and Wood, A. (2006). Reverse e-auctions and supplierbuyer relationships: an exploratory study, International Journal of Operations and Production Management, 26(2), 166184.
Teich, J. , Wallenius, H. , Wallenius, J. and Koppius, O. (2004). Emerging multiple issue e-auctions, European Journal of Operational Research, 159(1), 116.
Tenders Direct . (2015). Tender Alert Service for the Public Sector. Retrieved March 2015 from http://www.tendersdirect.co.uk/?source=OJEC&lgid=OJEC.
TSO . (2006). Public Contracts Regulations 2006. HMSO, London. Retrieved March 2015 from http://www.opsi.gov.uk/si/si2006/uksi_20060005_en.pdf.
TSO . (2009). Public Contracts (Amendment) Regulations 2009. Retrieved March 2015 from http://www.legislation.gov.uk/uksi/2009/2992/contents/made.
TSO . (2011). The Public Procurement (Miscellaneous Amendments) Regulations 2011. Retrieved March 2015 from http://www.legislation.gov.uk/uksi/2011/2053/pdfs/uksi_20112053_en.pdf.
TSO . (2015). The Public Contracts Regulations 2015. Retrieved March 2015 from http://www.legislation.gov.uk/uksi/2015/102/pdfs/uksi_20150102_en.pdf.

Drivers for electronic procurement and building information modelling in the construction industry

Albano, G. L. and Sparro, M. (2010). Flexible strategies for centralized public procurement. Review of Economics and Institutions, 1(2), Fall 2010, Article 4, 132.

Alshawi, M. , and Ingirige, B. (2003). Web-enabled project management: an emerging paradigm in construction. Automation in Construction, 12(4), 349364.

Alvarez-Rodrguez, J. , Labra-Gayo, J. , and Ordoez de Pablos , P. (2014). New trends on e-procurement applying semantic technologies: current status and future challenges. Computers in Industry, 65(5), 800820.

Arayici, Y. , Coates, P. , Koskela, L. , Kagioglou, M. , Usher, C. and OReilly, K. (2011). Technology adoption in the BIM implementation for lean architectural practice. Automation in Construction, 20(2), 189195.

Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. International Journal of Project Management, 17(6), 337342.

Auriol, E. (2006). Corruption in procurement and public purchase. International Journal of Industrial Organization, 24(5), 867885.

Azhar, S. (2011). Building information modelling (BIM): trends, benefits, risks and challenges for the AEC industry. Leadership and Management in Engineering, 11(3), 241252.

Azhar, S. , Carlton, W. , Olsen, D. and Ahmad, I. (2011). Building information modeling for sustainable design and LEED rating analysis. Automation in Construction, 20(2), 217224.

Azhar, S. , Hein, M. and Sketo, B. (2008). building information modeling (BIM): Benefits, Risks and Challenges, Retrieved December 2016, from http://ascpro. ascweb.org/chair/paper/CPGT182002008.pdf.

Barlish, K. and Sullivan, K. (2012). How to measure the benefits of BIMa case study approach. Automation in Construction, 24(1), 149159.

81 Bazjanac, V. (2005). Model based cost and energy performance estimation during schematic design. In Proceedings of CIB W78, 22nd International Conference on Information Technology in Construction, Dresden (eds. Scherer, R. , Katranuschkov, P. , and Schapke, S.), Institute for Construction Informatics, Technische Universitt Dresden, 677688.

Bentley . (2012). About BIM. Retrieved March 2015 from http://www.bentley.com/en-US/Solutions/Buildings/About+BIM.htm.

Bew, M. , and Underwood, J. (2009). Delivering BIM to the UK Market. Handbook of Research on Building Information Modeling and Construction Informatics Concepts and Technologies, IGI-Global, 3064. Retrieved March 2015 from http://www.igi-global.com/book/handbook-research-building-information-modeling/37234.

BIMhub (2012). Sophisticated BIM is now available to everyone, with great benefits and high ROI, Retrieved December, 2016, from http://www.bimhub.com/level-bim/.

BIM Industry working Group . (2011). A report for the Government Construction Client Group Building Information Modelling (BIM) Working Party Strategy Paper. Retrieved March 2015 from http://www.bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf.

Bryde, D. and Robinson, L. (2007). The relationship between total quality management and the focus of project management practices. The TQM Magazine, 19(1), 5061.

buildingSMART Australasia (2012). National Building Information Modelling Initiative Report. Retrieved December, 2016, from http://buildingsmart.org.au/advocacy/the-national-bim-initiative-nbi/#.WGPqno_XIw0.

Chen, S. , Ruikar, K. , Carrillo, P. , Khosrowshahi, F. and Underwood, J. (2011). Construct IT for Business, e-Business in the Construction Industry, Loughborough University, UK.

Coates, P. , Arayici, Y. , Koskela, L. and Usher, C. (2010). The changing perception in the artefacts used in the design practice through BIM adoption. In Proceedings of CIB 2010, 1013 May, University of Salford, Salford, UK.

Davila, A. , Gupta, M. , and Palmer, R. (2003). Moving procurement systems to the Internet: the adoption and use of e-procurement technology models, European Management Journal, 21(1), 1123.

Deutsch, R. (2011). BIM and Integrated Design, 1st ed. John Wiley & Sons, Hoboken, NJ.

Dyllick, T. and Hockerts, K. (2002). Beyond the business case for corporate sustainability. Business Strategy and the Environment, 11(2), 130141.

Eadie, R. , Perera, S. , Heaney, G. , and Carlisle, J. (2007). Drivers and barriers to public sector e-procurement within Northern Irelands construction industry. Journal of Information Technology in Construction, 12, 103120. Retrieved 28 January 2012 from http://www.itcon.org/cgi-bin/works/Show?2007_6.

Eadie, R. , Perera, S. , and Heaney, G. (2010a). Identification of e-procurement drivers and barriers for UK construction organisations and ranking of these from the perspective of quantity

surveyors. Journal of Information Technology in Construction, 15, 2343. Retrieved March 2015 from http://www.itcon.org/cgi-bin/works/Show?2010_2.
Eadie, R. , Perera, S. , and Heaney, G. (2010b). A cross-discipline comparison of rankings of e-procurement drivers and barriers for UK construction organisations. Journal of Information Technology in Construction, 15, 217233. Retrieved March 2015 from http://www.itcon.org/cgi-bin/works/Show?2010_17.
82 Eadie, R. , Browne, M. , Odeyinka, H. , McKeown, C. , and McNiff, S. (2013a), BIM implementation throughout the UK construction project lifecycle: an analysis. Automation in Construction, 36, 145151.
Eadie, R. , Odeyinka, H. , Browne, M. , McKeown, C. and Yohanis, M. (2013b). An analysis of the drivers for adopting building information modelling. Journal of Information Technology in Construction, 18, 338352.
Eastman, C. , Teicholz, P. , Sacks, R. and Liston, K. (2011). BIM Handbook: A Guide to Building Information Modelling, 2nd ed. John Wiley & Sons, Hoboken, NJ.
Ebbesen, J. and Hope, A. (2013). Re-imagining the iron triangle: embedding sustainability into project constraints. PM World Journal, 2(3). Retrieved March 2015 from http://pmworldjournal.net/article/re-imagining-the-iron-triangle-embedding-sustainability-into-project-constraints/.
Eei, K. , Husain, W. , and Mustaffa, N. (2012). Survey on benefits and barriers of e-procurement: Malaysian SMEs perspective. International Journal on Advanced Science Engineering Information Technology, 2(6), 1419.
Efficiency and Reform Group . (2011). Government Construction Strategy. Cabinet Office, London.
Egbu, C. , Vines, M. and Tookey, J. (2004). The Role of Knowledge Management in E-Procurement Initiatives for Construction Organisations, Paper presented at ARCOM Twentieth Annual Conference 2004, 13 September, Heriot Watt University, (Khosrowshami, F. Ed.), Vol. 1, Arcom, University of Reading, Reading, 661671.
Emmitt, S. (2007). Design Management for Architects, 1st ed. Blackwell Publishing, Oxford, UK.
Eom, S. , Kim, S. and Jang W. (2015). Paradigm shift in main contractor-subcontractor partnerships with an e-procurement framework. KSCE Journal of Civil Engineering, 19(7), 19511961, doi:10.1007/s12205-015-0179-5.
Erridge, A. , Fee, R. and McIlroy, J. (2001). Best Practice Procurement: Public and Private Sector Perspectives, Gover Publishing Company, Burlington, VT, USA.
European Commission . (2015). Delivering savings for Europe: moving to full e-procurement for all public purchases by 2016. Retrieved March 2016 from http://europa.eu/rapid/press-release_IP-12-389_en.htm.
Faniran, O. , Love, P. , Treloar, G. and Anumba, C. (2001). Methodological issues in design-construction integration. Logistics Information Management, 14(5/6), 421426.
Fitzpatrick, T. (2012). MOJ demands level 2 BIM by 2013. Retrieved March 2015 from http://www.cnplus.co.uk/news/moj-demands-level-2-bim-by-2013/8627140.article.
Furneaux, C. and Kivvits, R. (2008). BIMImplications for Government. CRC for Construction Innovation, Brisbane. Retrieved March 2015 from http://eprints.qut.edu.au/26997/.
Gebauer, J. , Beam, C. and Segev. A. (1998). Impact of the Internet on purchasing practices. Acquisitions Review Quarterly, 5(2), 167184.
Gray, P. (2006). The Management, Retention and Disposal of Administrative Records, Scottish Executive Health Department, Directorate of Primary Care and Community care. Retrieved March 2015 from http://www.sehd.scot.nhs.uk/mels/HDL2006_28.pdf.
83 Grilo, A. and Jardim-Goncalves, R. (2010). Value proposition on interoperability of BIM and collaborative working environments. Automation in Construction, 19(5), 522530.
Grilo, A. and Jardim-Goncalves, R. (2011). Challenging electronic procurement in the AEC sector: a BIM-based integrated perspective. Automation in Construction, 20(2), 107114.
Gunasekaran, A. , McGaughey, R. , Ngaic, E. and Rai, B. (2009a). E-Procurement adoption in the Southcoast SMEs. International Journal of Production Economics, 122(1), 161175.
Gunasekaran, A. , McGaughey, R. , Ngaic, E. and Rai, B. (2009b). Impact of e-procurement: experiences from implementation in the UK public sector. Journal of Purchasing & Supply Management, 13(4), 294303.
Gunasekaran, A. and Ngai, E. (2008). Adoption of e-procurement in Hong Kong: an empirical research, International Journal of Production Economics, Vol. 113 (1). 159175.
Hawking, P. , Stein, A. , Wyld, D. and Forster, S. (2004). E-procurement: is the ugly duckling actually a swan down under? Asia Pacific Journal of Marketing and Logistics, 16(1), 126.
Howard, R. , and Bjrk, B. (2008). Building information modellingexperts views on standardisation and industry deployment. Advanced Engineering Informatics, 22(2), 271280.
Huq, Z. , Seyed-Mahmoud, A. , Lotfollah, N. , and Saeedreza, H. (2010). Employee and customer involvement: the driving force for Six-Sigma implementation. Journal of Applied

Business & Economics, 11(1), 105123.
IDC . (2009). Westfield Uses Building Information Modelling to Reduce Time and Eliminate Rework across the Property Development Supply Chain. International Data Corporation, Framingham, MA.
Kalakota, R. , Tapscott, D. and Robinson, M. (2001). e-Business 2.0: Roadmap for Success, 2nd ed. Addison-Wesley Publishing Company, Boston MA.
Kiviniemi, M. , Sulankivi, K. , Kahkohnen, K. , Makela, T. and Merivirta, M. (2011). BIM-based Safety Management and Communication for Building Construction. VTT Technical Research Centre of Finland, Vuorimiehentie, Finland.
Knudsen, D. (2003). Aligning corporate strategy, procurement strategy and e-procurement tools. International Journal of Physical Distribution & Logistics Management, 33(8), 720734.
Kong, C. , Li, H. , and Love P. (2001). An ecommerce system for construction material procurement. Construction Innovation, 1(1), 4354.
Kymmell, W. , (2008). Building Information Modelling: Planning and Managing Construction Projects with 4D CAD and Simulations. McGraw Hill, New York.
Laryea, S. and Ibem, E. (2014), Barriers and prospects of e-procurement in the South African construction industry. In Proceedings of the 7th Annual Quantity Surveying Research Conference, Tshwane University of Technology, Pretoria, South Africa, 2123 September 2014, 112.
Leite, F. , Akinci, B. , and Garrett, J. (2009). Identification of data items needed for automatic clash detection in MEP design coordination. In Proceedings of Construction Research Congress 2009: Building a Sustainable Future (eds. Ariaratnam, S. and Rojas, E.), Seattle, Washington, 57 April 2009, 416425.
Lewis, A. , Riley, D. and Elmualim, A. (2010). Defining high performance buildings for operations and maintenance. International Journal of Facility Management, 1(2), 116.
84 Li, X. , Aouad, G. , Li, Q. , and Fu, C. (2008). An nD modeling enabled collaborative construction supply chain information system. In Proceedings of the Second International Symposium on Intelligent Information Technology Application, 2008. IITA 08. 2022 December, Vol. 3, 171175. Retrieved March 2015 from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4739981.
Lindskog, H. and Mercier-Laurent, E. (2014). Knowledge management applied to electronic public procurement. IFIP Advances in Information and Communication Technology, 422, 95111.
Liu, R. , Issa, R. and Olbina. S. (2010). Factors influencing the adoption of building information modeling in the AEC industry. In Proceedings of the International Conference on Computing in Civil and Building Engineering (ed. Tizani, W.), University of Nottingham, Nottingham. Retrieved March 2015 from http://www.engineering.nottingham.ac.uk/icccbe/proceedings/pdf/pf70.pdf.
Martin, J. (2009). 2009 BCIS eTendering Survey Report. Retrieved 28 January 2012 from http://www.bcis.co.uk/downloads/2009_BCIS_eTendering_Survey_Report_pdf_2_pdf
McGraw Hill (2009), The Business Value of BIM: Getting Building Information Modeling to the Bottom Line, Retrieved December, 2016, from http://www.slideshare.net/JohnathanE/mcgrawhill-the-business-value-of-bim.
McIntosh, G. and Sloan, B. (2001). The potential impact of electronic procurement and global sourcing within the UK construction industry. In Proceedings of Arcom 17th Annual Conference 2001 (ed. Akintoye, A.), University of Salford, Salford, September, 231239.
Minahan, T. and Degan, G. (2001). Best Practices in e-Procurement, The Abridged Report. Boston: Aberdeen Group. Retrieved March 2015 from http://www.inkoopportal.com/inkoopportal/download/common/e-procurement_1_.pdf.
National Archives . (2012). Records Management: Retention Scheduling 5. Contractual Records. Retrieved March 2015 from http://www.nationalarchives.gov.uk/documents/information-management/sched_contractual.pdf.
Nawari, N. (2012). BIM standard in off-site construction. Journal of Architectural Engineering, 18(2), 107113.
Nguyen, H. (2013). Critical factors in e-business adoption: Evidence from Australian transport and logistics companies. International Journal of Production Economics, 146 (1), 300312.
Olofsson, T. and Eastman, C. (2008). Benefits and lessons learned of implementing building virtual design and construction (VDC) technologies for coordination of mechanical, electrical, and plumbing (MEP) systems on a large healthcare project, Journal of Information Technology in Construction (ITcon), 13(1), 324342.
Panayiotou, N. , Sotiris, G. and Tatsiopoulos, I. (2003). An e-procurement system for governmental purchasing. International Journal of Production Economics, 90(1), 79102.
Panda, P. and Sahu, G. (2015). Electronic government procurement implementation in India: a cross sectional study. International Journal of Business Information Systems, 18(1), 125.

Raghavan, N. and Prabhu, M. (2004). Object-oriented design of a distributed agent-based framework for e-Procurement. Production Planning & Control, 15(7), 731741.
Rankin, J. , Chen, Y. and Christian, A. (2006). E-procurement in the Atlantic Canadian AEC industry. Journal of Information Technology in Construction, 11, Special Issue e-Commerce in construction, 7587. Retrieved March 2015 from http://www.itcon.org/cgi-bin/works/Show?2006_6.
85 RIBA . (2013). RIBA Plan of Work 2013. Retrieved March 2015 from http://www.ribaplanofwork.com/.
Ribeiro, F. and Henriques, P. (2001). How knowledge can improve e business in construction. Proceedings of 2nd International Postgraduate Research Conference in the Built and Human Environment, University of Salford, Blackwell Publishing, Salford UK.
Sacks, R. , Treckmann, M. and Rozenfeld, O. (2009). Visualization of work flow to support lean construction. Journal of Construction Engineering and Management, 135(12), 13071315.
Samuelson, O. and Bjrk, B. (2010). Adoption processes for EDM, EDI and BIM technologies in the construction industry. Retrieved March 2015 from https://helda.helsinki.fi/handle/10227/779.
Simu, T. (2012). E-government for good governance in Bangladesh: trade and commerce perspective. SUST Journal of Social Sciences, 18(4), 2839.
Sone, J. (2011). E-Governance in Central Texas: Patterns of e-Gov Adoption in Smaller Cities. Applied Research Projects, Texas State University-San Marcos. Paper 381. Retrieved March 2015 from http://ecommons.txstate.edu/arp/381.
Spalde, C. , Sullivan, F. , de Lusignan, S. and Madeley, J. (2006). e-Prescribing, Efficiency, Quality: Lessons from the Computerization of UK Family Practice, Journal of the American Medical Informatics Association, 13(5). 470475.
Tindsley, G. and Stephenson, P. (2008). E-tendering process within construction: a UK perspective. Tsinghua Science & Technology, 13(1), 273278.
Tokta-Palut, P. , Baylava, E. , Teomanb, S. , and Altunbeyc, M. (2014). The impact of barriers and benefits of e-procurement on its adoption decision: an empirical analysis. International Journal of Production Economics, 158(2014), 7790.
TRADA . (2012). Construction Briefings: Building Information Modelling. Timber Research and Development Association, High Wycombe, UK.
Tutt, D. , Dainty, A. , Gibb, A. and Pink, S. (2011). Migrant Construction Workers and Health & Safety Communication, Construction Industry Training Board, Kings Lynn, UK.
Walker, A. (2007). Project Management in Construction, 5th ed. Blackwell Publishing, Oxford, UK.
Wang, Y. , Xi, C. , Zhang, S. , Yu, D. , Zhang, W. and Li, Y. (2014). A combination of extended fuzzy AHP and fuzzy GRA for government E-tendering in hybrid fuzzy environment. The Scientific World Journal, 2014, 111.
Williams, C. and Lynnes, R. (2002). e-Business without the commerce. In Proceedings of the Water Environment Federation, WEF/AWWA Joint Management 2002, Water Environment Federation, Vol. 6, 298303.
Wong, C. and Sloan, B. (2004). Use of ICT for e-procurement in the UK construction industry: a survey of SMES readiness. In Proceedings of ARCOM 20th Annual Conference 2004 (ed. Khosrowshami, F.), 13 September, Heriot Watt University, Vol. 1, Arcom, University of Reading, Reading, UK, 620628.
86 Woo J. H. (2007). BIM (Building Information Modeling) and Pedagogical Challenges, Proceedings of the 43rd Annual Conference by Associated Schools of Construction (eds. Sulbaran, T. and Cummings, G.), Northern Arizona University, Flagstaff USA, 1214 April. Retrieved March 2015, from http://ascpro0.ascweb.org/archives/cd/2007/paper/CEUE169002007.pdf.
XEROX . (2007). Digital Archiving Promotes Sustainability and Improved Service Delivery for the London Borough of Islington. Retrieved March 2015 from https://docushare.xerox.com/pdf/ds_casestudy_LBI_En-UK.pdf.
Yan, H. and Damian P. (2008). Benefits and Barriers of Building Information Modelling. Retrieved March 2015 from http://homepages.lboro.ac.uk/~cvpd2/PDFs/294_Benefits%20and%20Barriers%20of%20Building%20Information%20Modelling.pdf.
Yu, S. , Mishra, A. , Gopal, A. , Slaughter, S. , and Mukhopadhyay, T. (2015). E-procurement infusion and operational process impacts in MRO procurement: complementary or substitutive effects? Production and Operations Management, 24(7), 10541070.

Building information modelling and management

AIA California Council (2007) Integrated Project Delivery: A Working Definition (Version 2). McGraw-Hill Construction and The American Institute of Architects, California Council, Sacramento, CA.
Autodesk (2002) Building Information Modeling. Autodesk Building Industry Solutions. Available at: http://www.laiserin.com/features/bim/autodesk_bim.pdf. Accessed 10 May 2015 .
Azhar, S. and Brown, J. (2009) BIM for sustainability analyses. International Journal of Construction Education and Research, 5 (4): pp. 276292.
102 Azhar, S. , Carlton, W.A. , Olsen, D. , and Ahmad, I. (2011) Building information modeling for sustainable design and LEED rating analysis. Automation in Construction, 20 (2): pp. 217224.
Babi, N.C. , Podbreznik, P. , and Rebolj, D. (2010) Integrating resource production and construction using BIM. Automation in Construction, 19: pp. 539543.
Barlish, K. and Sullivan, K. (2012) How to measure the benefits of BIMa case study approach. Automation in Construction, 24: pp. 149159.
Barnes, P. and Davies, N. (2014) BIM in Principle and in Practice. Institution of Civil Engineers, ICE Publishing, London.
BIM Task Group (2013) Government Soft Landings. Available at: http://www.bimtaskgroup.org/gsl/. Accessed 03 June 2015 .
BIM Working Party (2011) BIM: Management for Value, Cost and Carbon Improvement: A Report for the Government Construction Client Group. Available at: http://www.bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf. Accessed 03 June 2015 .
Bower, J.L. and Christensen, C.M. (1995) Disruptive technologies: catching the wave. Harvard Business Review, 73 (1): pp. 506520.
Bryde, D. , Broquetas, M. and Volm, J.M. (2013) The project benefits of Building Information Modelling (BIM). International Journal of Project Management, 31 (7): pp. 971980.
Brynjolfsson, E. and Hitt, L. M. (2000). Beyond computation: Information technology, organizational transformation and business performance. The Journal of Economic Perspectives, 14(4), 2348.
BSI . (2013) PAS 1192-2 Specification for information management for the capital/delivery phase of construction projects using building information modelling. BSI Standards Limited, London.
BSI . (2014) PAS 1192-3 Specification for information management for the operational phase of assets using building information modelling (BIM). BSI Standards Limited, London.
BSI . (2015). PAS 1192-5:2015 (BSI, 2015) Specification for security-minded building information modelling, digital built environment and smart asset management. BSI Standards Limited, London.
Cabinet Office (2011) Government Construction Strategy. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf. Accessed 04 June 2015 .
Cabinet Office (2014) New Models of Construction Procurement. Available at: https://www.gov.uk/government/publications/new-models-of-construction-procurement-introduction. Accessed 06 June 2015 .
Cerovsek, T. (2011) A review and outlook for a Building Information Model: a multi-standpoint framework for technological development. Advanced Engineering Informatics, 25 (2): pp. 224244.
CIC BIM2050 Group (2014) Built Environment 2050: A Report on Our Digital Future. Construction Industry Council BIM2050 Group. Available at: http://www.bimtaskgroup.org/wp-content/uploads/2014/09/2050-Report.pdf. Accessed 31 May 2015 .
Corke, G. (2012) BIM: Constructing a Virtual World. New Civil Engineer. Available at: http://www.nce.co.uk/bim-constructing-a-virtual-world/8640433.article. Accessed 31 May 2015 .
David, P.A. (1990) The dynamo and the computer: a historical perspective on the modern productivity paradox. American Economic Review Papers and Proceedings, 80 (2): pp. 355361.
103 Davis, F.D. (1993) User acceptance of information technology: system characteristics, user perceptions, and behavioral impacts. International Journal of Man Machine Studies, 38: pp. 475487.
Dossick, C. S. , and Neff, G. (2011). Messy talk and clean technology: communication, problem-solving and collaboration using Building Information Modelling. The Engineering Project

Organization Journal, 1(2), 8393.
Eastman, C. , Fisher, D. , Lafue, G. , Lividini, J. , Stoker, D. , and Yessios, C. (1974) An Outline of the Building Description System. Institute of Physical Planning, Carnegie-Mellon University, Pittsburgh, PA.
Eastman, C. , Teicholz, P. , Sacks, R. , and Liston, K. (2008) BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors. John Wiley & Sons, Hoboken, NJ.
Eastman, C. , Teicholz, P. , Sacks, R. , and Liston, K. (2011) BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. (2nd ed.). John Wiley and Sons, Hoboken, NJ.
Emery, F.E. and Trist, E.L. (1969) Socio-technical systems. In: Emery, F.E. (ed.) Systems Thinking: Selected readings. Penguin Books, London.
Fischer, M. and Kam, C. (2002) PM4D Final Report, CIFE Technical Report Number 143. Available at: http://cic.vtt.fi/vera/Documents/PM4D_Final_Report.pdf. Accessed 31 May 2013 .
Ford, S. , Aouad, G. , Brandon, P. , Brown, F. , Child, T. , Cooper, G. , Kirkham, J. , Oxman, R. , and Young, B. (1994) The object oriented modelling of building design concepts. Building and Environment, 29 (4): pp. 411419.
Golden, A. (2015) Where Does BIM Leave JCT and NEC3 Contracts? Chartered Institute of Building. Available at: http://www.bimplus.co.uk/management/where-does-bim-leave-jct-and-nec3-contracts/. Accessed 08 June 2013 .
Grilo, A. and Jardim-Goncalves, R. (2010) Value proposition on interoperability of BIM and collaborative working environments. Automation in Construction, 19: pp. 522530.
Gu, N. and London, K. (2010) Understanding and facilitating BIM adoption in the AEC industry. Automation in Construction, 19 (8): pp. 988999.
Hamza, N. and Horne, M. (2007) Building Information Modelling: empowering energy conscious design. In: 3rd International Conference of the Arab Society for Computer Aided Architectural Design (ASCAAD), 2628 November, Alexandria, Egypt.
H.M. Government (2014) Digital Built Britain: Level 3 Building Information Modelling Strategic Plan. Available at: http://www.digital-built-britain.com/DigitalBuiltBritainLevel3BuildingInformationModellingStrategicPlan.pdf. Accessed 30 May 2015 .
Holness, G.V.R. (2006) Building Information Modeling. ASHRAE Journal, 48 (8): pp. 3840, 42, 4446.
Howard, R. and Bjork, B.C. (2008) Building information modellingexperts views on standardisation and industry deployment. Advanced Engineering Informatics, 22: pp. 271280.
Laakso, M. and Kiviniemi, A. (2012) The IFC standarda review of history, development, and standardization. Journal of Information Technology in Construction (ITcon), 17: pp. 134161.
Laserin, J. (2008) BIM Handbook: A guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. In: Eastman, C. , Teicholz, P. , Sachs, R. , and Liston, C. (eds.). John Wiley & Sons, Hoboken, NJ.
104 Lockley, S. , Greenwood, D. , Matthews, J. , and Benghi, C. (2013) Constraints in authoring BIM components for optimal data reuse and interoperability: results of some initial tests. International Journal of 3-D Information Modeling (IJ3DIM), 2 (1): pp. 2944.
Malsane, S. , Matthews, J. , Lockley, S. , Love, P.E.D. , and Greenwood, D.J. (2015) Development of an object model for automated compliance checking. Automation in Construction, 49 (A): pp. 5158.
Marshall-Ponting, A.J. and Aouad, G. (2005) An nD modelling approach to improve communication processes for construction. Automation in Construction, 14 (3): pp. 311321.
McGraw-Hill Construction (2012). Business Value of BIM for Construction in North America. Available at: http://static-dc.autodesk.net/content/dam/autodesk/www/campaigns/BTT-RU/MHC-Business-Value-of-BIM-in-North-America-2007-2012-SMR.pdf. Accessed 04 June 2015 .
National Building Specification (2011) NBS National BIM Report 2011. Available at: http://www.thenbs.com/topics/bim/reports/index.asp. Accessed 04 June 2015 .
National Building Specification (2014) NBS National BIM Report 2014. Available at: http://www.thenbs.com/topics/bim/articles/nbs-national-bim-report-2014.asp. Accessed 31 May 2015 .
National Building Specification (2015) NBS National BIM Report 2015. Available at: http://www.thenbs.com/topics/bim/reports/index.asp. Accessed 04 June 2015 .
National Institute of Building Sciences (2007) National BIM Standard-United States. Available at: https://www.nationalbimstandard.org/faqs. Accessed 26 December 2016 .
Nour, M. , Hosny, O. , and Elhakeem, A. (2012) A BIM based energy and lifecycle cost analysis/optimization approach. International Journal of Engineering Research and Applications, 2 (6): pp. 411418.

PMI (2008). A Guide to the Project Management Body of Knowledge (PMBOK Guide). (4th ed.). Project Management Institute, Newton Square, PA.
RIBA (2013). The RIBA Plan of Work. Available at: https://www.ribaplanofwork.com/.Accessed 26 December 2016 .
Shetty, N. , Hayes, A. , Pocock, D. , and Watts, J. (2013) Building Information Modelling and Asset Management. Institute of Asset Management. Available at: https://theiam.org/knowledge/Building-Information-Modelling. Accessed 31 May 2015 .
Succar, B. (2009) Building information modelling framework: a research and delivery foundation for industry stakeholders. Automation in Construction, 18 (3): pp. 357375.
Tobin, J. (2013) BIM becomes VDC: A Case Study in Disruption. Building Design and Construction Network. Available at: http://www.bdcnetwork.com/bim-becomes-vdc. Accessed 31 May 15 .
van der Smagt, T. (2000) Enhancing virtual teams: social relations v. communication technology. Industrial Management & Data Systems, 100 (4): pp. 148156.
van Nederveen, G.A. and Tolman, F.P. (1992) Modelling multiple views on buildings. Automation in Construction, 1 (3): pp. 215224.
Volk, R. , Stengel, J. , and Schultmann, F. (2014) Building Information Modeling (BIM) for existing buildingsliterature review and future needs. Automation in Construction, 38: pp. 109127.
Wright, A.J. , Lockley, S.R. , and Wiltshire, A.J. (1992) Sharing data between application programs in building design: product models and object-oriented programming. Building and Environment, 27 (2): pp. 163171.
105 Yang, Q.Z. and Zhang, Y. (2006) Semantic interoperability in building design: methods and tools. Computer-Aided Design, 38: pp. 10991112.

BIM in practise industry case studies

AIA, AGC , 2013. Level of Development Specification. BIMForum.
Autodesk , 2002. Building Information Modelling. White paper. Available at: http://www.laiserin.com/features/bim/autodesk_bim.pdf. Accessed 9 June 2002 .
Autodesk , 2016. Dynamo Studio [WWW Document]. URL http://www.autodesk.com/products/dynamo-studio/overview. Accessed 18 January 2016 .
129 Becerik-Gerber, B. , Kensek, K. , 2010. Building information modeling in architecture, engineering, and construction: emerging research directions and trends. Journal of Professional Issues in Engineering Education and Practice 136, 139147. doi:10.1061/(ASCE)EI.1943-5541.0000023.
BIM Task Group , 2011. A Report for the Government Construction Client Group Building Information Modelling (BIM) Working Party Strategy Paper. Department of Business, Innovation and Skills, London.
Bordass, B. , Cohen, R. , Field, J. , 2004. Energy performance of non-domestic buildingsClosing the credibility gap. Presented at the Building Performance Congress. 3rd International Conference on Improving Energy Efficiency in Commercial Buildings (IEECB04). The Usable Buildings Trust, Frankfurt, Germany.
BSI , 2013. PAS 1192-2 Specification for information management for the capital/delivery phase of construction projects using building information modelling. BSI Standards Limited, London.
Commission for Architecture and the Built Environment (CABE) and RIBA, 2003. The professionals choice: the future of the built environment professions. Building Futures. Available at: http://www.buildingfutures.org.uk/assets/downloads/The_Professionals_Choice2003.pdf.
Eadie, R. , Browne, M. , Odeyinka, H. , McKeown, C. , McNiff, S. , 2013. BIM implementation throughout the UK construction project lifecycle: an analysis. Automation in Construction 36, 145151. doi:10.1016/j.autcon.2013.09.001.
Gardiner, J. , 2014. Is BIM what it says on the tin? Building Magazine. Available at: http://www.building.co.uk/analysis/is-bim-what-it-says-on-the-tin?/5072149. article. Accessed on 22 December 2016 .
Gartner, Inc, 2014. Gartner Hype Cycle. Gartner Research Methodologies. URL http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp. Accessed 4 June 2016 .
International Facility Management Association , 2013. BIM for Facility Managers. Wiley, Hoboken, NJ.
McGraw Hill Construction , 2014. The Business Value of BIM for Construction in Major Global Markets: how Contractors around the World Are Driving Innovation with Building Information

Modelling (SmartMarket Report). New York.
NBS , 2011. National BIM Report (UK) 2011. NBS, London.
NBS , 2012. National BIM Report (UK) 2012. NBS, London.
NBS , 2013. National BIM Report (UK) 2013. NBS, London.
NBS , 2014. National BIM Report (UK) 2014. NBS, London.
Neumann, C. , Jacob, D. , 2010. Results of the project Building EQ: tools and methods for linking EPBD and continuous commissioning (No. EIE/06/038/SI2 .448300). Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany.
RIBA , 2013. RIBA Plan of Work 2013 Overview. RIBA, London.
Rogers, E.M. , 2003. Diffusion of Innovations, 5th ed. Simon & Schuster International, New York.
University of York , 2014. New Environment Building Construction Works Start [WWW Document]. University of York: environment. URL http://www.york.ac.uk/ environment/news-events/news/new-building-august-2014/. Accessed 16 January 2016 .
van Nederveen, G.A. , Tolman, F.P. , 1992. Modelling multiple views on buildings. Automation in Construction 1, 215224. doi:10.1016/0926-5805(92)90014-B.
Volk, R. , Stengel, J. , Schultmann, F. , 2014. Building Information Modeling (BIM) for existing buildingsLiterature review and future needs. Automation in Construction 38, 109127. doi:10.1016/j.autcon.2013.10.023.
WHR and Jones Lang LaSalle, 2013. One Angel Square. Available at: http://www.noma-manchester.com/media/1066/one-angel-square.pdf. Accessed 15 January 2016 .
130 Wood, B. , 2012. COBie Data Drops. BIM Task Group. Available at http://www.bimtaskgroup.org/wp-content/uploads/2012/03/COBie-data-drops-29.03.12.pdf. Accessed 22 December 2016 .
Yalcinkaya, M. , Singh, V. , 2015. Patterns and trends in Building Information Modeling (BIM) research: a latent semantic analysis. Automation in Construction 59, 6880. doi:10.1016/j.autcon.2015.07.012.

Manchester Central Library and Town Hall Extension Project

AIA . (2007). Integrated Project Delivery: A Guide, The American Institute of Architects, Washington, DC.
AIA . (2010). Integrated Project Delivery: Case Studies, The American Institute of Architects California Council, Sacramento, CA.
AutoDesk . (2012). White paper: a framework for implementing a BIM business transformation, AutoDesk, Inc.: San Rafael, USA.
BIM Industry Working Group . (2011). A report for the Government Construction Client Group: Building Information Modelling (BIM) working party strategy paper. Retrieved from http://www.bimtaskgroup.org/wp-content/uploads/2012/03/BIS-BIM-strategy-Report.pdf.
Brady, L. (2015). Reaping the Benefits, RICS Construction Journal, February/March 2015, RICS, London, 1619.
British Standard Institute . (2013). Design, Construction and Operation Data and Process Management. [online] BSI. Available at: http://shop.bsigroup.com/upload/construction_downloads/b555_roadmap_june_2013.pdf.
Codinhoto, R. , Kiviniemi, A. , Kemmer, S. and da Rocha, C. G. . (2011). BIM Implementation: Manchester Town Hall ComplexResearch Report 1, University of Salford, Salford, UK.
Codinhoto, R. , Kiviniemi, A. , Kemmer, S. , Esiet, U. B. , Donato, V. and Tonso, L. G. (2013). BIM-FM: Manchester Town Hall ComplexResearch Report 2, University of Salford, Salford, UK.
Harmon, P. (2004). Evaluating an organisations business process maturity, Business Process Trends, 2(3), 111.
McGraw-Hill . (2013). The Business Value of BIM in North America: Mulit-Year Trend Analysis and User Ratings (20072012), McGraw-Hill Construction, Bedford, MA.
National Institute of Building Science . (2007). National Building Information Modeling Standard, version 1, Part 1: Overview, Principles, and Methodologies.
NBS . (2014). NBS National BIM Report 2014, RIBA Enterprises Ltd., Newcastle-upon-Tyne, UK.
152 NWCH . (2014a). More for Your Money, North West Construction Hub, http://www.nwconstructionhub.org/mfym.pdf.
NWCH . (2014b). Award Wins to Date in 2014, North West Construction Hub, http://www.nwconstructionhub.org/news/award-wins-to-date-in-2014.

NWCH . (2015a). What is the North West Construction Hub? North West Construction Hub, http://www.nwconstructionhub.org/.
NWCH , (2015b). BIM Focus 2015Driving back-to-basics best practice Project Delivery 21 May 2015 , North West Construction Hub, http://www.nwconstruction hub.org/news/bim-focus-2015-driving-back-to-basics-best-practice-project-delivery.
NWCH . (2015c). NWCH Projects Awards List 2015, North West Construction Hub http://www.nwconstructionhub.org/assets/documents/case-studies/Award_update_Apr15_2.pdf.
Ottewell, D. (1 July 2008). 150m to save Central Library. Manchester Evening News (M.E.N. Media), Oldham, UK. [Accessed on: 28 May 2016].
Succar, B. (2009). BIM Episode 12: BIM Performance Measurement. BIM ThinkSpace Blog. Available at: http://www.bimthinkspace.com/2009/09/index.html [Accessed on: 28 May 2016].
Succar, B. (2010). Building Information Modelling Maturity Matrix. In Underwood, J. and Isikdag, U. (Eds.), Handbook of Research on Building Information Modelling and Construction Informatics: Concepts and Technologies, Information Science Reference, IGI Publishing, New York.

Project extranets and developments in project collaboration

Alshawi, M. and Goulding, J. (2008), Organisational e-readiness: embracing IT for sustainable competitive advantage, Construction Innovation: Information, Process, Management, 8(1), doi:10.1108/ci.2008.33308aaa.001.
Alshawi, M. , Goulding, J.S. , Khosrowshahi, F. , Lou, E.C.W. and Underwood, J. (2008), Strategic Positioning of IT in Construction - An Industry Leaders Perspective, Construct IT for Business, Salford, UK.
Angeles, R. (2001), Creating a digital marketplace presence: lessons in extranet implementation, Internet Research, 11(2), 167184.
178 Arslan, G. , Tuncan, M. , Birgonul, M.T. and Dikmen, I. (2006), E-bidding proposal preparation system for construction projects, Building and Environment, 41(10), 14061413.
Aziz, N.M. and Salleh, H. (2013), Case studies of the human critical success factors in information technology (IT) implementation in Malaysian construction industry, Journal of Building Performance, 5(1), 19.
Basu, A. and Jarnagin, C. (2008), How to Tap ITs Hidden Potential, Sloan Management Review/Wall Street Journal Business Insights Series, The Wall Street Journal, 10 March 2008 .
Bharadwaj, A. , El Sawy, O.A. , Pavlou, P.A. and Venkatraman, N. (2013), Digital business strategy: toward a next generation of insights, MIS Quarterly, 37(2), 471482.
Bin Zakaria, Z. , Mohamed Ali, N. , Tarmizi Haron, A. , Marshall-Ponting, A.J. and Abd Hamid, Z. (2013), Exploring the adoption of Building Information Modelling (BIM) in the Malaysian construction industry: a qualitative approach, International Journal of Research in Engineering and Technology, 2(8), 384395.
Brook, M. (2012), Estimating and Tendering for Construction Work, Routledge, Oxon UK.
Bryde, D. , Broquetas, M. and Volm, J.M. (2013), The project benefits of building information modelling (BIM), International Journal of Project Management, 31(7), 971980.
BSI . (2013), Specification for Information Management for the Capital/Delivery Phase of Construction Projects Using Building Information Modelling (PAS 1192), British Standards Institute, London.
buildingSMART . (2016), Industry Foundation Classes Release 4 (IFC4), building SMART International, http://www.buildingsmart-tech.org/ifc/IFC4/final/html/ [Accessed 3 January 2016].
Business Wire . (2008), Survey cites dissatisfaction with incumbent ERP vendors, Business Wire, www.sys-con.com/node/594952 [Accessed 2 January 2013].
Byatt, I. (2000), A review of local government procurement in England: main report, Office of the Deputy Prime Minister, The Stationery Office, London.
Cabinet Office (2011), Government Construction Strategy, London: HMSO.
Carty, V. (2010), New information communication technologies and grassroots mobilization, Information, Communication and Society, 13(2), 155173.
Dehlin, S. and Olofsson, T. (2008), An evaluation model for ICT investments in construction projects, Journal of Information Technology in Construction, special issue, Case studies of BIM in use, 13, 343361.
Diabagate, A. , Azmani, A. and El Harzli , M. (2015), E-tendering: modeling of a multi-agents system integrating the concepts of ontology and big data, Global Journal of Computer Science, 5(2), 8089.

Du, T.C. (2009), Building an automatic e-tendering system on the Semantic Web, Decision Support Systems, 47(1), 1321.
Eadie, R. , Perera, S. and Heaney, G. (2010), Identification of e-procurement drivers and barriers for UK construction organisations and ranking of these from perspective of quantity surveyors, Journal of Information Technology in Construction, 15, 2343.
Egan, J. (1998). Rethinking construction: The report of the construction task force, London: HMSO.
Elhag, T.M.S. , Boussabaine, A.H. and Ballal, T.M.A. (2005), Critical determinants of construction tendering costs, International Journal of Project Management, 23(7), 538545.
179 Emmitt, S. and Gorse, C.A. (2009), Construction communication, John Wiley & Sons, Oxford UK.
Eriksson, P.E. and Westerberg, M. (2011), Effects of corporative procurement procedures on construction project performance: a conceptual framework, International Journal of Project Management, 29(2), 197208.
Gann, D.M. and Salter, A.J. (2000), Innovation in project-based, service-enhanced firms: the construction of complex products and systems, Research Policy, 29, 955972.
Goulding, J.S. and Lou, E.C.W. (2013), E-readiness in construction: an incongruous paradigm of variables, Journal of Architectural Engineering and Design Management, 9(4), 265280.
Haque, M.E. and Rahman, M. (2009), Time-space-activity conflict detection using 4D visualisation in multi-storied construction project, Visual Informatics: Bridging Research and Practice, Springer, Berlin and Heidelberg, 266278.
Hassan, I.E. and Abu Talib, N. (2015), State-led cluster development initiatives: a brief anecdote of multimedia super corridor, Journal of Management Development, 34(5), 524535.
HM Government . (2012), Building Information Modelling, Industrial Strategy: Government and Industry in Partnership, URN 12/1327, HMSO, London.
IET . (2014), Digital engineering and project controls in the construction industry, The Institution of Engineering and Technology, http://www.theiet.org/sectors/built-environment/files/Laing-digital-casestudy.cfm [Assessed 19 October 2014].
Internet World Statistics . (2012), Internet usage statistics - the big picture, Internet World Statistics, http://www.internetworldstats.com/stats.htm [Accessed 17 January 2012].
Jrgensen, K.A. , Skauge, J. , Christiansson, P. , Svidt, K. , Srensen, K.B. and Mitchell, J. (2008), Use of IFC Model Servers-Modelling Collaboration Possibilities in Practice, Department of Production, Aalborg University, Aalborg, Denmark.
Khorana, S. , Furguson-Boucher, K. and Kerr, W.A. (2015), Governance issues in the EUs e-procurement framework, Journal of Common Market Studies, 53(2), 292310.
Kiviniemi, A. (2011), The effects of integrated BIM in processes and business models, Distributed Intelligence in Design, Wiley-Blackwell, Oxford, UK, 125135.
Knudsen, D. (2003), Aligning corporate strategy, procurement strategy and e-procurement tool, International Journal of Physical Distribution and Logistics Management, 33(8), 720734.
Krigsman, M. (2009), IT project failure. Worldwide cost of IT failure: $6.2 trillion, ZDNet, http://blogs.zdnet.com/projectfailures/?p=7627&tag=col1;post-7695 [Assessed 19 March 2014].
Krigsman, M. (2010). Understanding Marin Countys $30 million ERP failure. ZDNet, Retrieved September 13, 2010, from http://www.zdnet.com/blog/projectfailures/understanding-marin-countys-30-million-erp-failure/10678?tag=nl.e539
Latham, M. (1994). Constructing the team. London: HMSO.
Lavelle, D. and Bardon, A. (2009), E-tendering in construction: Time for a change?, Northumbria Working Paper Series: Interdisciplinary Studies in the Built and Virtual Environment, Newcastle, UK.
Lee, S.K. and Yu, J.H. (2012), Success model of project management information system in construction, Automation in Construction, 25, 8293.
180 Lou, E.C.W. , and Alshawi, M. (2009). Critical success factors for e-tendering implementation in construction: People and process issues. ITcon, 14, 98109.
Lou, E.C.W. , Goulding, J.S. , Alshawi, M. , Khosrowshahi, F. and Underwood, J. (2012), Leveraging IT-based competitive advantage: UK industry perspective, Journal of Architecture, Planning and Construction Management, 2(1), 2762.
NBS . (2015), National BIM Report 2015, National Building Specification, London.
Peansupap, V. and Walker, D.H. (2006), Information communication technology (ICT) implementation constraints: a construction industry perspective, Engineering, Construction and Architectural Management, 13(4), 364379.
Retik, A. and Langford, D. (2001), Computer Integrated Planning and Design for Construction, Thomas Telford Limited, London.
Robinson, H. and Udeaja, C. (2015), Reusing knowledge and leveraging technology to reduce design and construction costs, Design Economics for the Built Environment: Impact of Sustainability on Project Evaluation, John Wiley & Sons, Chichester, UK, 227239.

Rodrik, D. (2014), The past, present, and future of economic growth, Challenge, 57(3), 539.
Ronald, N.K. and Omwenga, J.Q. (2015), Factors contributing to adoption of e-procurement in county governments: a case study of County Government of Bomet, Internal Journal of Academic Research in Business and Social Science, 5(10), 233239.
Ruikar, K. , Anumba, C.J. and Carrillo, P.M. (2005), End-user perspectives on use of project extranets in construction organisations, Engineering, Construction and Architectural Management, 12(3), 222235.
Sakas, D. , Vlachos, D. and Nasiopoulos, D. (2014), Modelling strategic management for the development of competitive advantage, based on technology, Journal of Systems and Information Technology, 16(3), 187209.
Salah, Y. (2003), IT Success and Evaluation: A General Practitioner Model, PhD Thesis, Research Institute for the Built Environment (BuHu), University of Salford, UK.
Saxon, R.G. (2013), Growth through BIM, Construction Industry Council, London.
Singh, V. , Gu, N. and Wang, X. (2011), A theoretical framework of a BIM-based multi-disciplinary collaboration platform, Automation in Construction, 20, 134144.
Singleton, T. and Cormican, K. (2013), The influence of technology on the development of partnership relationships in the Irish construction industry, International Journal of Computer Integrated Manufacturing, 26(12), 1928.
Thompson, G. (2013), The Economic Impact of EU Membership on the UK, House of Commons Library, London.
Turban, E. , King, D. , Lee, J.K. , Liang, T.P. and Turban, T.P. (2015), Overview of electric commerce, Electronic Commerce, 8th Edition, Springer International Publishing, Switzerland, 349.
Vaidya, K. , Sajeev, A.S.M. and Callender, G. (2006), Critical factors that influence e-procurement implementation success in the public sector, Journal of Public Procurement, 6(1/2), 70.
Virkar, S. (2015), Globalisation, the Internet, and the nation-state: a critical analysis, in Sahlin, J.P. (ed.), Social Media and the Transformation of Interaction in Society, IGI Global, Hershey PA USA, 5166.
Vlosky, P.R. , Fontenot, R. and Blalock, L. (2000), Extranets: impacts on business practices and relationships, Journal of Business and Industrial Marketing, 15(6), 438457.
181 Wang, M.T. (2014), The design and implementation of enterprise management system based on ERP, Applied Mechanics and Materials, 655, 62216224.
Wirtz, J. , Tuzovic, S. and Ehret, M. (2015), Global business services: increasing specialization and integration of the world economy as drivers of economic growth, Journal of Service Management, 26(4), 565587.
Won, J. , Lee, G. , Dossick, C. and Messner, J. (2013), Where to focus for successful adoption of building information modeling within organization, Journal of Construction Engineering and Management, 139(11), doi:10.1061/(ASCE)CO.1943-7862.0000731.
Wright, J. , Brinkley, I. and Clayton, N. (2010), Employability and Skills in the UK: Redefining the Debate, The Work Foundation, London.
Yigitcanlar, T. and Sarimin, M. (2015), Multimedia Super Corridor, Malaysia: knowledge-based urban development lessons from an emerging economy, VINE Journal of Information and Knowledge Management Systems, 45(1), 126147.

Transforming policy documents into intelligent three-dimensional collaboration tools

Anderson, P. (2007). 'What is Web 2.0? Ideas, Technologies and Implications for Education, JISC Technology & Standards Watch, http://www.ictliteracy.info/rf.pdf/Web2.0_research.pdf. Accessed on 25 July 2009 .
Armburst, M. et al . (2009). Above the Clouds: A Berkeley View of Cloud Computing, Electrical Engineering and Computer Sciences. University of California at Berkeley, http://www2.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.pdf. Accessed on 2 December 2010 .
ATKINS . (2012). Future Proofing Cities, Risks and Opportunities for Inclusive Urban Growth in Developing Countries, Department for International Development and University of London: Development Planning Unit, Atkins, Epsom, UK.
Bacheldor, B. (2013). Tageos Apparel RFID Label Certified by the University of Arkansas, RFID News Roundup, RFID Journal Europe 2013, http://www. rfidjournal.com/articles/view?11116. Accessed on 28 June 2014 .

Bluyssen, P.M. (2014). The Healthy Indoor Environment, How to Assess Occupants Wellbeing in Buildings, Routledge, New York, p. 283.
Buchanan, G. and Shortliffe, E.H. (1984). Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming, Addison-Wesley, Reading, M.A. Sourced from Wilmering, T.J. and Mott, C.D. 2011. Health Management Systems Engineering and Integration, System Health Management with Aerospace Applications, p. 96.
Business Transformation Agency . (2009). Vocabulary-Driven Enterprise Architecture Development, Guidelines for DoDAF AV-2: Design and Development of the Integrated Dictionary, pp. 1112, http://dodcio.defense.gov/Portals/0/Documents/DODAF/Primitives_AV-2_Guidelines.pdf. Accessed on 22 March 2013 .
Butler, J. (2007). Automated Demand Response and BACnet: Article by Jim Butler, Cimetrics, from AutomatedBuildings, Buildings that have BACnet-based building control systems are particularly well positioned to participate in DR programs, Cimetrics Inc. 2011, http://www.automatedbuildings.com/news/sep07/articles/cimetrics/070831101606cimetrics.htm (Accessed 12 November 2013).
Chandler, D. and Werther, W.B., Jr . (2014). Strategic Corporate Social Responsibility, Stakeholders, Globalization, and Sustainable Value Creation, 3rd Ed., Sage Publications, Inc., Thousand Oaks, CA.
210 Charles, K. , Magee, R.J. , Won, D. and Lusztyk, E. (2005). Indoor Air Quality Guidelines and Standards, National research Council Canada, Final Report 5.1CMEIAQ-II: Consortium for Material Emission and IAQ Modelling II, http://nparc.cisti-icist.nrc-cnrc.gc.ca/eng/view/fulltext/?id=c597c638-536c- 4ed9-b99c-20eb102a3bc0.
Clymer, J.R. (2009). Simulation-Based Engineering of Complex Systems, 2nd Ed., John Wiley & Sons, Inc., Hoboken, NJ, pp. 911.
Element Energy . (2009). Uptake of Energy Efficiency in Buildings. Report for the Committee on Climate Change, Final Report, 11 August 2009 , Sourced from Leach, M. , Deshmukh, S. and Ogunkunle, D. 2014. Pathways to Decarbonising Urban Systems, Urban Retrofitting For Sustainability, Mapping the Transition to 2050, p. 200.
Government Accountability Office (GAO). (2012). VA and DOD Department-Level Actions Needed to Assess Collaboration Performance, Address Barriers, and Identify Opportunities, GAO-12992 VA and DOD Collaboration, United States Accountability Office, Washington, DC.
Hagan, S.R. and Onuma, K. (2014). FED iFM and iFM, Integrated Facility Management for Federal Agencies and the Broader Facility Owner Community, The Future of BIM Vision-Integration-Savings, Journal of The National Institute of Building Sciences, 2 (6): pp. 2629.
Hay, D. and Healy, K.A. (2000). Defining Business RulesWhat Are They Really? The Business Rules Group formerly, known as the GUIDE Business Rules Project, Final Report revision 1.3, http://www.businessrulesgroup.org/first_paper/BRG-whatisBR_3ed.pdf.
International Finance Corporation (IFC) . (2012). IFC Sustainability Framework, Policy and Performance Standards on Environmental and Social Sustainability, Access to Information Policy, International Finance Corporation, Washington, DC.
Josuttis, N.M. (2007). SOA in Practice, The Art of Distributed System Design, OReilly Media, Inc., Sebastopol, CA.
Kundoo, A. (2015). Affordable housing, rethinking affordability in economic and environmental terms in india, Inclusive Urbanization, Rethinking Policy, Practice and Research in the Age of Climate Change, Edited by Shrestha, K. , Ojha, H. , McManus, P. , Rubbo, A. and Dhote, K. , Routledge, New York, pp. 108119.
Kurtalj, N. (2011). Mashup, Data World Data Never Sleeps, AutomatedBuildings.com, http://www.automatedbuildings.com/news/jan11/articles/brightcore/101230115707brightcore.html. Accessed January 2011.
Lavelle, M.R. (2014). Cloud Computing for Better Energy Management, Pending Publication, Technical notes, Lavelle Energy LLC, Indianapolis, IN.
Leach, M. , Deshmukh, S. and Ogunkunle, D. (2014). Pathways to Decarbonizing Urban Systems, Urban Retrofitting For Sustainability, Mapping the Transition to 2050, Edited by Dixon, T. , Eames, M. , Hunt, M. and Lannon, S. , Routledge, New York, NY, pp. 191207.
LogicGem . (2006). LogicGem 3.0 QuickStart, Catalyst Development, Copyright 1996, 2006 Catalyst Development Corporation.
MiraCosta Comprehensive Master Plan . (2011). Comprehensive Master Plan MiraCosta Community College District, http://www.miracosta.edu/governance/budgetandplanning/masterplan.html.
Missia, D.A. , Demetriou, E. , Michael, N. , Tolis, E.I. and Bartzis, J.G. (2010). Indoor exposure from building materials: A field study. Atmospheric Environment 44 (35): pp. 43884395. doi:10.1016/j.atmosenv.2010.07.049.
Moller, A. and Schwartzbach, M.I. (2006). An Introduction to XML and Web Technologies, Addison-Wesley, Boston, MA.

Exchanges; Version 1Part 1: Overview, Principles, and Methodologies , 2007 National Institute of Building Sciences,
http://www.1stpricing.com/pdf/NBIMSv1_ConsolidatedBody_Mar07.pdf.National Building Information Modeling Standard (NBIMS) (2007). Transforming the Building Supply Chain through Open and Interoperable Information
211 National Building Information Modeling Standard (NBIMS) (2007). Transforming the Building Supply Chain through Open and Interoperable Information Exchanges; Version 1Part 1: Overview, Principles, and Methodologies, 2007 National Institute of Building Sciences, http://www.1stpricing.com/pdf/NBIMSv1_ConsolidatedBody_Mar07.pdf.
National Protection and Programs Directorate (NPPD) . (2014). Sector Resilience Report: Hospitals, Office of Cyber and Infrastructure Analysis (OCIA) Including the Homeland Infrastructure Threat and Risk Analysis (HITRAC) and the National Infrastructure Simulation and Analysis Center (NISAC), http://www.dhs.gov/office-cyber-infrastructure-analysis.
Onuma, K. (2010). Location, location, location, BIM, BIM, BIM. Journal of Building Information modelling, Fall 2010, Cloud, pp. 2122.
Open Geospatial Consortium (OGC) (2007). OGC Web Services Architecture for CAD GIS and BIM, Reference number of this OpenGIS Project Document: OGC 07-023r2, Version: 0.9, OGC Discussion Paper, Editor: Paul Cote , https://portal.opengeospatial.org/files/?artifact_id=21622. Accessed on 22 August 2011 .
Oracle . (2008). Business Process Management, Service-Oriented Architecture, and Web 2.0: Business Transformation or Train Wreck? Oracle Corporation, World Headquarters, Redwood Shores, CA.
Redmond, A. (2013). Designing a Framework for Exchanging Partial Sets of BIM Information on a Cloud-Based Service, PhD Thesis Submitted to Dublin Institute of Technology, School of Real Estate and Management for Degree of Doctor of Philosophy.
Redmond, A. , Alshawi, M. and Underwood, J. (2014). Designing Business Rules to Identify BIM Impact on Driving Policies for the Built Environment, The 1st International Conference on Industrial, System and Manufacturing Engineering (ISME14), Amman, Jordan, November 1113.
Redmond, A. , Hore, A. , Alshawi, M. and West, R. (2012). Exploring how information exchanges can be enhanced through Cloud BIM, Automation in Construction Volume 24, July 2012, pp. 175183.
Redmond, A. and Smith, B. (2012). The use of semantic methods capable of supporting an Urban Sustainability Multi-Attribute Decision Model. The Higher Education Academy, STEM Annual Conference, April 1213, Imperial College London.
Redmond, A. and Smith, B. (2013). Designing a Cloud BIM Business Process Model Case Study, AACE International Transactions, BIM-1265, AACE International, Morgantown, WV, ISBN 9781885517807.
Redmond, A. , West, R. and Hore, A. (2013). Designing a framework for exchanging partial sets of BIM information on a cloud based service. International Journal of 3-D Information Modeling 2 (4): 1224. IGI Publishing, Hershey, PA.
Rich, C. , Singleton, J.K. and Wadhwa, S. (2013). Sustainability for Healthcare Management, A Leadership Imperative, Routledge, New York, pp. 1736.
Schools Interoperability Framework (SIF). (2012). SIF Data Model Implementation Specification (US) 2.6, http://specification.sifassociation.org/Implementation/US/2.6/html/.
Squires, G. (2013). Urban and Environmental Economics, An Introduction, Routledge, Abingdon, UK.
Stair, R. , Reynolds, G. and Chesney, T. (2008). Principles of Business Information Systems, Cengage Learning EMEA.
212 Thorel, M. , Andrieux, F. and Buhe, C. (2013). Knowledge Management Supporting Decision Making in Holistic Building Renovation Design, CIB W078 2013, International Conference on Information Technology for Construction, Tsinghua University, Beijing, China, October 911.
Walton, C. (2006). Agency and the Semantic Web, OUP, Oxford.
Wang, H. , Yi, X. , Lai, J. and Li, Y. (2005). Fabricating microbolometer array on unplanar readout integrated circuit. International Journal of Infrared and Millimeter Waves 26 (5): pp. 751762.
Wasson, C.S. (2006). System Analysis, Design, and Development: Concepts, Principles, and Practices, John Wiley & Sons, Inc., Hoboken, NJ, p. 735.
Wikipedia . (2013). Microbolometer, http://en.wikipedia.org/wiki/Microbolomete. Accessed on 21 November 2013 .
Wilmering, T.J. and Mott, C.D. (2011). Health Management Systems Engineering and Integration, System Health Management with Aerospace Applications, Edited by Johnson, S.B. , Gormley, T.J. , Kessler. S.S. , Mott, C.D. , Patterson-Hine, A. , Reichard, K.M. and Scandura, P.A. Jr , John Wiley & Sons Ltd, West Sussex, UK, pp. 95113.

Impact of collaboration tools and shaping the future of data exchange A model for BIM communication waste

Abdelmohsen, S. (2012). Genres of communication interfaces in BIM-enabled architectural practice. In 6th ASCAAD Conference 2012 CAAD Innovation Practice, Kingdom University, Manama, Bahrain (p. 81).

Aouad, G. and Arayici, Y. (2010). Requirements Engineering for Computer Integrated Environments. Wiley-Blackwell: Oxford, UK.

Aouad, G. , Lee, A. , and Wu, S. (2005). nD modelling for collaborative working in construction. Architectural Engineering and Design Management, 1(1), 3344.

Arayici, Y. , Ahmed, V. , and Aouad, G. (2006). A requirements engineering framework for integrated systems development for the construction industry. Journal of Information Technology in Construction, 11 (October 2005), 3555.

Asite . (2017). AsiteCorporate Collaboration, eProcurement, BIM, eSourcing, Contract Management, Building Information Modelling. Retrieved 2 January 2017 from https://www.asite.com/.

242 Ballard, G. and Howell, G. (1998). What kind of production is construction? In Proceedings IGLC 1998, Guaruj, Brazil, 1315 August.

Ballard G. , Tommelein I. , Koskela L. and Howell G. , 2002. Lean Construction Tools and Techniques. In Best and de Valence (editors), Design and Construction: Building in Value (pp. 227255). Butterworth-Heinemann: Oxford.

Bastian, M. , Heymann, S. , and Jacomy, M. (2009). Gephi: an open source software for exploring and manipulating networks. ICWSM, 8, 361362.

Beach, T. H. , Y. Rezgui , and O. F. Rana . Cloudbim: Management of BIM Data in a Cloud Computing Environment. Proceedings of the 28th International Conference of CIB W78, Sophia Antipolis, France, 26. Vol. 28. 2011.

Becerik, B. and Pollalis, S. N. (2006). Computer aided collaboration in managing construction, Harvard Design School, Department of Architecture, Design and Technology Report Series 20062.

Bertelsen, S. , Henrich, G. , Koskela, L. J. , and Rooke, J. A. (2007). Construction physics. In Proceedings of the 15th Annual Conference of the International Group for Lean Construction (pp. 1326).

BIM Task Group . (2013). Employers Information Requirements Core Content and Guidance. Retrieved from http://www.bimtaskgroup.org/wp-content/uploads/2013/04/Employers-Information-Requirements-Core-Content-and-Guidance.pdf on 2 January 2017 .

BIM Task Group . (2014). http://www.bimtaskgroup.org/. Accessed 7 July 2014 .

BRE . (2014). BRE Group: Level 2 BIM on Triala buildingSMART UK User Group Event. Retrieved July 24, 2014, from http://www.bre.co.uk/page.jsp?id=3368.

BSI . (2007). BS ISO 1192:2007. Collaborative production of architectural, engineering and construction informationcode of practice. Retrieved from http://shop.bsigroup.com/forms/PASs/BS-1192-2007/ on 2 January 2017 .

BSI . (2013). PAS 1192-2: 2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling. Retrieved from http://shop.bsigroup.com/forms/PASs/PAS-1192-2/ on 2 January 2017 .

BSI . (2014). Specification for information management for the operational phase of assets using building information modelling. Retrieved from http://shop.bsigroup.com/upload/Construction_downloads/PAS1192-3%20final%20bookmarked.pdf on 2 January 2017 .

Cabinet Office . (2011). Government Construction Strategy. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf on 2 January 2017 .

Cabinet Office . (2012). Government Soft Landing Policy. Retrieved from http://www.bimtaskgroup.org/wp-content/uploads/2012/09/The-Government-Soft-Landings-Policy.doc on 2 January 2017 .

Cabinet Office, BSI . (2013). COBie Data Drops. Retrieved from http://www.bimtaskgroup.org/wp-content/uploads/2012/03/COBie-data-drops-29.03.12.pdf on 2 January 2017 .

Cerovsek, T. (2011). A review and outlook for a Building Information Model (BIM): a multi-standpoint framework for technological development. Advanced Engineering Informatics, 25(2), 224244.

Chachere, J. , Kunz, J. , and Levitt, R. (2009). The role of reduced latency in integrated concurrent engineering. CIFE Working Paper# WP116.

243 CIC, Construction Industry Council . (2013a). Building Information Model Protocol CIC/BIM Pro. Retrieved from http://cic.org.uk/download.php?f=the-bim-protocol.pdf on 2 January 2017 .

CIC, Construction Industry Council . (2013b). Best Practice Guide for Professional Indemnity Insurance When Using Building Information Models, 1st ed. London: Construction Industry Council.
Coates, P. , Arayici, Y. , Koskela, L.J. , Kagioglou, M. , Usher, C. , O' Reilly, K. (2010). The limitations of BIM in the architectural process, First International Conference on Sustainable Urbanization, Hong Kong, China, 1517 December 2010.
Dainty, A. , Moore, D. , and Murray, M. (2007). Communication in Construction: Theory and Practice. Routledge: New York.
Dave, B. , Koskela, L. J. , Kiviniemi, A. O. , Tzortzopoulos Fazenda, P. , and Owen, R. L. (2013). Implementing Lean in Construction: Lean Construction and BIM. CIRIA: London.
Froese, T. M. (2010). The impact of emerging information technology on project management for construction. Automation in Construction, 19(5), 531538, doi:10.1016/j.autcon.2009.11.004.
Hull, E. , Jackson, K. , and Dick, J. (2005). Requirements Engineering (Vol. 3).Springer: London.
Isikdag, U. and Underwood, J. (2010). Two design patterns for facilitating building information model-based synchronous collaboration. Automation in Construction, 19(5), 544553, doi:10.1016/j.autcon.2009.11.006.
Koskela, L. (1997). Lean production in construction. In Alarcon, L. (Ed.), Lean Construction. Balkema, Rotterdam, pp. 110.
Koskela, L. (2000). An Exploration Towards a Production Theory and Its Application to Construction. Espoo, Finland: VTT Technical Research Centre of Finland.
Koskela, L.J. , Blviken, T. and Rooke, J.A. (2013), Which are the wastes of construction? in: The 21st Annual Conference of the International Group for Lean Construction., July 31- August 2, 2013, Fortaleza, Brazil, 29 July2 August.
Kreider, R. G. and Messner, J. I. (2013). The Uses of BIM: Classifying and Selecting BIM Uses, Version 0.9, September. University Park, PA: The Pennsylvania State University. http://bim.psu.edu. Accessed 5 May 2013 .
Liu, N. , Kagioglou, M. , and Liu, L. (2011, March). An overview of the marketed functionalities of web-based construction collaboration extranets. In Information Science and Technology (ICIST), 2011.
MoJ, Ministry of Justice . (2013). Early Adopters Project-HMYOI Cookham Wood: New House Block and Education Building, BIM Lessons Learnt, Report Version 3. Available at: http://www.bimtaskgroup.org/wp-content/uploads/2012/03/Cookham-Wood-Consolidated-Lessons-Learned-version3-with-intro.pdf. Accessed 6 June 2012 .
Mooney, J. D. (1947). The Principles of Organization. Harper: New York:.
National Institute of Standards and Technology (NIST). (2004). Cost analysis of inadequate interoperability in the US capital facilities industry. National Institute of Standards and Technology (NIST), Advanced Technology Program, Information Technology and Electronics Office: Gaithersburg, MD.
Nisbet, N. (2012). COBie-UK-2012: Required Information for Facility Ownership.
Rezgui, Y. , Beach, T. , and Rana, O. (2013). A governance approach for BIM management across lifecycle and supply chains using mixed-modes of information delivery. Journal of Civil Engineering and Management, 19(2), 239258.
244 Rezgui, Y. and Zarli, A. (2006). Paving the way to the vision of digital construction: a strategic roadmap. Journal of Construction Engineering and Management, 132(7), 767776.
Sacks, R. , Koskela, L. , Dave, B. A. , and Owen, R. (2010). Interaction of lean and building information modeling in construction. Journal of Construction Engineering and Management, 136(9), 968, doi:10.1061/(ASCE)CO.1943-7862.0000203.
Shannon, C. E. , and Weaver, W. (1949). The mathematical theory of communication. University of Illinois Press.
Simon, H. A. (1981). The Sciences of the Artificial. Massachusetts Institute of Technology: Cambridge, MA:.
Sinclair, D. (2012). BIM Overlay to the RIBA Outline Plan of Work. RIBA: London, UK.
Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. Automation in Construction, 18(3), 357375.
Tribelsky, E. and Sacks, R. (2006). Measures of information flow for lean design in civil engineering. Scientific Committee, 1493. Retrieved from http://centaur.reading.ac.uk/31329/1/CME25-Whole_Procs.pdf#page=1515 on 2 January 2017 .
Venugopal, M. , Eastman, C. M. , Sacks, R. , and Teizer, J. (2012). Semantics of model views for information exchanges using the industry foundation class schema. Advanced Engineering Informatics, 26(2), 411428.
Yeomans, S. G. , Bouchlaghem, N. M. , and El-Hamalawi, A. (2006). An evaluation of current collaborative prototyping practices within the AEC industry. Automation in Construction, 15(2), 139149.

Towards the establishment of a district information modelling

AGC Contractors Guide to BIM . 2006. Associated General Contractors Guide. Retrieved from http://www.agcnebuilders.com/documents/BIMGuide.pdf/.
Bansal, V.K. , 2011. Application of geographic information systems in construction safety planning. International Journal of Project Management, 29, 6677.
Bishr, Y. , 1998. Overcoming the semantic and other barriers to GIS interoperability. International Journal of Geographical Information Science, 12, 299314.
Choi, J.W. et al. , 2008. Developing ubiquitous space information model for indoor GIS service in ubicomp environment. In Fourth International Conference on Networked Computing and Advanced Information Management, 2, Gyeongju, Korea, IEEE, pp. 381388.
Colak, I. et al. , 2015. A survey on the contributions of power electronics to smart grid systems. Renewable and Sustainable Energy Reviews, 47(1), 562579.
Del Giudice, M. , Osello, A. and Patti, E. , 2014. BIM and GIS for district modelling. In eWork and eBusiness in Architecture, Engineering and Construction, Proceedings of the 10th European Conference on Product and Process Modelling, ECPPM, Vienna, Taylor & Francis Group: London, pp. 851855.
District Information Modelling and Management for Energy Reduction (DIMMER). Available at: http://dimmer.polito.it/ [Accessed April 15, 2015].
Elbeltagi, E. and Dawood, M. , 2011. Integrated visualized time control system for repetitive construction projects. Automation in Construction Journal, 20(7), 940953.
Energy@home . 2012. Energy@home Project. Retrieved December 27, 2015 from http://www.energy-home.it/SitePages/Home.aspx.
EPBD , 2010. Directive 2010/31/EU of the European parliament and of the Council. Official Journal of the European Union, L 153, pp. 1335.
European Commission , 2011. Energy Efficiency Plan 2011, COM(2011) 109 Final. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0109:FIN:EN:PDF.
European Commission , 2012. A Roadmap to Low Carbon Economy in 2050, COM(2011) 112 final.
Fang, X. et al. , 2012. Smart gridthe new and improved power grid: a survey. IEEE Communications Surveys and Tutorials, 14(4), 944980.
Fracastoro, G.V. and Serraino, M. , 2011. A methodology for assessing the energy performance of large scale building stocks and possible applications. Energy and Buildings, 43(4), 844852.
Grohnheit, P.E. and Gram Mortensen, B.O. , 2003. Competition in the market for space heating. District heating as the infrastructure for competition among fuels and technologies. Energy Policy, 31(9), 817826.
Hagedorn, B. and Dllner, J. , 2007. High-level web service for 3D building information visualization and analysis. In Proceedings of the 15th Annual ACM International Symposium on Advances in Geographic Information SystemsGIS 07. ACM Press, New York, p. 1.
Hijazi, I. et al. , 2009. IFC to CityGML transformation framework for geo-analysis: a water utility network case. In 4th International Workshop on 3D Geo-Information, Ghent, Belgium, conference proceeding, pp. 123127.
Hippolyte, J.L. et al. , 2014. ICT for a low carbon economy, an ee-district ontology to support the development of the ee-District Information Model of the RESILIENT project. In European Commission DG (ed.), 260 EEBuilding Data Models Energy Efficiency Vocabularies & Ontologies, Proceedings of the 4th Workshop organised by the EEB Data Models Community ICT for Sustainable Places, Nice, France, European Commission, pp. 106119.
Huxhold, W.E. , 1991. An Introduction to Urban Geographic Information Systems, Oxford University Press, New York.
IPCC . 2014. Climate Change 2014: Mitigation of Climate Change, The Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA. Retrieved from http://www.ipcc.ch/report/ar5/wg3/.
Irizarry, J. , Karan, E.P. and Jalaei, F. , 2013. Integrating BIM and GIS to improve the visual monitoring of construction supply chain management. Automation in Construction, 31, 241254.
Isikdag, U. , Underwood, J. and Aouad, G. , 2008. An investigation into the applicability of building information models in geospatial environment in support of site selection and fire response management processes. Advanced Engineering Informatics, 22(4), 504519.
Kelly, S. and Pollitt, M. , 2010. An assessment of the present and future opportunities for combined heat and power with district heating (CHP-DH) in the United Kingdom. Energy Policy, 38(11), 69366945.
Koch, A. , Girard, S. and McKoen, K. , 2012. Towards a neighbourhood scale for low- or zero-carbon building projects. Building Research & Information, 40(4), 527537.
Levin, A. , 2015. Customer incentives and potential energy savings in retail electric markets: a Texas case study. The Electricity Journal, 28(3), 5164.

Lombardi, P. , 2011. Managing the green IT agenda. Intelligent Buildings International, 3(1), 4145.
Lombardi, P. , 2015. Local experiencies in energy transition. ENEA, Energia Ambiente e Innovazione, LCS-RNet Transition and Global Challenges towards Low Carbon Societies, 61, 5558.
Lombardi, P. and Trossero, E. , 2013. Beyond energy efficiency in evaluating sustainable development in planning and the built environment. International Journal of Sustainable Building Technology and Urban Development, 4(4), 274282.
Lombardi, P. et al. , 2014. Web and cloud management for building energy reduction: toward a smart district information modelling. In Z. Sun (ed.), Demand-Driven Web Services: Theory, Technologies, and Applications. IGI Global: Pennsylvania, USA, pp. 340355.
Lund, H. et al. , 2014. 4th Generation District Heating (4GDH). Integrating smart thermal grids into future sustainable energy systems. Energy, 68, pp. 111.
Moon, H. et al. , 2015. BIM-based construction scheduling method using optimization theory for reducing activity overlaps. Journal of Computing in Civil Engineering, 29(3), 130709222650005, pp. 116.
Mostafavi, S. , Beltran, M.M. and Biloria, N. , 2013. Performance driven design and design information exchange. In 31st International Conference on Education and research in Computer Aided Architectural Design in Europe, Delft, The Netherlands: eCAADe (Education and Research in Computer Aided Architectural Design in Europe), pp. 117126.
National project Cluster Zero Energy Buildings in Smart Urban Districts (EEB). Available at: http://home.deib.polimi.it/bolchini/research/eeb.html [Accessed April 25, 2015].
Osello, A. et al. , 2013. Ugliotti information interoperability and interdisciplinarity: the BIM approach from SEEMPubS project. Territorio Italia, 2, 922.
261 Pea-Mora, F. et al. , 2010. Mobile ad hoc network-enabled collaboration framework supporting civil engineering emergency response operations. Journal of Computing in Civil Engineering, 24(3), 302312.
Rafiee, A. et al. , 2014. From BIM to geo-analysis: view coverage and shadow analysis by BIM/GIS integration. In 12th International Conference on Design and Decision Support Systems in Architecture and Urban Planning, Procedia Environmental Sciences, 22, EindhovenThe Netherlands, Procedia Environmental Sciences, ELSEVIER, pp. 397402.
Ramesh, S. et al. , 2013. Urban energy information modelling: an interactive platform to communicate simulation-based high fidelity building energy analysis using Geographical Information Systems (GIS). In 13th Conference of International Building Performance Simulation Association, Proceedings of BS2013: 13th Conference of International Building Performance Simulation Association, Chambry, France, Proceedings of Building Simulation, pp. 11361143.
Sebastian, R. et al. , 2013. Semantic BIM and GIS modelling for energy-efficient buildings integrated in a healthcare district. In ISPRS 8th 3DGeoInfo Conference & WG II/2Workshop, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Istanbul, Turkey, ISPR, pp. 2729.
Sehrawat, P. and Kensek, K. , 2014. Urban energy modelling: GIS as an alternative to BIM. In 2014 ASHRAE/IBPSA-USA Building Simulation Conference, Atlanta, GA, ASHRAE, pp. 235242.
Stojanovski, T. , 2013. City information modelling (CIM) and urbanism: blocks, connections, territories, people and situations. In SimAUD 2013, Symposium on Simulation for Architecture and Urban Design, Proceeding SimAUD 13 Proceedings of the Symposium on Simulation for Architecture & Urban Design. Society for Computer Simulation International, San Diego, CA, p. 12.
The Intergovernmental Panel on Climate Change (IPCC), 2014. Climate Change 2014: Mitigation of Climate Change.
Toniolo, J. , Silvi, C. and Masoero, M. , 2013. Energy savings in HVAC systems by continuous monitoring. Results of a long term monitoring campaign on buildings. In International Conference on Renewable Energies and Power Quality (ICREPQ13), Bilbao, Spain, EA4EPQ, pp. 16.
Torabi Moghadam, S. et al. , 2015. Simulating window behaviour of passive and active users. Energy Procedia, 78, 621626.
Ulyatt, M. , BIM+thinking beyond a buildings lifespan. Available at: http://www.bimplus.co.uk/management/thinking-beyond-buildings-lifespan/ [Accessed April 22, 2015].
UNEP , 2009. Buildings and Climate Change, UNEP, Paris, France.
UNEP , 2012. Global Initiative for Resource Efficient Cities Engine to Sustainability. UNEP, Paris, France.

Wiel, S. et al. , 1998. The role of building energy efficiency in managing atmospheric carbon dioxide. Environmental Science & Policy, 1, 2738.
Wolisz, H. et al. , 2014. City district information modelling as a foundation for simulation and evaluation of smart city approaches. In 2014 Building Simulation and Optimization Conference, Proceeding of Building Simulation and Optimization Conference, UCL, London, UK, University College London, Proceeding.
Wu, I. and Hsieh, S. , 2007. Transformation from IFC data model to GML data model: methodology and tool development. Journal of the Chinese Institute of Engineers, 30(6), 10851090.
262 Yamaguchi, Y. , Shimoda, Y. and Mizuno, M. , 2007. Proposal of a modelling approach considering urban form for evaluation of city level energy management. Energy and Buildings, 39(5), 580592.
Zhang, X. et al. , 2009. Integrating BIM and GIS for large scale (building) asset management: a critical review. In The Twelfth International Conference on Civil, Structural and Environmental Engineering Computing, Funchal, Madeira, Portugal, CC2009, pp. 115.

Capability maturity modelling of construction e-business processes

Alshawi, M. (2007) Rethinking IT in Construction and Engineering: Organisational Readiness. Oxon, UK: Taylor & Francis.
Anumba, C. J. & Ruikar, K. (2008) e-Business in Construction. Oxford: Wiley-Blackwell.
Atkin, B. , Borgbrant, J. & Josephson, P. (2003) Construction Process Improvement. Oxford: Blackwell Science.
Bach, J. (1994) The immaturity of CMM, American Programmer, September, pp. 1318.
Bate, R. , Garcia, S. , Armitage, J. , Cusick, K. , Jones, R. , Kuhn, D. , Minnich, I. , Pierson, H. , Powell, T. , Reichner, A. & Wells, C. (1994) A System Engineering Capability Maturity Model, Version 1.0. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University.
Becta . (2005) The Becta Review: Evidence on the Progress of ICT in Education. Becta ICT Research, British Educational Communications and Technology Agency, UK, http://dera.ioe.ac.uk/1428/ accessed on 23 Dec 2016 .
293 Bew, M. and Richards, M. (2008) Bew-Richards BIM Maturity Model, http://www.bimtaskgroup.org/bim-faqs/, accessed on 23 Dec 2016 .
Chaffey, D. (2011) e-Business and e-Commerce Management: Strategy, Implementation and Practice. 5th ed. Harlow, UK: Pearson Education Limited.
Chen, C. , Chen, Y. & Yu, P. (2006) Establishing an e-business CMM with the concepts of capability, maturity and institutionalization, International Journal of Electronic Business Management, 4(3), pp. 205213.
Chen, Y. J. (2012) Strategic implications of e-business in the construction industry. Degree of Doctor of Philosophy. Loughborough University.
Eadie, R. (2009) Methodology for developing a model for the analysis of e-procurement capability maturity of construction organisations. Degree of Doctor of Philosophy. Ulster University.
Eadie, R. , Perera, S. & Heaney, G. (2011) Key process area mapping in the production of an e capability maturity model for UK construction organisations, Journal of Financial Management of Property and Construction, 16(3), pp. 197210.
Eadie, R. , Perera, S. & Heaney, G. (2012) Capturing maturity of ICT applications in construction processes, Journal of Financial Management of Property and Construction, 17(2), pp. 176194.
Egan, J. (1998) Rethinking Construction: The Report of the Construction Task Force. London: Department of the Environment, Transport and the Regions.
Egan, J. (2002) Accelerating Change: Strategic Forum for Construction. London: Construction Industry Council.
Fairclough, S. J. (2002) Rethinking Construction Innovation and Research: A Review of Government R&D Policies and Practices. London: Department of Trade and Industry.
GCS . (2011) Government construction strategy. Cabinet Office Report. [Accessed April 2015]. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-Construction-Strategy_0.pdf.
Harmon, P. (2004) Evaluating an organizations business process maturity. [Accessed April 2015]. Available from: http://www.bptrends.com/publicationfiles/03-04%20NL%20Eval%20BP%20Maturity%20-%20Harmon.pdf, accessed on 22 Dec 2016 .

Harris, F. & McCaffer, R. (2013) Modern Construction Management. 7th ed. Oxford: Wiley-Blackwell.
Humphrey, W. S. , Sweet, W. L. , Edwards, R. K. , LaCroix, G. R. , Owens, M. F. & Schulz, M. P. (1987) A Method for Assessing the Software Engineering Capability of Contractors. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon university.
Hutchinson, A. & Finnemore, M. (1999) Standardised process improvement for construction enterprises (SPICE), Total Quality Management & Business Excellence, 10(4), pp. 576583.
Jeong, K. S. , Kagioglou, M. , Haigh, R. , Amaratunga, D. & Siriwardena, M. L. (2006) Embedding good practice sharing within process improvement, Engineering, Construction and Architectural Management, 13(1), pp. 6281.
Jones, C. (1994) Assessment and Control of Software Risks. Upper Saddle River, NJ: Prentice-Hall.
Keraminiyage, K. P. (2009) Achieving high process capability maturity in construction organisatons. Degree of Doctor of Philosophy. The University of Salford, UK.
294 Keraminiyage, K. , Amaratunga, D. & Haigh, R. (2008) UK construction processes and IT adoptability: learning from other industries. In: Kazi, A. S. (ed.) ICT in Construction and Facility Management. Finland: VTT (Technical Research Centre of Finland) and RIL (Association of Finnish Civil Engineers).
Latham, M. (1994) Constructing the Team: Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry. London: HMSO.
Li, F. (2007) What Is e-Business? How the Internet Transforms Organizations. Oxford: Blackwell Publishing.
Love, P. E. D. , Irani, Z. & Edwards, D. J. (2004) Industry-centric benchmarking of information technology benefits, costs and risks for small-to-medium sized enterprises in construction, Automation in Construction, 13, pp. 507524.
Mutula, S. M. and Van Brakel P. (2006), An evaluation of e-readiness assessment tools with respect to information access: Towards an integrated information rich tool, International Journal of Information Management, Volume 26, Issue 3, June 2006, Pages 212223, http://www.sciencedirect.com/science/article/pii/S0268401206000077, accessed on 22 Dec 2016 .
NBS . (2014) BIM levels explained. [Accessed June 2015]. Available from: http://www.thenbs.com/topics/bim/articles/bim-levels-explained.asp.
NIBS . (2007) National Institute for Building Sciences (NIBS) Facility Information Council (FIC)BIM Capability Maturity Model. [Accessed April 2015]. Available from: http://www.facilityinformationcouncil.org/bim/pdfs/BIM_CMM_v1.9.xls.
NIST . (2007) National Building Information Modeling StandardVersion 1.0Part 1: Overview, Principles and Methodologies. Washington, DC: National Institute of Building Sciences.
Paulk, M. C. , Curtis, B. , Chrissis, M. B. & Weber, C. V. (1993) Capability Maturity Model for Software, Version 1.1. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, (CMU/SEI-93-TR-024).
Rodrigo, A. , Perera, S. , Udeaja, C. & Zhou, L. (2011) Towards a stepwise improvement tool for construction e-business: conceptual approach. 10th International Postgraduate Research Conference (IPGRC), 1415 September 2011, University of Salford, UK.
Rodrigo, A. , Perera, S. , Zhou, L. & Udeaja, C. (2014) Construction process categorisation towards developing an e-business maturity model. International Conference on Construction in a Changing World, 47 May 2014, Heritance Kandalama, Sri Lanka.
Ruikar, K. , Anumba, C. J. & Carrillo, P. M. (2006) VERDICTan e-readiness assessment application for construction companies, Automation in Construction, 58, pp. 98110.
Sarshar, M. , Finnemore, M. & Haigh, R. (1999) SPICE: is the capability maturity model applicable in the construction industry?, 8th International Conference on Durability of Building Materials and Components (CIB W78), May 30June 3 , Vancouver, Canada.
Sarshar, M. , Haigh, R. , Finnemore, M. , Aouad, G. , Barrett, P. , Baldry, D. & Sexton, M. (2000) SPICE: a business process diagnostics tool for construction project, Journal of Engineering, Construction and Architectural Management, 7(3), 241250.
Sarshar, M. , Hutchinson, A. , Aouad, G. , Barrett, P. & Golding, J. (1998) Standardised process improvement for construction enterprises (SPICE). 2nd European Conference on Product and Process Modelling, Watford, Hertfordshire, UK.
295 Schneider, G. P. (2010) Electronic Commerce. 9th ed. Boston, MA: Thomson Course Technology.
SEI . (2002) Capability Maturity Model Integration (CMMI): Version 1:1. Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University.
Shaikh, A. , Ahmed, A. , Memon, N. & Memon, M. (2009) Strengths and weaknesses of maturity driven process improvement effort. Complex, Intelligent and Software Intensive Systems, 2009. CISIS 09. International Conference, 1619 March 2009 , Fukuoka, Japan.

Sommerville, J. & Craig, N. (2006) Implementing IT in Construction. Oxon, UK: Taylor & Francis.
Stelzer, D. & Mellis, W. (1999) Success factors of organizational change in software process improvement, Software Process Improvement and Practice, 4(4), pp. 227250.
Stewart, R. A. & Spencer, C. A. (2006) Six-sigma as a strategy for process improvement on construction projects: a case study, Construction Management and Economics, 24(4), pp. 339348.
Stockdale, R. , Standing, C. & Love, P. E. D. (2006) Propagation of a parsimonious framework for evaluating information systems in construction, Automation in Construction, 15, pp. 729736.
Succar, B. (2009) Building information modelling maturity matrix. In: Underwood, J. & Isikdag, E. (eds) Handbook of Research on Building Information Modelling and Construction Informatics: Concepts and Technologies. Hershey, PA: IGI Publishing.
Succar, B. , Sher, W. & Williams, A. (2012) Measuring BIM performance: five metrics, Architectural Engineering and Design Management, 8, pp. 120142.
Sun, M. & Howard, R. (2004) Understanding IT in Construction. Oxon, UK: Taylor & Francis.
Weinberg, G. M. (1993) Quality Software Management (Vol. 2): First-Order Measurement. New York: Dorset House Publishing.
Wilkinson, P. (2005) Construction Collaboration Technologies: The Extranet Evolution. Oxon, UK: Taylor & Francis.

e-Business infrastructure and strategic frameworks

Al-Mashari, M. (2002) Enterprise resource planning (ERP) systems: a research agenda. Industrial Management & Data Systems, 102(3), 165170.
Alshawi, M. (2007) Rethinking IT in Construction and EngineeringOrganisational Readiness. Abington, PA: Taylor and Francis.
Alshawi, M. , Goulding, J. , Khosrowshahi, F. , Lou, E. and Underwood, J. (2008) Strategic positioning of IT in construction: an industry leaders perspective. A Report for BERR by Construct IT for Business and the Research Institute for the Built and Human Environment. [Accessed March 2016]. Available from: http://www.salford.ac.uk/built-environment/research/research-centres/construct-it/publications.
Anice, I.A. , Strat, D.L. and Moor, W.C. (2001) Building blocks of a successful e-business strategy. In: Proceedings of Portland International Conference on Management of Engineering and Technology, Portland, OR, 29 July2 August 2001 . IEEE Conference Publications, 1, p. 144.
Billingham, V. (2008) Project Management: How to Plan and Deliver a Successful Project. Abergele, UK: Studymates.
Business Dictionary Online (2016) The definition of action plan. [Accessed March 2016]. Available from: http://www.businessdictionary.com/definition/action-plan.html.
Chaffey, D. (2009) E-business and E-commerce Management: Strategy, Implementation and Practice, 4th Edition. Harlow: Pearson Education Limited.
Chaffey, D. (2011) E-business and E-commerce Management: Strategy, Implementation and Practice. 5th Edition. Harlow, UK: Pearson Education.
Charlesworth, A. (2016) Is the definition of e-commerce the same as the definition of e-business. In: AlanCharlesworth.eduA Market View of Marketing on the Internet. [Accessed March 2016]. Available from: http://www.alancharlesworth.eu/alans-musings/e-commerce-or-e-business.html#.
Chen, Y. , Ruikar, K.D. and Carrillo, P.M. (2013) Strategic e-business framework: a holistic approach for organisations in the construction industry. Journal of Information Technology in Construction, 18, 306320, http://www.itcon.org/2013/15.
Cooper, R. , Kagioglou, M. , Aouad, G. , Hinks, J. , Sexton, M. and Sheath, D. (1998) The construction process protocol. Engineering and Physical Science Research Council. The Generic Design and Construction Process Protocol (GDCPP) Project Report.
313 Creswell, W.J. (2003) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd Edition. London: SAGE Publications Ltd.
Creswell, W.J. (2009) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd Edition. Thousand Oaks: SAGE Publications Ltd.
Creswell, W.J. (2013) Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition. London: Sage Publications.
Craig, T. (2004) Three Issues to Supply Chain Management Success: Process, People, Technology. [Online]. LTD Management: Supply Chain Management Consulting. Lehigh Valley.

[Viewed March 2016]. Available from: http://www.ltdmgmt.com/072503.php.
Daghfous, A. and Al-Nahas, N. (2006) The role of knowledge and capability evaluation in e-business strategy: an integrative approach and case illustration. SAM Advanced Management Journal, 71(2), 1120.
Deise, M. , King, P. , Nowikow, C. and Wright, A. (2000) Executives Guide to E-Business: From Tactics to Strategy. New York: John Wiley & Sons.
European Commission . (2006) ICT and electronic business in the construction industry: ICT adoption and e-business activities in 2006. The European E-business Market Watch Sector Report No.72006. [Accessed March 2016]. Available from: http://www.umic.pt/images/stories/publicacoes/BR06.pdf.
Fink, D. (2006) Value decomposition of e-commerce performance. Benchmarking: An International Journal, 13(1/2), 8192.
Griffin, R.W. (2013) Management. 8th Edition. Andover, MA: Cengage Learning.
Jarvenpaa, S.L. and Tiller, E.H. (2001) The new frontier in e-business: integrated Internet strategy. IBM Faculty Partnership Award, 2001. [Accessed March 2016]. Available from: https://www.yumpu.com/en/document/view/35810437/the-new-frontier-in-e-business-integrated-internet-strategy.
Jelassi, T. and Enders, A. (2009) Strategies for E-business: Creating Value Through Electronic and Mobile Commerce, 2nd Edition. Harlow: Pearson Education Ltd.
Jelassi, T. , Enders, A. and Martinez-Lopez, F. J. (2014) Strategies for E-business: Creating Value Through Electronic and Mobile Commerce, 3rd Edition. Harlow: Pearson Education Ltd.
Johnson, G. and Scholes, K. (2003). Exploring Corporate Strategy: Text and Cases, 6th Edition. Harlow: Pearson Education Ltd.
Johnson, G. , Scholes, K. and Whittington, R. (2008) Exploring Corporate Strategy. 8th Edition. Harlow, UK: Pearson Education.
Jelassi, T. and Enders, A. (2009) Strategies for E-business: Creating Value Through Electronic and Mobile Commerce, 2nd Edition. Harlow: Pearson Education Ltd.
Jelassi, T. , Enders, A. and Martinez-Lopez, F. J. (2014) Strategies for E-business: Creating Value Through Electronic and Mobile Commerce, 3rd Edition. Harlow: Pearson Education Ltd.
Johnson, G. and Scholes, K. (2003). Exploring Corporate Strategy: Text and Cases, 6th Edition. Harlow: Pearson Education Ltd.
Johnson, G. , Whittington, R. and Scholes, K. (2011) Exploring Corporate Strategy: Text and Cases. 9th Edition. Harlow, UK: Prentice Hall.
Jutla, D.N. , Craig, J. and Bodorik, P. (2001) A methodology for creating e-business strategy. In: Proceedings of the 34th Hawaii International Conference on System Sciences, Hawaii, January 2001 , IEEE Conference Publications, pp. 110.
314 Kalakota, R. and Robinson, M. (2004) E-business 2.0: Roadmap for Success. 2nd Edition. Reading, UK: Addison-Wesley Professional
Laudon, K.C. and Laudon, J.P. (2014) Essentials of Management Information Systems. 11th Edition. Upper Saddle River, NJ: Prentice Hall.
Levenburg, N.M. and Magal, S.R. (2004) Applying importance performance analysis to evaluate e-business strategies among small firms. e-Service Journal, 3(3), 2948.
McDonald, M. (2008) Malcolm McDonald on Marketing Planning: Understanding Marketing Plans and Strategy. London: Kogan Page.
Moen, R. and Norman, C. (2009) Evolution of the PDCA cycle. [Accessed March 2016]. Available from: http://www.westga.edu/~dturner/PDCA.pdf.
Mongollon, M. and Raisinghani, M. (2003). Measuring ROI in E-business: A Practical Approach. Information Systems Management, 20(2), 6381.
Mohammadian, A. , Pursultani, H. and Akhgar, B. (2010) An integrative framework of e-business strategy building blocks for knowledge based and intelligent systems. In: Proceedings of IEEE 2010 International Conference on Computing and Automation Engineering, Singapore, February, 2010 , IEEE Conference Publications, 5, pp. 593597.
Norton, J. (2001) Winning in the Race for E-business. London: The Royal Academy of Engineering.
Pai, J.C. and Yeh, C.H. (2008) Factors affecting the implementation of e-business strategies: an empirical study in Taiwan. Management Decision, 46(5), 681690.
Porter, M.E. (1985) Competitive Advantage. New York: The Free Press.
Process Protocol . (2016) Process protocol: background. Salford University. [Accessed March 2016]. Available from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.503.2035&rep=rep1&type=pdf.
Ruikar, K.D. (2004) Business process implications of e-commerce in construction organisations. EngD Thesis. Loughborough University.

Ruikar, K.D. , Anumba, C.J. and Carrillo, P.M. (2006) VERDICTan e-readiness assessment application for construction companies. Automation in Engineering, 15(1), 98110.
Ruikar, K.D. , Anumba, C.J. and Carrillo, P.M. (2008) Organisational readiness for e-business. In: Anumba, C.J. and Ruikar, K.D. (eds). E-business in Construction. Oxford: Blackwell Publishing.
Shelbourn, M. , Bouchlaghem, D. , Anumba, C. and Carrillo, P. (2006) The PIECC decision-making framework. The Planning & Implementing Effective Collaboration in Construction Industry (PIECC) Project Report. Loughborough University.
Smith, P.R. and Taylor, J. (2004) Marketing Communications: An Integrated Approach. London: Kogan Page.
Sultan, F. and Hussain, H.A. (2001) Design a trust-based e-business strategy. Marketing Management, 10(4), 4045.
Tashakkori, A. and Teddlie, C. (2010) Handbook of Mixed Methods in Social & Behavioral Research. 2nd Edition. Thousand Oaks, CA: Sage Publications.
Traynor, V. (2004) Mixed methods presentation by Vanessa Traynor. Research Methodology Resources for Beginners. [Accessed March 2016]. Available from: http://www.scoop.it/t/research-methods.
Wellington, J.J. (2000) Education Research: Contemporary Issues and Practical Approaches. London: Continuum International Publishing Group.
315 Zeng, Q. and Li, X. (2008) Evolution of e-business transformation strategy: a four dimension model. In: Proceedings of IEEE 2008 International Conference on Service Systems and Service Management, Melbourne, VIC, 30 June2 July 2008, IEEE Conference Publications, pp. 15.

Innovation in e-business

Aboelmaged, M. G. 2010. Predicting e-procurement adoption in a developing country. Industrial Management and Data Systems, 110, pp. 392414.
Acar, E. , Koak, I. , Sey, Y. and Arditi, D. 2005. Use of information and communication technologies by small and medium-sized enterprises (SMEs) in building construction. Construction Management and Economics, 23, pp. 713722.
Aduwo, E. B. , Ibem, E. O. , Uwakonye, O. , Tunji-Olayeni, P. and Ayo-Vuaghan, E. K. 2016. Barries to the uptake of e-procurement in the Nigerian building industry. Journal of Theoretical and Applied Information Technology, 89, pp. 113147.
Adzroe, E. K. A. and Ingirige, B. 2014. Improving the technological capacity of the local contractors through e-business technology transfer the case of the local Ghanaian contractors. CIB W55/65/89/92/96/102/117 and TG72/81/83 International Conference on Construction in a Changing World Heritance Kandalama, Sri Lanka, 4th7th May 2014 .
Ahmed, M. S. , Ahmad, I. , Azhar, S. and Arunkumar, S. 2005. Current State and Trends of E-Commerce in the Construction Industry: Analysis of a Questionnaire Survey. Retrieved 07 February 2013 from http://www.cteseerx.ist.psu.edu/viewdoc/download, pp. 121.
Alshawi, M. A. and Ingirige, B. 2003. Web-enabled project management: an emerging paradigm in construction. Automation in Construction, 12, pp. 349364.
Amit, R. and Zott, C. 2001. Value creation in e-business. Strategic Management Journal, 22, pp. 493520.
Ang, J. A. and Koh, S. 1997. Exploring the relationships between user information satisfaction and job satisfaction. International Journal of Information Management, 17, pp. 169177.
Anumba, C. J. and Ruikar, K. 2008. e-Business in Construction, Wiley-Blackwell, London.
Anumba, C. J. and Ruikar, K. 2002. Electronic commerce in construction trends and prospects. Automation in Construction, 11, pp. 265275.
Ashrafi, G. , Schlehe, J. S. , Lavoie, M. J. and Schwarz, T. L. 2014. Mitophagy of damaged mitochondria occurs locally in distal neuronal axons and requires PINK1 and Parkin. JCB, 206, pp. 655670.
Barnes, S. A. and Hunt, B. 2013. E-Commerce and V-Business, London: Taylor & Francis.
Beheshti, H. M. A. and Salehi-Sangari, E. 2007. The benets of e-business adoption: an empirical study of Swedish SMEs. Service Business. Retrieved 10 July 2013 from http://www.diva-portal.org/smash/get/diva2:474933/FULLTEXT01.pdf, 1, pp. 233245.
336 Bjrk, B.-C. 1999. Information technology in construction: domain definition and research issues. International Journal of Computer Integrated Design And Construction, SETO, London. Retrieved 08 August 2012 from https://helda.helsinki.fi/bitstream/handle/10227/617/bjork.pdf?sequence=2, 1, pp. 116 (The

journal is no longer published).
Buvik, M. P. and Rolfsen, M. 2015. Prior ties and trust development in project teams a case study from the construction industry. International Journal of Project Management, 33, pp. 14841494.
Chang, H. H. , Tsai Y.C. and Hsu, C.H. 2013. E-procurement and supply chain performance. Supply Chain Management: An International Journal, 18, pp. 3451.
Chang, H. H. and Wong, K. H. 2010. Adoption of e-procurement and participation of e-marketplace on firm performance: trust as a moderator. Information & Management, 47, pp. 262270.
Cheng, E. W. L. , Li, H. , Love, P. E. D. A. and Irani, Z. 2001. An e-business model to support supply chain activities in construction. Logistics Information Management, 14, pp. 6878.
Chong, A. Y.-L. , Ooi, K.-B. , Bao, H. and Lin, B. 2014. Can e-business adoption be influenced by knowledge management? An empirical analysis of Malaysian SMEs. Journal of Knowledge Management, 18, pp. 121136.
Combe, C. 2012. Introduction to E-Business, Routledge, New York.
Damanpour, F. and Damanpour, J. A. 2001. E-business e-commerce evolution: perspective and strategy. Managerial Finance, 27, pp. 1633.
e-Business W@tch . 2006. ICT and e-Business in the Construction Industry: ICT adoption and e-business activity in 2006. Retrieved 19 December 2013 from http://www.umic.pt/images/stories/publicacoes/BR06.pdf.
Eadie, R. , Millar, P. , Perera, S. , Heaney, G. A. and Barton, G. 2012. E-readiness of construction contract forms and e-tendering software. International Journal of Procurement Management, 5, pp. 126.
Eadie, R. , Perera, S. A. and Heaney, G. 2007. Drivers and barriers to public sector e-procurement within Northern Irelands construction industry. ITcon, 12, pp. 103119.
Eadie, R. , Perera, S. A. and Heaney, G. 2010a. A cross discipline comparison of rankings for e-procurement drivers and barriers within UK construction organisations. ITcon, 15, pp. 217233.
Eadie, R. , Perera, S. A. and Heaney, G. 2010b. Identification of e-procurement drivers and barriers for UK construction organisations and ranking of these from the perspective of quantity surveyors. ITcon, 15, pp. 2343.
Egan, J. 1998. Rethinking construction: The report of the Construction Task Force to the Deputy Prime Minister, John Prescott, on the scope for improving the quality and efficiency of UK construction. Retrieved 8 September 2014 from http://constructingexcellence.org.uk/wp-content/uploads/2014/10/rethinking_construction_report.pdf.
Egbu, C. O. and Botterill, K. 2002. Information technologies for knowledge management: their usage and effectiveness. ITcon, 7, pp. 125136.
Ekholm, A. A. and Molnr, M. 2009. ICT development strategies for industrialisation of the building sector. ITcon, 14, pp. 429444.
337 El-Ghandour, W. A. and Al-Hussein, M. 2004. Survey of information technology applications in construction. Construction Innovation: Information, Process, Management, 4, pp. 8398.
Fulford, R. and Standing, C. 2014. Construction industry productivity and the potential for collaborative practice. International Journal of Project Management, 32, pp. 315326.
Galliers, R. D. A. and Leidner, D. E. 2014. Strategic Information Management: Challenges and Strategies in Managing Information Systems, London: Routledge.
Griffith, A. 2011. Delivering best value in the small works portfolio of public sector organizations when using preferred contractors. Construction Management and Economics, 29, pp. 891900.
Gunasekaran, A. A. and Ngai, E. W. T. 2008. Adoption of e-procurement in Hong Kong: an empirical research. International Journal of Production Economics, 113, pp. 159175.
Hashim, N. A. and Said, I. 2011. Exploring e-business applications in the construction industry: issues and challenges. Annual Summit on Business and Entrepreneurial Studies (ASBES 2011) Proceedings. Available at http://econpapers.repec.org/paper/cms1asb11/2011-014-134.htm.
Hinson, R. , Sorensen, O. A. and Buatsi, S. 2007. Internet use patterns amongst internationalizing Ghanaian exporters. The Electronic Journal of Information Systems in Developing Countries, 29(3), pp. 114.
Hinson, R. A. and Sorensen, O. 2006. E-business and small Ghanaian exporters: preliminary micro firm explorations in the light of a digital divide. Online Information Review, 30, pp. 116138.
Hosseini, M. R. , Chileshe, N. , Zuo, J. and Baroudi, B. 2012. Approaches for implementing ICT technologies within construction industry. Australasian Journal of Construction Economics and Building, Conference Series, 1, pp. 112.
Ibem, E. O. , Aduwo, E. B. , Tunji-Olayeni, P. , Adekunle Ayo-Vaughan, E. A. and Uwakonye, U. O. 2016. Factors influencing e-procurement adoption in the Nigerian building industry. Construction Economics and Building 16, pp. 5467.

Iddris, F. 2012. Adoption of E-commerce solutions in small and medium-sized enterprises in Ghana. European Journal of Business and Management, 4(10), pp. 4857. Available online at www.iiste.org.
Ismail, I. A. A. and Kamat, V. R. 2008. Integrated multi-disciplinary e-business infrastructure framework. In: Anumba, C. J. and Ruikar, K. (Eds) e-Business in Construction, Wiley-Blackwell, Oxford, pp. 6578.
Issa, R. , Flood, I. A. and Caglasin, G. 2003. A survey of e-business implementation in the US construction industry. Journal of Information Technology in Construction, 8, pp. 1528.
Issa, R. R. A. , Flood, I. A. and Treffinger, B. 2008. Assessment of e-business implementation in the US construction industry. In: Anumba, C. J. and Ruikar, K. (Eds) e-Business in Construction, Wiley-Blackwell, Oxford, pp. 248264.
Kalakota, R. A. and Whinston, A. B. 1996. Frontiers of Electronic Commerce, Addison Wesley Longman Publishing Co., Inc., Reading, MA.
Kauffman, R. J. and Tallon, P. P. 2014. Economics, Information Systems, and Electronic Commerce: Empirical Research, Taylor & Francis.
Kenny, C. 2007. Construction, Corruption, and Developing Countries. World Bank Policy Research Working Paper 4271, June 2007. Available at http://www2.globalclearinghouse.org/Infradev/assets%5C10/documents/WB%20(Kenny)%20-%20Construction,%20Corruption%20and%20Developing%20Countries%20(2007).pdf.
338 London, K. , Nathaniel, B. , Jonathan, M. , Benjamin, E. , Ron, W. A. and Guillermo, A.-M. 2006. E-business Adoption in Construction Industry. Queensland University of Technology.
Love, P. E. D. , Irani, Z. , Li, H. , Cheng, E. W. L. A. and Tse, R. Y. C. 2001. An empirical analysis of the barriers to implementing e-commerce in small-medium sized construction contractors in the state of Victoria, Australia. Construction Innovation: Information, Process, Management, 1, pp. 3141.
Molla, A. A. and Heeks, R. 2007. Exploring e-commerce benefits for businesses in a developing country. Information Society, 23, pp. 95108.
Moodley, S. 2003. The challenge of e-business for the South African apparel sector. Technovation, 23, pp. 557570.
Muffatto, M. A. and Payaro, A. 2004. Implementation of e-procurement and e-fulfillment processes: acomparison of cases in the motorcycle industry. International Journal of Production Economics, 89, pp. 339351.
OECD 2004. ICT, E-Business and Small and Medium Enterprises. OECD Digital Economy Paper, No. 86. Retrieved 12 July 2015 from http://www.oecd-ilibrary.org/science-and-technology/ict-e-business-and-small-and-medium-enterprises_232556551425.
Ofori, G. , Ai Lin , T. E. and Tjandra, K. I. 2011. Developing the Construction Industry: A Decade of Change in Four Countries. In Laryea, S. , Leiringer, R. and Hughes, W. (Eds) Procs West Africa Built Environment Research (WABER) Conference, 1921 July 2011 , Accra Ghana.
Oliveira, T. and Martins, M. F. 2010. Understanding e-business adoption across industries in European countries. Industrial Management and Data Systems, 110, pp. 13371354.
Oliveira, T. A. and Martins, M. F. 2011. Literature review of information technology adoption models at firm level. Electronic Journal of Information Systems Evaluation, 14, pp. 110121.
Onetti, A. , Zucchella, A. , Jones, M. A. and Mcdougall-Covin, P. 2012. Internationalization, innovation and entrepreneurship: business models for new technology-based firms. Journal of Management and Governance, 16, pp. 337368.
Parmigiani, A. and Rivera-Santos, M. 2015. The influence of institutions on trust and governance. Strategic Management Society Conference, Denver CO, October 2015 .
Perera, S. , Udeaja, C. , Zhou, L. , Rodrigo, A. A. and Park, R. 2012. Mapping the E-business Profile and Trends in Cost Management in the UK Construction Industry. Retrieved 7 February 2013 from http://nrl.northumbria.ac.uk/11823/
Qin, Z. 2010. Introduction to E-commerce, Springer, Berlin and Heidelberg.
Rivard, H. 2000. A survey on the impact of information technology on the Canadian architecture, engineering and construction industry. Electronic Journal of Information Technology in Construction, 5, pp. 3756.
Ruikar, K. 2004. Business Process Implications of E-commerce in Construction Organisations. Doctor of Engineering (EngD) thesis, EngD, Loughborough.
Ruikar, K. , Anumba, C. J. and Carrillo, P. 2008. e-Business: the construction context. In: Anumba, C. J. and Ruikar, K. (Eds) e-Business in Contruction. Wiley-Blackwell, Oxford, pp. 621.
339 Ruikar, K. and Anumba, C. J. 2008. Fundamentals of e-Business. In: Anumba, C. J. and Ruikar, K. (Eds) e-Business in Construction, Wiley-Blackwell, Oxford, pp. 122.
Sabri, S. M. , Sulaiman, R. , Ahmad, A. and Tang, A. 2014. A review on IT outsourcing practices for e-business transformation among SMEs in Malaysia. 2014 International Conference on Information Technology and Multimedia (ICIMU), 1820 November , pp. 124129.

Samuelson, O. 2002. IT-Barometer 2000-the use of IT in the Nordic construction industry. ITcon, 7, pp. 126.
Seyal, A. H. , Rahim, M. M. A. and Rahman, M. N. A. 2000. An empirical investigation of use of information technology among small and medium business organizations: a Bruneian scenario. The Electronic Journal of Information Systems in Developing Countries, 2, pp. 117.
Shiels, H. , Mcivor, R. and OReilly, D. 2003. Understanding the implications of ICT adoption: insights from SMEs. Logistics Information Management, 16, pp. 312326.
Srensen, O. J. A. and Buatsi, S. 2002. Internet and exporting: the case of Ghana. Journal of Business and Industrial Marketing, 17, pp. 481500.
Teece, D. J. 2010. Business models, business strategy and innovation. Long Range Planning, 43, pp. 172194.
Tran, Q. , Zhang, C. , Sun, H. and Huang, D. 2015. Initial adoption versus institutionalization of e-procurement in construction firms: an empirical investigation in Vietnam. Journal of Global Information Technology Management, 17, pp. 91116.
Underwood, J. A. and Khosrowshahi, F. 2012. ICT expenditure and trends in the UK construction industry in facing the challenges of the global economic crisis. ITcon, 17, pp. 2542.
Wamelink, H. A. and Teunissen, W. 2003. E-Business in the construction industry: a search for practical applications using the Internet. International Association for Automation and Robotics in Construction. Available at http://www.iaarc.org/publications/fulltext/isarc2003-93.pdf, pp. 543547.
Weill, P. A. and Vitale, M. 2013. Place to Space: Migrating to Ebusiness Models, Harvard Business Review Press, Boston, MA.
Wilkinson, P. 2008. The role of extranet in construction e-Business. In: Anumba, C. J. and Ruikar, K. (Eds) e-Business in Construction, Wiley-Blackwell, Oxford, pp. 81102.
WTO . 2013. e-Commerce in developing countries: opportunities and challenges for small and medium-sized enterprises. World Trade Organization. Retrieved 11 July 2015 from https://www.wto.org/english/res_e/booksp_e/ecom_brochure_e.pdf.
Xiao, Z. , Zhang, W. , Li, Q. , Liu, L. and Cui, L. 2015. A method of e-commerce trading process construction based on PaaS platform. e-Business Engineering (ICEBE), 2015 IEEE 12th International Conference on e-Business Engineering (ICEBE), 2325 October, 2015. Retrieved (04/12/2015) from
https://www.computer.org/csdl/proceedings/icebe/2015/8002/00/8002a220.pdf 2015. pp. 220227.

Application of social media in the construction industry

Bolton, Holly , Galvin, Dana , and Kilbourne, Adam (2011), The Clients Use of Social Media and Social Networking (white paper), Society for Marketing Professional Services, Alexandria, VA.
Boyd, Danah M. , and Ellison, Nicole B. (2008), Social network sites: Definition, history, and scholarship. Journal of Computer Mediated Communication, 13 (1), 201230. doi:10.1111/j.1083-6101.2007.00393.x.
https://www.researchgate.net/profile/Nicole_Ellison/publication/259823204_Social_network_sites_Definition_history_and_scholarship/links/541354060cf2bb7347db216a.pdf (accessed: 12 January 2016).
Butcher, Scott (2015), The State of Social Media in the A/E/C Industry (aka, The Three SoMegos Ride Again!), Engineering News Record, (Marketropolis blog, 27 January 2015). http://enr.construction.com/opinions/blogs/butcher.asp?plckController=Blog&plckBlogPage=BlogViewPost&newspaperUserId=623 ad72a-6766-4594-8d42-07bfdc0821a1&plckPostId=Blog%3a623ad72a-6766-4594-8d42-07bfdc0821a1Post%3aae7de5c6-22c3-47e3-806f-52ad9a22117b&plckScript= blogScript&plckElementId=blogDest (accessed: 5 June 2015).
Butcher, Su (2014), The #ukbimcrew is Not a Clique; its for Everyone, Just Practising blog, 7 May 2014 . http://www.justpractising.com/social-tools/networking/ukbimcrew-clique-everyone/ (accessed: 16 January 2016).
Colao, J.J. (2012), With 60 Million Websites, WordPress Rules The Web. So Wheres The Money?, Forbes (24 September 2012; web article dated 5 September 2012). http://www.forbes.com/sites/jjcolao/2012/09/05/the-internets-mother-tongue/ (accessed: 6 June 2015).
Connell, Regina M. , Shuck, Barbara D. , and Thatch, Marion (2009), Social Networking for Competitive Advantage (white paper, July 2009), Society for Marketing Professional Services, Alexandria, VA.

Dent, Steve (2014), There are Now 3 Billion Internet Users, Mostly in Rich Countries, Engadget (25 November 2014). http://www.engadget.com/2014/11/25/3-billion-internet-users/ (accessed: 6 June 2015).
Digital Built Britain/UCL (2015), Digital Built Britain: Level 3 Building Information ModellingStrategic Plan, BIS, London.
372 Digital Trends (2014), The History of Social Networking (5 August 2014). http://www.digitaltrends.com/features/the-history-of-social-networking/ (accessed: 5 June 2014).
Dorset County Council (20102012), Weymouth Relief Road Blog. https://weymouthreliefroad.wordpress.com/ (accessed: 14 January 2016).
Gilmore, John (2009), Life at HOKthe HOK perspective, pwcom.co.uk blog post (19 March 2009), online at http://blog.pwcom.co.uk/2009/03/19/live-from-hok-guest-post/ (accessed: 7 June 2015).
Global Web Index (2015), GWI Social Summary, Q3, 2015download from http://www.globalwebindex.net (accessed: 16 January 2016).
Grant, Rebecca (2013), Startups from Around the World take on America at Plug and Play Expo 2013, VentureBeat, 13 June 2013 . http://venturebeat.com/2013/06/13/startups-from-around-the-world-take-on-america-at-plug-and-play-expo-2013/ (accessed: 5 June 2014).
Green, Brian (2014), A 20 Billion Repair Bill to Fix the UK Construction Industry After the Recession, Building, 19 November 2014 . http://brickonomics.building.co.uk/2014/11/20-billion-repair-bill-fix-uk-construction-industry-recession/ (accessed: 4 June 2014).
Kaplan, Andreas M. , and Haenlein, Michael (2010), Users of the world, unite! The challenges and opportunities of social media. Business Horizons, 53 (1), 61. http://www.sciencedirect.com/science/article/pii/S0007681309001232 (accessed: 5 June 2014).
Leach, Anna (2011), Most bosses monitor or block social-network use at work, The Register, 7 September 2011 . http://www.theregister.co.uk/2011/09/07/fear_of_social_media_holds_back_tech_adoption_survey/ (accessed: 5 June 2015).
Leeds Beckett University Centre for Knowledge Exchange (2016), ThinkBIM blog. http://ckegroup.org/thinkbimblog/ (accessed: 16 January 2016).
Levine, Rick , Locke, Christopher, Searls , Doc, and Weinberger, David (2000), The Cluetrain Manifesto: The End of Business as Usual, Perseus, Cambridge, MA.
Ofcom (2015), Adults Media Use and Attitudes, Ofcom, London. http://stakeholders.ofcom.org.uk/binaries/research/media-literacy/media-lit-10years/2015_Adults_media_use_and_attitudes_report.pdf (accessed: 5 June 2014).
Poeter, Damon (2012), Tweet or Die: Employers Hiring Based on Applicants Klout Scores?, PC Mag (26 April 2012). http://uk.pcmag.com/internet-products/64362/news/tweet-or-die-employers-hiring-based-on-applicants (accessed: 16 January 2016).
Prensky, Marc (2001), Digital natives, digital immigrants. On the Horizon, 9 (5), 16.
Rhodes, Chris (2014), The construction industry: statistics and policy (Standard Note SN/EP/1432), House of Commons Library.
Sacolick, Isaac . (2012), Construction Industry Dead Last in IT Spend, Engineering News Record, 28 November 2012 . http://enr.construction.com/technology/construction_technology/2012/1203-gartner-stats-aec-dead-last-in-it-spend.asp (accessed: 4 June 2015).
Sacolick, Isaac . (2014), Construction Industry Continues to Underspend in Technology, Engineering News Record, 5 May 2014 . http://enr.construction.com/technology/information_technology/2014/0303-construction-industry-continues-to-underspend-in-technology.asp (accessed: 4 June 2015).
Sawyer, Tom , and Abaffy, Luke (2013), Facebook of Construction Uses Timeline to Manage Projects, Engineering News Record, 9 October 2013 . http://enr.construction.com/technology/information_technology/2013/1014-facebook-of-construction-uses-8216timeline8217-to-manage-projects.asp (accessed: 5 June 2015).
373 Sepasgozar, Samad M. E. , and Leonhard, E. Bernold . (2012), Factors influencing the decision of technology adoption in construction. ICSDEC 2012, pp. 654661, doi:10.1061/9780784412688.078.
Singh, Vishal , and Holmstrom, Jan (2015), Needs and technology adoption: observation from BIM experience. Engineering, Construction and Architectural Management, 22 (2), 128150. doi:10.1108/ECAM-09-2014-0124.
Smith, Andrew (2012), Social media monitoring in Waddington, Stephen (ed), Share This: The Social Media Handbook for PR Professionals, John Wiley, London, pp. 157162.
Solis, Brian (2012), The End of Business as Usual, John Wiley & Sons, Hoboken, NJ.
Solis, Brian (2013), The Conversation Prism online at https://conversationprism.com/ (accessed: 5 June 2015).

Tumblr.com (2015), Activity statistics online at https://www.tumblr.com/about (accessed: 6 June 2015).
UK Government (2013), Construction 2025: Industrial Strategy: Government and Industry in Partnership, July 2013.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf (accessed: 4 June 2015).
Waller, Andrew , and Bob Thompson (2009), The Role of Social Media in Commercial Property, Remit Consulting/RICS, London.
Wilkinson, Paul (2005), Construction Collaboration Technologies: The Extranet Evolution, Taylor & Francis, London.
Wilkinson, Paul (2009), Life at HOK, pwcom.co.uk blogblog post, 16 March 2009 , online at http://blog.pwcom.co.uk/2009/03/16/life-at-hok/ (accessed: 7 June 2015).
WordPress.com (2015), Activity statistics online at https://wordpress.com/activity/ (accessed: 6 June 2015).

Social media in construction: an exploratory case study

Ahlqvist, T. , Bck, A. , Halonen, M. and Heinonen, S. , 2008. Social Media Roadmaps: Exploring the futures triggered by social media. Helsinki: Edita Prima Oy.
Ahuja, V. , Yang, J. and Shankar, R. 2009. Study of ICT adoption for building project management in the Indian construction industry. Automation in Construction, 18, 415423.
Altimeter . 2015. Social business strategy. Available: http://www.altimetergroup.com/work-with-us/challenges-we-solve/social-business-strategy/. [Accessed 17 May 2015].
Andrews, C. 2012. Social media recruitment. Applied Clinical Trials, 21, 3242.
402 Bennett, S. 2014. The 13 most popular social networks (by age group). Available: http://www.adweek.com/socialtimes/popular-social-networks-age/502497 [Accessed 20 May 2015].
Bradwell, P. and Reeves, R. 2008. Network Citizens Power and Responsibility at Work, London, Demos.
Broughton, A. , Higgins, T. , Hicks, B. and Cox, A. 2010. Workplaces and Social Networking: The Implications for Employment Relations, Brighton, The Institute for Employment Studies.
Brown, M. 2012. Why the construction sector should engage with social media. Available: http://www.theguardian.com/sustainable-business/construction-sector-social-media [Accessed 17 May 2015].
Coleman, V. 2013. Social media as a primary source: a coming of age. EDUCAUSE Review, 48, 6061.
Construction Industry Council . 2014. CIC 2050 Group Construction Industry Survey 2014, London, CIC 2050 Group.
Dave, B. and Koskela, L. 2009. Collaborative knowledge managementA construction case study. Automation in Construction, 18, 894902.
eBiz . 2015. Top 15 most popular social networking sites|May 2015. Available: http://www.ebizmba.com/articles/social-networking-websites. Accessed on 20 May 2015 .
Fellows, R. and Lieu, A. 2003. Research Methods for Construction, UK, Blackwell Publishing.
Fuchs, C. 2014. Social Media: A Critical Introduction. London: Sage.
Golden, M. 2010. Social Media Strategies for Professionals and Their Firms: The Guide to Establishing Credibility and Accelerating Relationships, Hoboken, NJ, John Wiley & Sons.
Grahl, T. 2015. The 6 types of social media. Available: http://timgrahl.com/the-6-types-of-social-media/ [Accessed 17 May 2015].
Harling, K. , 2002. Workshop. Annual meeting of the American Agricultural Economics Association, Case studies: their future role in agricultural and resource economics. 27 July 2002. California.
Kietzmann, J. H. , Hermkens, K. , McCarthy, I. P. , and Silvestre, B. S. 2011. Social media? Get serious! Understanding the functional building blocks of social media. Business Horizons, 54(3), 241251.
Kotrlik, J. and Higgins, C. 2001. Organizational research: determining appropriate sample size in survey research appropriate sample size in survey research. Information Technology, Learning, and Performance Journal, 19, 43.
Li, C. and Solis, B. 2015. The 7 success factors of social business strategy. Available: http://www.briansolis.com/2015/04/7-success-factors-social-business-strategy-infographic/ [Accessed 17 May 2015].

LinkedIn . 2012. Case study LOreal. Available: http://www.slideshare.net/linkedineurope/loreal-case-studyv5 [Accessed 17 May 2015].
LinkedIn . 2015. About LinkedIn. Available: https://press.linkedin.com/about-linkedin [Accessed 17 May 2015].
Michaelidou, N. , Siamagka, N. T. and Christodoulides, G. 2011. Usage, barriers and measurement of social media marketing: an exploratory investigation of small and medium B2B brands. Industrial Marketing Management, 40, 11531159.
Moreau, E. 2014. Top 15 social networking sites you should be using. Available: http://webtrends.about.com/od/socialnetworkingreviews/tp/Social-Networking-Sites.htm. [Accessed 20 May 2015].
Myers, A. 2012. 13 types of social media platforms and counting. Available: http://decidedlysocial.com/13-types-of-social-media-platforms-and-counting/ [Accessed 17 May 2015].
403 O'Reilly, T. 2005. What is Web 2.0. Available: http://www.oreilly.com/pub/a/web2/archive/what-is-web-20.html. [Accessed 20 May 2015].
Patten, J. 2007. Blogging in the workplace: building a safe culture. Available: http://www.personneltoday.com/hr/blogging-in-the-workplace-building-a-safe-culture/ [Accessed 17 May 2015].
Pauley, N. 2014. How the top UK construction companies are using social media marketing in 2014. Available: http://www.pauleycreative.co.uk/2014/01/how-the-top-construction-companies-are-using-social-media-in-2014/ [Accessed 17 May 2015].
Peansupap, V. and Walker, D. H. 2006. Information communication technology (ICT) implementation constraints: a construction industry perspective. Engineering, Construction and Architectural Management, 13, 364379.
Porkka, J. , Jung, N. , Pivnen, J. , Jvj, P. and Suwal, S. 2012. Role of social media in the development of land use and building projects, Proceedings of ECPPM 2012, Iceland, Reykjavik, July 2527th.
Salcido, M. 2011. Benefits and advantages of using social media|advantages of social media. Available: http://www.organicseoconsultant.com/advantages-of-using-social-media/ [Accessed 17 May 2015].
Scott, M. 2014. Understanding the basic categories of social media marketing. Available: https://blog.ahrefs.com/understanding-basic-categories-social-media-marketing/ [Accessed 17 May 2015].
SEOPressor . 2015. The 6 types of social media. Available: http://seopressor.com/social-media-marketing/types-of-social-media/ [Accessed 17 May 2015].
Smith, N. , Zhou, C. and Wollan, R. 2011. The Social Media Management Handbook: Everything You Need to Know to Get Social Media Working in Your Business, Hoboken, NJ, John Wiley & Sons.
Statista . 2015. Number of monthly active Facebook users worldwide as of 1st quarter 2015 (in millions). Available: http://www.statista.com/statistics/264810/number-of-monthly-active-facebook-users-worldwide/ [Accessed 17 May 2015].
Szkolar, D. 2012. Social networking for academics and scholars. Information Space. Available: http://infospace.ischool.syr.edu/2012/06/21/social-networking-for-academics-and-scholars/ [Accessed 10 February 2016].
Vasquez, E. , Karely, F. , Bastidas, C. and Enrique, C. 2015. Academic social networking sites: a comparative analysis of their services and tools. iConference 2015, California, USA, 2427 March 2015.
Whiston Solutions . 2015. Social media benefits for the property and construction industry. Available: http://www.whiston-solutions.com/industry-developments/social-media-benefits-property-and-construction-industry [Accessed 17 May 2015].
Wikipedia . 2015a. Facebook. Available: https://en.wikipedia.org/wiki/Facebook [Accessed 17 May 2015].
Wikipedia . 2015b. HipHop for PHP. Available: http://en.wikipedia.org/wiki/HipHop_for_PHP [Accessed 17 May 2015].
Wikipedia . 2015c. Twitter. Available: https://en.wikipedia.org/wiki/Twitter#cite_note-10 [Accessed 17 May 2015].
Wikipedia . 2015d. YouTube. Available: https://en.wikipedia.org/wiki/YouTube [Accessed 17 May 2015].

Mobile computing applications within construction

Anumba, C. and Wang, X. (2012). Mobile and Pervasive Computing in Construction. West Sussex, UK: Wiley-Blackwell.

Brandon, P.S. , Li, H. , and Shen, Q. (2005). Construction IT and the tipping point. Automation in Construction, 14, pp. 281286.

Bringardener and Dasher (2011). Tablets! Gain an Edge by Connecting to Project Information and BIM Models in the Field or on the Go Autodesk University 2011 [Online] http://aucache.autodesk.com/au2011/sessions/5226/class_handouts/v1_CR5226_Bringardner.pdf (last accessed on 16th Nov, 2016)

Bowden, S. , Dorr, A. , Thorpe, A. , and Anumba, C. (2006). Mobile ICT support for construction process improvement. Automation in Construction, 15 (5), pp. 664676.

Chen, Y. (2008). Using Mobile Computing for Construction Site Information Management. (PhD thesis), Newcastle, UK: Newcastle University.

Chen, Y. and Kamara, M. (2011). A framework for using mobile computing for information management on construction sites. Automation in Construction, 20, pp. 776788. doi:10.1016/j.autcon.2011.01.002

Chen, Z. and Li, H. (2000). Environmental management of urban construction project in China. Journal of Construction Engineering and Management, 126, p. 320.

421 CIRIA (2010). Environmental Good Practice on Site, (3rd Edition). London: CIRIA.

Damian, C. , Fosalau, C. , and Zet, C. (2007). Wireless Communication System for Environmental Monitoring. In Proceedings of the 1stIMEKO-TC19 International Symposium on Measurement and Instrumentation for Environmental Monitoring: 1921 September 2007, (pp. 108112). Iasi, Romania.

Davies, R. and Harty, C. (2013). Implementing Site BIM: A case study of ICT innovation on a large hospital project. Automation in Construction, 30, pp. 1524. dx.doi.org/10.1016/j.autcon.2012.11.024

Dong, A. , Maher, M.L. , Kim, M.J. , Gu, N. , and Wang, X. (2009). Construction defect management using a telematic digital workbench. Automation in Construction, 18 (6), pp. 814824.

Environmental Protection Authority of Australia . (1996). Environmental Guidelines for Major Construction Sites. Melbourne, VIC: Environmental Protection Authority of Australia.

Gray, J. 2015. Pollution From Construction. Available: http://www.sustainablebuild.co.uk/pollutionfromconstruction.html [Accessed 9 July 2015].

Harun, A.N. , Bichard, E. , and Nawi, M. (2015). Traditional vs technological based surveillance on construction site: A review. Applied Mechanics and Materials, Transtech Publications Ltd, pg. 247252.

Irizarry, J. and Gill, T. (2009). Mobile applications for information access on construction jobsites. In: OBrien, W.J. and Caldas, C.H. (Eds.). Proceedings of the International Workshop on Computing in Civil Engineering: 2427 June 2009 , (pp. 176185). Austin, US.

Jabatan Kerja Raya Malaysia . 2013. Langkah-Langkah Tebatan Bagi Kawalan Pencemaran Alam Sekitar. Available: https://www.jkr.gov.my/cast/index.php?action=cms&id=B2QCMAQ1 [Accessed 1 May 2015].

Kim, Y.S. , Oh, S.W. , Cho, Y.K. , and Seo, J.W. (2008). A PDA and wireless web-integrated system for quality inspection and defect management of apartment housing projects. Automation in Construction, 17, pp. 163179.

Kim, C. , Lim, H. , and Kim, H. (2011). Mobile computing platform for construction site management. In Proceedings of the 28th Annual Conference of the International Symposium on Automation and Robotics in Construction (ISARC): 29 June2 July 2011, 28 , (pp. 280287). Seoul, South Korea.

Kim, C. , Park, T. , Lim, H. , and Kim, H. (2013). On-site construction management using mobile computing technology. Automation in Construction, 35, pp. 415423. doi:dx.doi.org/10.1016/j.autcon.2013.05.027

Kimoto, K. , Endo, K. , Iwashita, S. , and Fujiwara, M. (2005). The application of PDA as a mobile computing system on construction management. Automation in Construction, 14, pp. 500511.

Kjeldskov, J. , Graham, C. , Pedell, S. , Vetere, F. , Howard, S. , Balbo, S. , and Davies, J. (2005). Evaluating the usability of a mobile guide: The influence of location, participants and resources. Behaviour and Information Technology, 24, pp. 5165.

Mohamad, R.H. and Aripin, A. (2006). Issues and Challenges in Environmental Monitoring and Enforcement in Sabah. In: Fourth Sabah-Sarawak Environmental Convention 2006, 2006 Kota Kinabalu, Sabah, Malaysia: Chief Ministers Department, Sabah and Environment Protection Department, Sabah, Malaysia.

Nourbakhsh, M. , Zin, R.M. , Irizarry, J. , Zolfagharian, S. , and Gheisari, M. (2012). Mobile application prototype for on-site information management in construction industry. Journal of Construction Engineering and Management, 19 (5), pp. 474494.
422 Saidi, K.S. , Ilaas, C.T. , and Balli, N.A. (2002). The value of handheld computers in construction. In: Proceedings of the 19th International Symposium on Automation and Robotics in Construction (ISARC), (pp. 557562). Gaithersburg, MD.
Samuelson, O. and Bjrk, B. (2014). A longitudinal study of the adoption of IT technology in the Swedish building sector. Automation in Construction, 37, pp. 182190. dx.doi.org/10.1016/j.autcon.2013.10.006
Son, H. , Park, Y. , Kim, C. , and Chou, J. (2012). Toward an understanding of construction professionals acceptance of mobile computing devices in South Korea: An extension of the technology acceptance model. Automation in Construction, 28, pp. 8290. doi:10.1016/j.autcon.2012.07.002
Tam, V.W. and Tam, C. (2006). A review on the viable technology for construction waste recycling. Resources, Conservation and Recycling, 47, 209221.
Venkatraman, S. and Yoong, P. (2009). Role of mobile technology in the construction industrya case study. International Journal of Business Information Systems, 4 (2), pp. 195209.
Vilkko, T. , Kallonen, T. , and Ikonen, J. (2008). Mobile fieldwork solution for the construction industry. In: Proceedings of the 16th International Conference of the Software, Telecommunications and Computer Networks (SoftCOM): 2527 September 2008 , (pp. 269273). Dubrovnik, Croatia.
Vivoni, E.R. and Camilli, R. (2003). Real-time streaming of environmental field data. Computers and Geosciences, 29, pp. 457468.
Wang, L.C. , Lin, Y.C. , and Lin, P.H. (2007). Dynamic mobile RFID-based supply chain control and management system in construction. Advanced Engineering Informatics, 21 (4), pp. 377390.
Wang, X. , Kim, M. , Love, P. , Park, C.S. , Sing, C.P. , and Hou, L. (2012). A conceptual framework for integrating building information modeling with augmented reality. Automation in Construction, 34, pp. 3744. doi:10.1016/j.autcon.2012.10.012
Yammiyavar, P. and Kate, P. (2010). Developing a mobile phone based GUI for users in the construction industry: a case study. In: Katre, D. , Orngreen, R. , Yammiyavar, P. , and Clemmensen, T. (Eds.). International Proceedings of Human Work Interaction Design: Usability in Social, Cultural and Organizational Contexts. 316, (pp. 211223). Springer, Boston and Pune.
Zhang, D. and Adipat, B. (2005). Challenges, methodologies, and issues in the usability testing of mobile applications. International Journal of Human-Computer Interaction, 18, 293308.
Zolfagharian, S. , Nourbakhsh, M. , Irizarry, J. , Ressang, A. , and Gheisari, M. (2012). Environmental Impact Assessment on Construction sites. In: Construction Challenges in a Flat World, Proceedings of the 2012 Construction Research Congress. (pp. 17501759).

Envisioning buildings: advances in construction visualisations

Adamu, A.Z. , Emmitt, S. , and Soetanto, R. (2015) Social BIM: co-creation with shared situational awareness, Journal of Information Technology in Construction, 20, pp. 230252. Available at: http://www.itcon.org/papers/2015_16.content.07536.pdf. (Accessed: 1 June 2015).
Ager, M.T. and Sinclair, B.R. (1995) StereoCAD: three Dimensional Representation, in (ed.) Sixth International Conference on Computer-Aided Architectural Design Futures. Singapore: National University of Singapore, pp. 343355.
Azhar, S. , and Cox, A.J. (2015) Impact of Mobile Tools and Technologies on Jobsite Operations, in (ed.) 51st ASC Annual International Conference Proceedings Associated Schools of Construction. College Station, TX: Texas A&M University.
Bille, R. , Smith, S.P. , Maund, K. , and Brewer G. (2014) Extending Building Information Models into Game Engine, in (ed.) Proceedings of the 2014 Conference on Interactive Entertainment. New York, NY: ACM, pp. 18.
Campbell, T. , Williams, C. , Ivanova, O. , and Garrett, B. (2011) Could 3D printing change the world. Technologies, Potential, and Implications of Additive Manufacturing, Washington, DC: Atlantic Council.
Chen, K. , Lu, W. , Peng, Y. , Rowlinson, S. , and Huang, G.Q. (2015) Bridging BIM and building: from a literature review to an integrated conceptual framework, International Journal of Project Management, 33(6), pp. 14051416.
Chi, H. , Kang, S. , and Wang, X. (2013) Research trends and opportunities of augmented reality applications in architecture, engineering, and construction, Automation in Construction,

33, pp. 116122.
Collier, E. and Fischer, M. (1995) Four-dimensional modeling in design and construction, Stanford, CA: CIFE Technical Report #101.
Dalton, B. and Parfitt, M. (2013) Immersive visualization of building information models, Design Innovation Research Centre working paper, 6, [1.0], Reading: University of Reading.
DBB . (2015) The Digital Built Britain, London: HM Government.
https://www.gov.uk/government/publications/uk-construction-industry-digital-technology.
Dima, M. , Farisato, G. , Bergomi, M. , Viotto, V. , Magrin, D. , Greggio, D. , Farinato, J. , Marafatto, L. , Ragazzoni, R. , and Piazza, D. (2014) From 3D view to 3D print, Proceedings of SPIE, 9143: p. 91435E.
sites , in (ed.) 18th International Conference on Virtual Systems and Multimedia (VSMM). Politecnico Di Milano, Italy. IEEE, pp. 369376.
447 Dore, C. and Murphy, M. (2012) Integration of Historic Building Information Modeling (HBIM) and 3D GIS for recording and managing cultural heritage sites, in (ed.) 18th International Conference on Virtual Systems and Multimedia (VSMM). Politecnico Di Milano, Italy. IEEE, pp. 369376.
Eastman, C.M. (1975) The use of computers instead of drawings in building design, AIA Journal, 63(3), pp. 4650.
Edwards, G. , Li, H. , and Wang, B. (2015) BIM based collaborative and interactive design process using computer game engine for general end-users, Visualization in Engineering, 3(1), pp. 117.
El-Omari, S. and Moselhi, O. (2008) Integrating 3D laser scanning and photogrammetry for progress measurement of construction work, Automation in Construction, 18(1), pp. 19.
Fadi, C. , Lee, S. , Nikolic, D. , and Messner, J.I. (2014) Visualization in 4D Construction Management Software: a Review of Standards and Guidelines, in (ed.) Proceedings of the International Conference on Computing in Civil and Building Engineering. Orlando, FL: American Society of Civil Engineers, pp. 315322.
Giddings, B. and Horne, M. (2003) Artists Impressions in Architectural Design, London: Taylor & Francis.
Gong, J. and Caldas, H.C. (2008) Data processing for real-time construction site spatial modeling, Automation in Construction, 17(5), pp. 526535.
Greenwood, D. , Horne, M. , Thompson, E.M. , Allwood, C.M. , Wernemyr, C. , and Westerdahl, B. (2008) Strategic perspectives on the use of virtual reality within the building industries of four countries, Architectural Engineering and Design Management, 4(2), pp. 8598.
ISO 294811:2010(E) . (2010) ISO 294811:2010(E): Building Information Modeling Information Delivery ManualPart 1: Methodology and Format, Geneva: International Organization for Standardization.
Jiao, Y. , Zhang, S. , Li, Y. , Wang, Y. , and Yang, B. (2013) Towards cloud augmented reality for construction application by BIM and SNS integration, Automation in Construction, 33, pp. 3747.
Johansson, M. , Roup, M. , and Viklund Tallgren, M. . (2014) From BIM to VR-Integrating immersive visualizations in the current design process. In: Thompson, E.M. (ed.) Fusion-Proceedings of the 32nd eCAADe Conference-Volume 2. Newcastle upon Tyne: Northumbria University, pp. 261269.
Kimpton, G. , Horne, M. , and Heslop, D. (2010) Terrestrial laser scanning and 3D imaging: heritage case studyThe Black Gate, Newcastle upon Tyne, in (ed.) ISPRS Commission V Mid-Term Symposium Close Range Image Measurement Techniques. [online] ISPRS, pp. 325330. Available at: http://www.isprs.org/proceedings/XXXVIII/part5/papers/223.pdf [Accessed 25 Jan. 2017].
Koo, B. and Fischer, M. (2000) Feasibility study of 4D CAD in commercial construction, Journal of Construction Engineering and Management, 126(4), pp. 251260.
Lieyun, D. , Zhou, Y. , and Akinci, Y. (2014) Building Information Modeling (BIM) application framework: the process of expanding from 3D to computable nD, Automation in Construction, 46, pp. 8293.
Mallia-Parfitt, M. and Whyte, J. (2014) Developing a mobile visualization environment for construction applications. Available at: http://centaur.reading.ac.uk/37543/ (Accessed: 18 December 2015).
McKinney, K. , Kim, J. , Fischer, M. , and Howard, C. (1996) Interactive 4D-CAD, in (ed.) Proceedings of the Third Congress on Computing in Civil Engineering. ASCE: Anaheim, CA, pp. 383389.
Pauwels, P. , De Meyer, R. , and Van Campenhout, J. (2011) Linking a game engine environment to architectural information on the semantic web, Journal of Civil Engineering and Architecture, 5(9), pp. 787798.

448 Pierrakakis, K. , Kandias, M. , Gritzali, C. , and Gritzalis, D. (2014) 3D Printing and its regulation dynamics: the world in front of a paradigm shift, in (ed.) Proceedings of the 6th International Conference on Information Law and Ethics. Available at: http://www.cis.aueb.gr/Publications/ICIL-2014%203D%20Printing.pdf. Accessed on 1 June 2015 .
Qian, Z. , Agnew, B. , and Thompson, E.M. , (2014) Simulation of Air flow, Smoke Dispersion and Evacuation of the Monument Metro Station based on Subway Climatology, In: Thompson E.M. (ed.) FusionProceedings of the 32nd eCAADe ConferenceVolume 1. Newcastle upon Tyne: Northumbria University, pp. 119128.
Roebuck, K. (2011). 3D Printing: High-impact Emerging Technology-What You Need to Know Definitions, Adoptions, Impact, Benefits, Maturity, Vendors. Dayboro, QLD: Tebbo.
Smith, R. (2007) Game impact theory: five forces that are driving the adoption of game technologies within multiple established industries, Games and Society Yearbook, Available at: http://www.modelbenders.com/papers/Smith_Game_Impact_Theory.pdf (Accessed: 1 June 2015).
Sun, M. and Howard, R. (2004) Understanding IT in Construction, Abington OXON: Routledge.
Taylor, A. and Unver, E. (2014) 3D Printing-Media Hype or Manufacturing Reality: Textiles Surface Fashion Product Architecture, Textiles Society Lecture, 17th February 2014, Huddersfield, UK: Textile Centre of Excellence, Available at: http://eprints.hud.ac.uk/19714/ (Accessed: 1 June 2015).
Thompson, E.M. (2008) Is today architecture about real space, virtual space or what?, The Northumbria Working Paper Series: Interdisciplinary Studies in the Built and Virtual Environment, 1(2), pp. 171178. Available at: https://www.northumbria.ac.uk/static/5007/bepdf/vol1no2june08.pdf (Accessed: 1 June 2015).
Trenholme, D. and Smith, S. (2008) Computer game engines for developing first-person virtual environments, Virtual Reality, 12(3), pp. 181187. Available at: http://dro.dur.ac.uk/5274/1/5274.pdf?DDD4+dcs0sps. (Accessed: 1 June 2015).
Turk, Z. (2006) Construction informatics: definition and ontology, Advanced Engineering Informatic, 20(2), pp. 187199. Available at: http://www.sciencedirect.com/science/article/pii/S1474034605000911 (Accessed: 1 June 2015).
Unity . (2014) The Future of Visualisation in Architecture, Available at: http://try.unity3d.com/report/?utm_source=CE&utm_medium=link%20click&utm_campaign=try%20unity%20DR: Unity and CGarchitect. Accessed on 1 June 2015 .
Volk, R. , Stengel, J. , and Schultmann, F. (2014) Building Information Modeling (BIM) for existing buildingsLiterature review and future needs, Automation in Construction, 38(2), pp. 109127. Available at: http://www.sciencedirect.com/science/article/pii/S092658051300191X (Accessed: 1 June 2015).
Wang, J. , Wang, X. , Shou, W. , and Xu, B. (2014a) Integrating BIM and augmented reality for interactive architectural visualisation, Construction Innovation, 14(4), pp. 453476.
Wang, X. , Kim, M.J. , Love, P.E. , and Kang, S. (2013a) Augmented Reality in built environment: classification and implications for future research, Automation in Construction, 34(2), pp. 3744. Available at: http://www.sciencedirect.com/science/article/pii/S0926580512002166 (Accessed: 1 June 2015).
Wang, X. , Love, P.E. , Kim, M.J. , Park, C.S. , Sing, C.P. , and Hou, L. (2013b) A conceptual framework for integrating building information modeling with augmented reality, Automation in Construction, 34, 3744.
449 Wang, X. , Truijens, M. , Hou, L. , Wang, Y. , and Zhou, Y. (2014b) Integrating augmented reality with building information modeling: onsite construction process controlling for liquefied natural gas industry, Automation in Construction, 40, pp. 96105. Available at: http://www.sciencedirect.com/science/article/pii/S092658051300215X (Accessed: 1 June 2015).
WHO (World Health Organization). (2010) Hidden Cities: Unmasking and Overcoming Health Inequities in Urban Settings. Centre for Health Development, & United Nations Human Settlements Programme, ISBN 978 92 4 154803 8. Available at: http://www.who.int/kobe_centre/publications/hiddencities_media/who_un_habitat_hidden_cities_web.pdf (Accessed: 1 June 2015).
Whyte, J. (2002) Virtual Reality and the Built Environment, Abington OXON: Routledge.
Wong, J. , Wang, X. , Li, H. , Chan, G. , and Li, H. (2014) A review of cloud-based BIM technology in the construction sector, Journal of Information Technology in Construction (ITcon), 19, pp. 281291. Available at: http://www.itcon.org/2014/16 (Accessed: 1 June 2015).
Wyre, I. (2015) A methodology for spatial archaeology: visualising the legacy of Medieval Newcastle Upon Tyne using digital and virtual toolsets. PhD thesis, Northumbria University.
Xiong, X. , Adan, A. , Akinci, B. , and Huber, D. (2013) Automatic creation of semantically rich 3D building models from laser scanner data, Automation in Construction, 31, pp. 325337. Available at: http://www.sciencedirect.com/science/article/pii/S0926580512001732 (Accessed: 1

June 2015).
Zhu, Z. and Donia, S. (2013) Spatial and visual data fusion for capturing, retrieval, and modeling of as-built building geometry and features, Visualization in Engineering, 1(1), pp. 110. Available at: http://rd.springer.com/article/10.1186/2213-7459-1-10. (Accessed: 1 June 2015).
Zlatanova, S. (2008) Working Group IIAcquisitionPosition Paper: data collection and 3D reconstruction, in (ed.) Advances in 3D Geoinformation Systems. Berlin and Heidelberg: Springer, pp. 425428.
3ders (2015). WinSun China Builds Worlds First 3D Printed Villa and Tallest 3D Printed Apartment Building, Available at: http://www.3ders.org/articles/20150118-winsun-builds-world-first-3d-printed-villa-and-tallest-3d-printed-building-in-china.html (Accessed: 1 June 2015).
3DPrint (2015). Andrey Rudenko Plans to 3D Print a 2-Story Zero Energy House in 5 Days with Advanced 3D Printer, Available at: http://3dprint.com/40154/3d-printed-house-rudenko/ (Accessed: 1 June 2015).
3DprintCH (2015). 3D Print Canal House, Available at: http://3dprintcanalhouse.com/smart-building (Accessed: 1 June 2015).
Contour Crafting (2014). Contour Crafting, Available at: http://www.contourcrafting.org/ (Accessed: 1 June 2015).
UN-Habitat . Climate Change, Available at: http://unhabitat.org/urban-themes/climate-change/ (Accessed: 1 June 2015).

The multi-agent paradigm in construction e-business and its use in the next generation of data-driven decision-making tools

Billhardt, H. , Julin, V. , Corchado, J.M. and Fernndez, A. (2014). An architecture proposal for human-agent societies. Highlights of Practical Applications of Heterogeneous Multi-Agent Systems. The PAAMS Collection: PAAMS 2014 International Workshops, Salamanca, Spain, June 46, 2014. Springer International Publishing, pp. 344357.
Booch, G. (1994). Object-Oriented Analysis and Design. 2nd edition. Addison-Wesley, Reading, MA.
Bussmann, S. (1998). Agent-oriented programming of manufacturing control tasks. In Proceedings of Third International Conference on Multi-Agent Systems (ICMAS98), IEEE Computer Society, Washington, DC, pp. 5763.
Case, D.M. (2014). Engineering multi-group agents for complex cooperative systems. In Proceedings of the 2014 International Conference on Autonomous Agents and Multi-Agent Systems, International Foundation for Autonomous Agents and Multiagent Systems, Paris, pp. 17071708.
460 Coutinho, L.R. Jaime, S. , Sichmam J.S. and Boissier, O. (2005), Modeling organisation in MAS: a comparison of models, First Workshop on Software Engineering for Agent-oriented Systems, SEAS. Brazilian Computer Society, Uberlncia, Brazil.
DeLoach, S.A. and Garcia-Ojeda, J.C. (2014). The O-MaSE methodology. In Handbook on Agent-Oriented Design Processes. Springer, Berlin and Heidelberg, pp. 253285.
El Habib Souidim, M. Songhao, P. , Guo, L. and Chang, L. (2015). Multi-agent cooperation pursuit based on an extension of AALAADIN organisational model. Journal of Experimental & Theoretical Artificial Intelligence, 07 July 2015 .
http://dx.doi.org/10.1080/0952813X.2015.1056241. Accessed 30 January 2016 .
Ferber, J. (1999). Multi-Agent Systems, An introduction to Distributed Artificial Intelligence, Addison-Wesley, An imprint of Pearson Education, Harlow, UK.
Ferber, J. and Gutknecht, O. (1998). Aalaadin: A meta-model for the analysis and design of organisations in multiagent systems. In Third International Conference on Multi-Agent Systems, IEEE, Paris, pp. 128135.
Ferber, J. , Gutknecht, O. and Michele, F. (2004). From agents to organisations: An organisational view of multi-agent systems. In Giorgini, P. , Muller, J. and Odell, J. , (eds), Agent-Oriented Software Engineering (AOSE) IV, LNCS 2935, July 2003, Melbourne, VIC, pp. 214230.
Girodon, J. , Monticolo, D. , Bonjour. E. and Perrier, M. (2015). An organisational approach to designing an intelligent knowledge-based system: Application to the decision-making process in design, projects. Advanced Engineering Informatics, 29(3), pp. 696713.
Jenning, N.R. (2000). On agent-based software engineering. Artificial Intelligence, 117(2), pp. 277296.
Jennings, N.R. and Wooldridge, M. (2000). Agent-oriented software engineering. In Bradshaw, J. (ed.), Handbook of Agent Technology, AAAI/MIT Press, Cambridge, MA.

Larson, E. (2016). A checklist for making faster, better decisions. Harvard Business Review, 7 March, 2016.
Lesser, V. (1999). Cooperative multi-agent systems: A personal view of the state of the art. IEEE Transactions on Knowledge and Data Engineering, 11(1), 133142.
Mahani, M.N. and Agah, A. (2014). Strategic reorganisation in multi-agent systems: Inspired by intelligent human organisations. International Journal of Cooperative Information Systems, 23(4), 1450009.
McElheran, K. and Brynjolfsson, E. (2016). The rise of data-driven decision making is real but uneven. Harvard Business Review, 3 February, 2016.
Obonyo, E.A. (2004). APRON: Agent-based specification and procurement of construction products. Doctoral thesis, Department of Civil and Building Engineering, Loughborough University.
Obonyo, E.A. , Anumba, C.J. and Thorpe, A. (2004). Specification and procurement of construction products, a case for an agent-based system, International Journal of IT in Architecture, Engineering and Construction, 2(3), 204215.
Obonyo, E.A. , Anumba, C.J. and Thorpe, A. (2005a). APRON: An agent-based specification and procurement system for construction products, Engineering, Construction and Architectural Management, 12(4), 329350.
461 Obonyo, E.A. , Anumba, C.J. and Thorpe, A. (2005b). Specification and procurement of construction products using agents, In Anumba, C.J. , Ugwu, O.O. and Ren. Z. (eds), Agents and Multi-Agent Systems in Construction. Taylor & Francis Group, London and New York.
Rahmanzadeh, A. and Nazemi, E. (2015). Fhorganization: New organization model for multi-agent systems, International Journal of Computer Networks and Communications Security, 3(8), 337342.
Rodrgueza, S. , De Paza, J.F. , Villarrubiaa, G. , Zatoa, C. , Bajob, J. and Corchadoa, J.M. (2015). Multi-agent information fusion system to manage data from a WSN in a residential home, Information Fusion, 23, 4357.
Verburg, P.H. , Dearing, J.A. , Dyke, J.G. , Leeuw, S. , Seitzinger, S. , Steffen, W. Syvitski, J. (2016). Methods and approaches to modelling the Anthropocene. Global Environmental Change, Volume 39, July 2016, pp. 328340, ISSN 0959-3780, http://dx.doi.org/10.1016/j.gloenvcha.2015.08.007. Accessed 6 June 2016 . (http://www.sciencedirect.com/science/article/pii/S0959378015300285).
Vermeulen, B. and Pyka, A. (2015). Agent-based modeling for decision making in economics under uncertainty. Economics Discussion Papers, No 2015-45, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2015-45.
Woldesenbet, A.K. (2014). Highway infrastructure data and information integration and assessment framework: A data-driven decision-making approach. Graduate theses and dissertations. Paper 14017.
Zambonelli, F. , Jennings, N.R. and Wooldridge, M.J. (2000). Organisational abstractions for the analysis and design of multi-agent systems. Workshop on Agent-oriented Software Engineering ICSE 2000. Limerick, Ireland, June, 2000.

Conclusions Summary, the status quo and future trends

Davenport, T.H. (2009). Make Better Decisions, Harvard Business Review, Harvard Business School Press.
Egan, J. (1998). Rethinking construction: The report of the construction task force. London: Department of the Environment, Transport and the Regions.
Latham, M. (1994). Constructing the team: Joint review of procurement and contractual arrangements in the United Kingdom construction industry. London: HMSO.